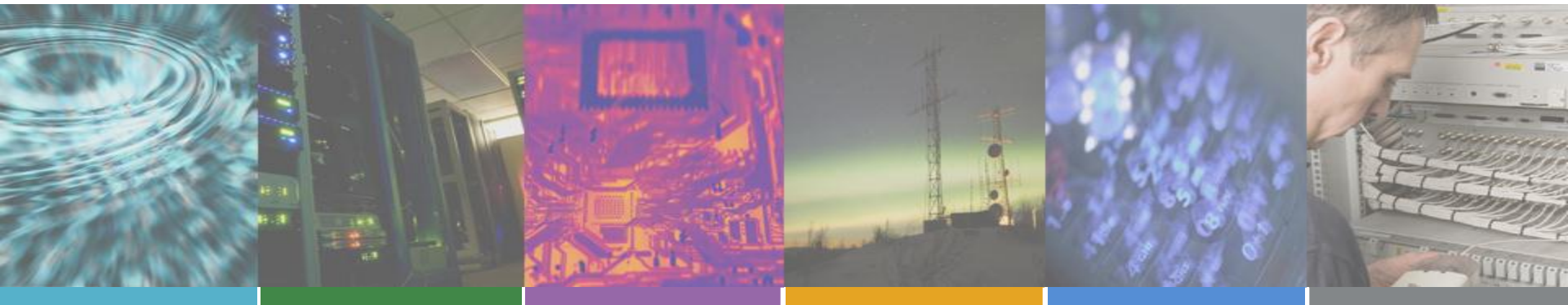


GPS Interference & Space Weather Real or Imagined Vulnerability?



Prof. Charles Curry B.Eng, FIET

Managing Director
Chronos Technology Ltd

7th Nov 2012

ITSF – Nice, France

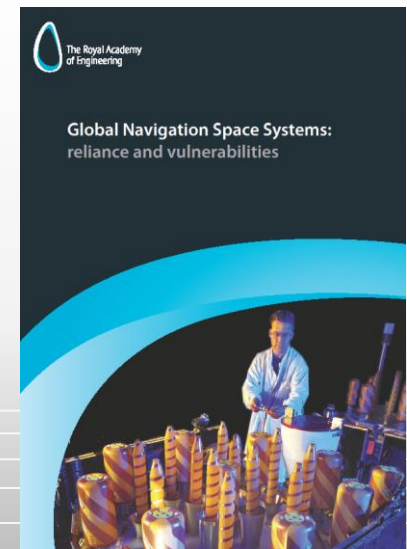
Presentation Contents

- Background
- GNSS Jamming & Space Weather
- SENTINEL Jamming Detections
- Conclusions

Background

- GPS Interference & Jamming
 - Royal Academy of Engineering Report
 - Published 2011
 - http://www.raeng.org.uk/news/publications/list/reports/RAoE_Global_Navigation_Systems_Report.pdf

- Space Weather
 - Royal Academy of Engineering Report
 - To be published 2013



Interesting Headlines!

NewScientist

Feb 2012

GPS jamming: a clear and present reality

“A secret network of 20 roadside listening stations across the UK has confirmed that criminals are attempting to jam GPS signals on a regular basis....”

 **May 2012**

GPS Vulnerable To Hacks, Jamming

“This week, the South Korean government reported that electronic jamming signals from North Korea were affecting communications and GPS signals for passenger aircraft.....”

GNSS Interference or Jamming

■ Interference

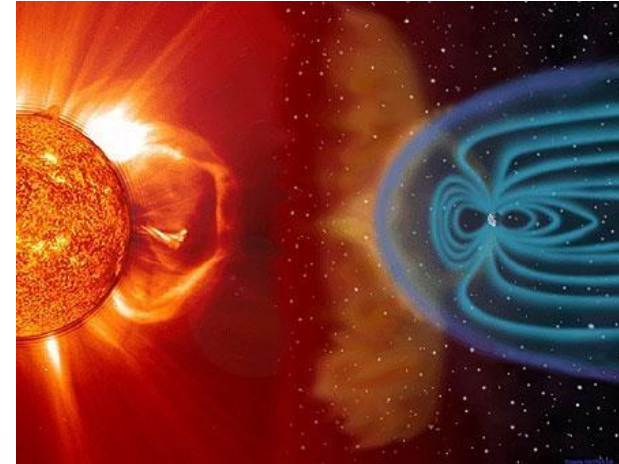
- Unintentional Jamming, e.g RFI at L1
 - Mostly at L1
- Serious Multipath
- Space Weather

■ Jamming

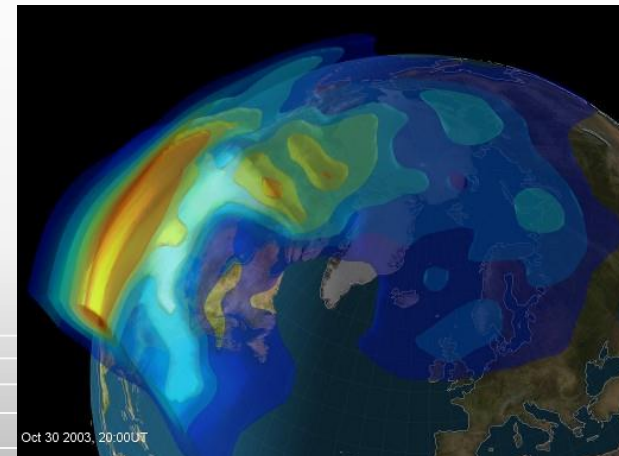
- Deliberate compromising of the GPS signal
- Spoofing
- Meaconing

Space Weather (SWx)

- 11 Year Solar Cycles
- Aurora Borealis
- “Carrington” Event 1859
- Solar Flares (8 Minutes)
- Coronal Mass Ejection
 - CME
 - Up to 2 days

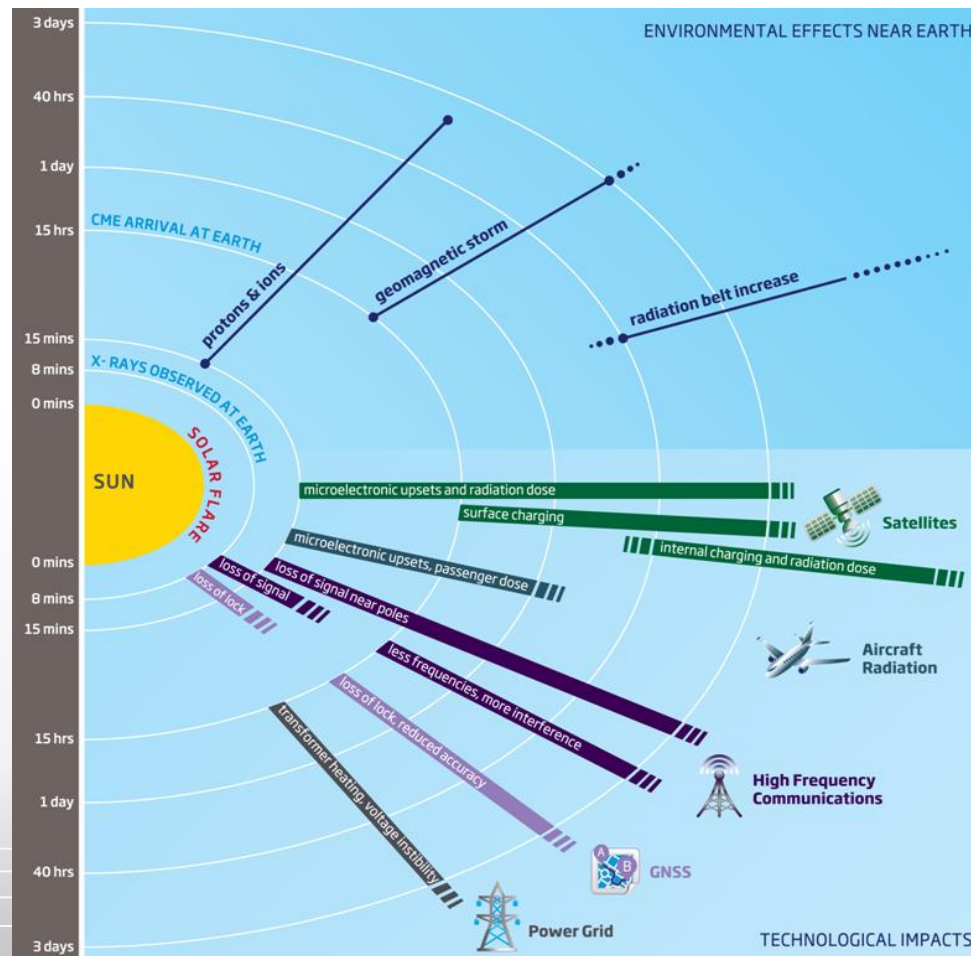


Nasa



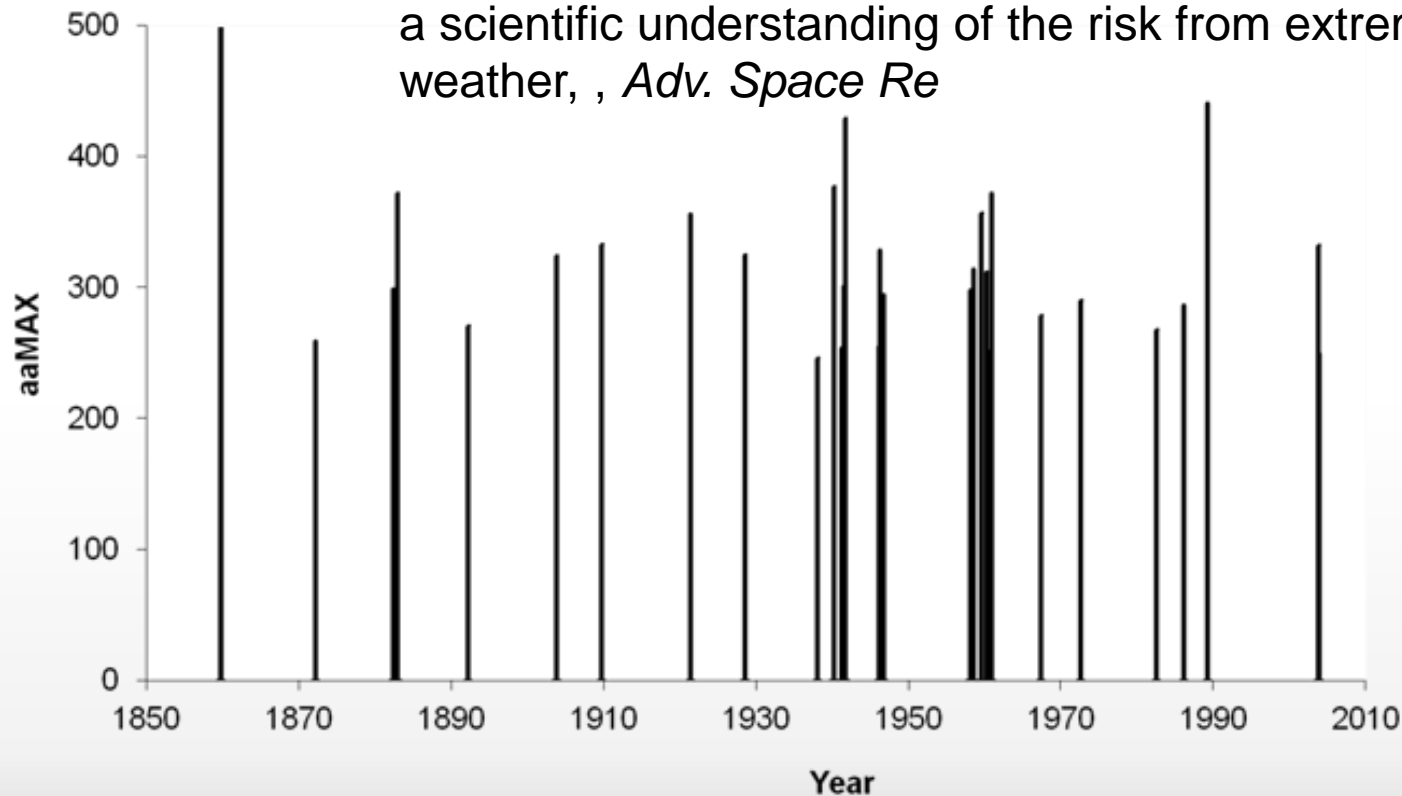
Univ of Bath

SWx Impact on Technology



Significant SWx Events

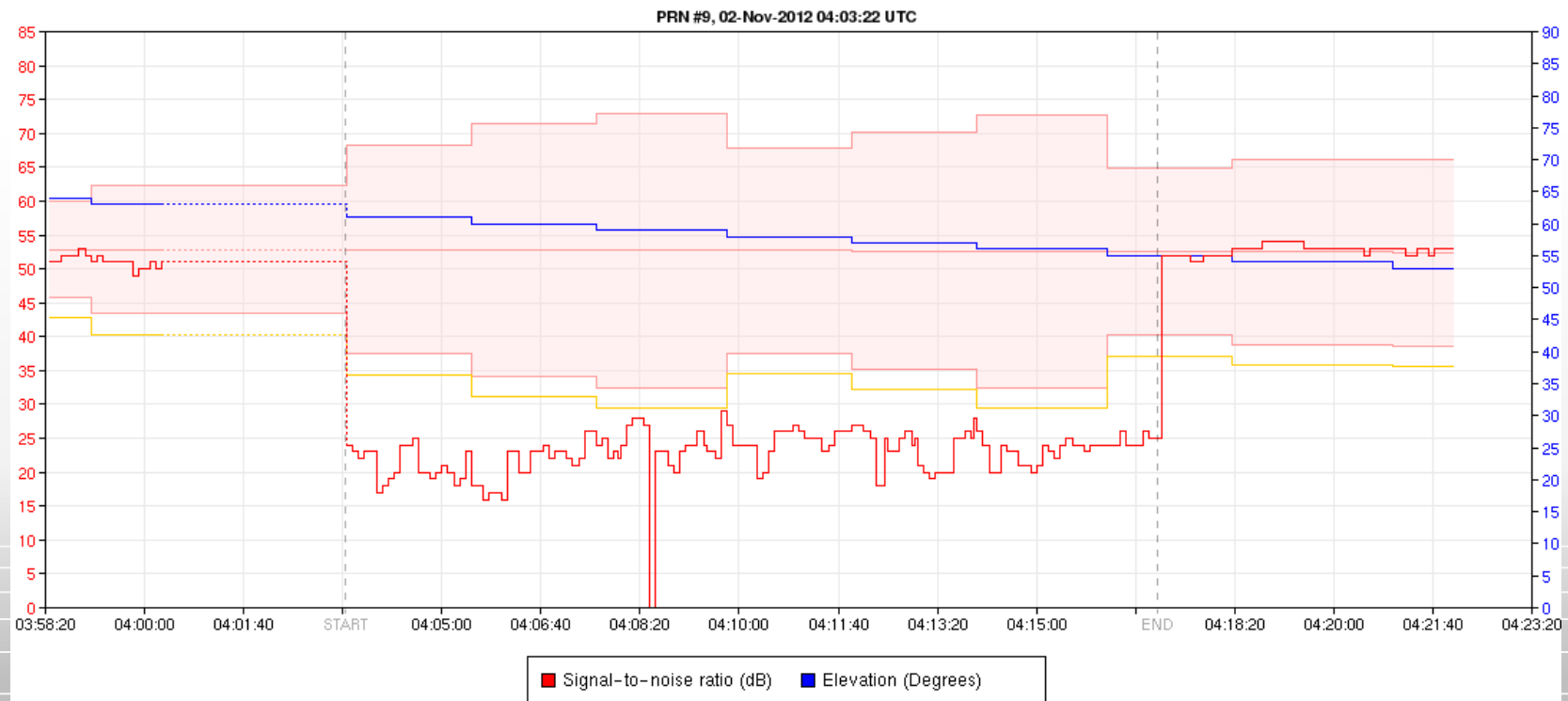
Draft RAEng SWx Report. Hapgood, M. A. (2011), Towards a scientific understanding of the risk from extreme space weather, , *Adv. Space Re*



Expert view on 2003 event – we were lucky due to location on sun, rotation away and Earth's relative geometry to emerging flare and CME

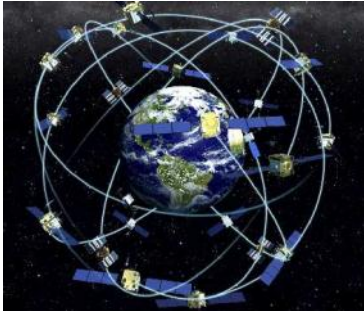
Example of RFI

- Top of 15 Storey Building in London
- 17 Minute Loss of GPS!



Who does Jamming?

- Evasion of Company Vehicle Tracking Systems
- Evasion of Road User Charging Schemes
- Fooling the Tachograph
- Stealing High Value Assets, Cars, Vans, Loads
- Evasion of Covert Tracking
- Securing Off-Site Meetings
- ***Spans Civil, Criminal & Terrorist activity***



- GNSS **SE**rvices **N**eeding **T**rust **I**n **N**avigation, **E**lectronics, **L**ocation & timing
- 2011: UK Government Funded R&D Project, 2 years, ~£1.5m
 - through **Technology Strategy Board**
 - ***“Trusted Services”*** Call
- Research to establish extent to which GNSS and eLoran PNT signals can be trusted





The SENTINEL Partners



- ACPO-ITS – Association of Chief Police Officers
 - User Community – Law Enforcement
 - Brings other Government agencies into the collaboration



- GLA – General Lighthouse Authorities
 - User Community - Maritime
 - eLoran



- University of Bath - Dept. of Electrical & Electronics
 - GPS & Space Weather



- Ordnance Survey
 - User Community – Land Geolocation
- NPL – National Physical Laboratory
 - Time, UTC Traceability



- Thatcham Vehicle Security
 - Certification of safety critical services



- Chronos Technology Ltd
 - GAARDIAN Research
 - SENTINEL Project Leader

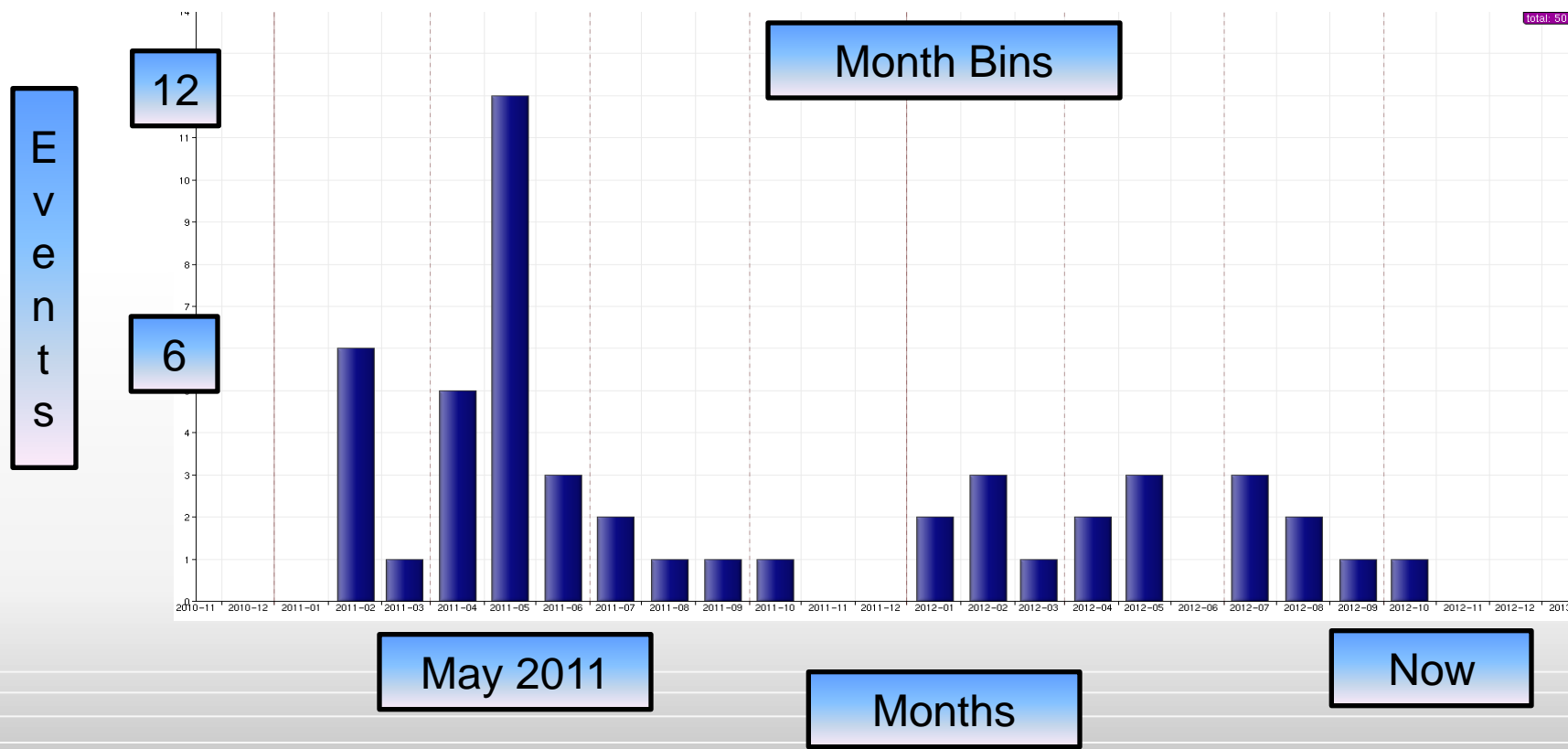


SENTINEL Research...

- Can we detect?
- Can we prove it's a jammer?
- Can we locate, identify, seize?
- Can we determine extent of problem?

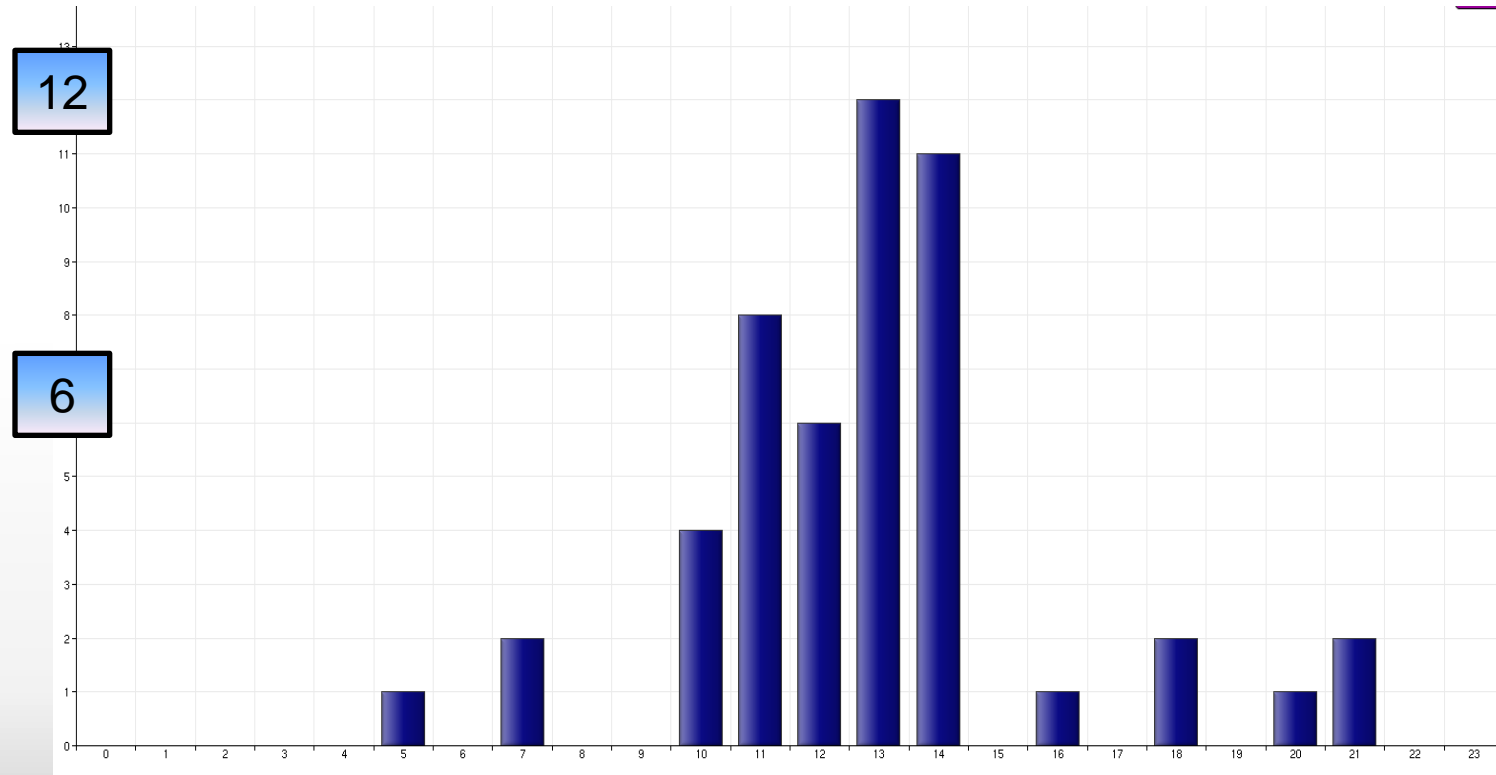
- Let's examine some SENTINEL data...
 - Create Actionable Intelligence

Location “A” – Small Town



Can we detect a pattern?

“A” - Hour Bins Through Day



12

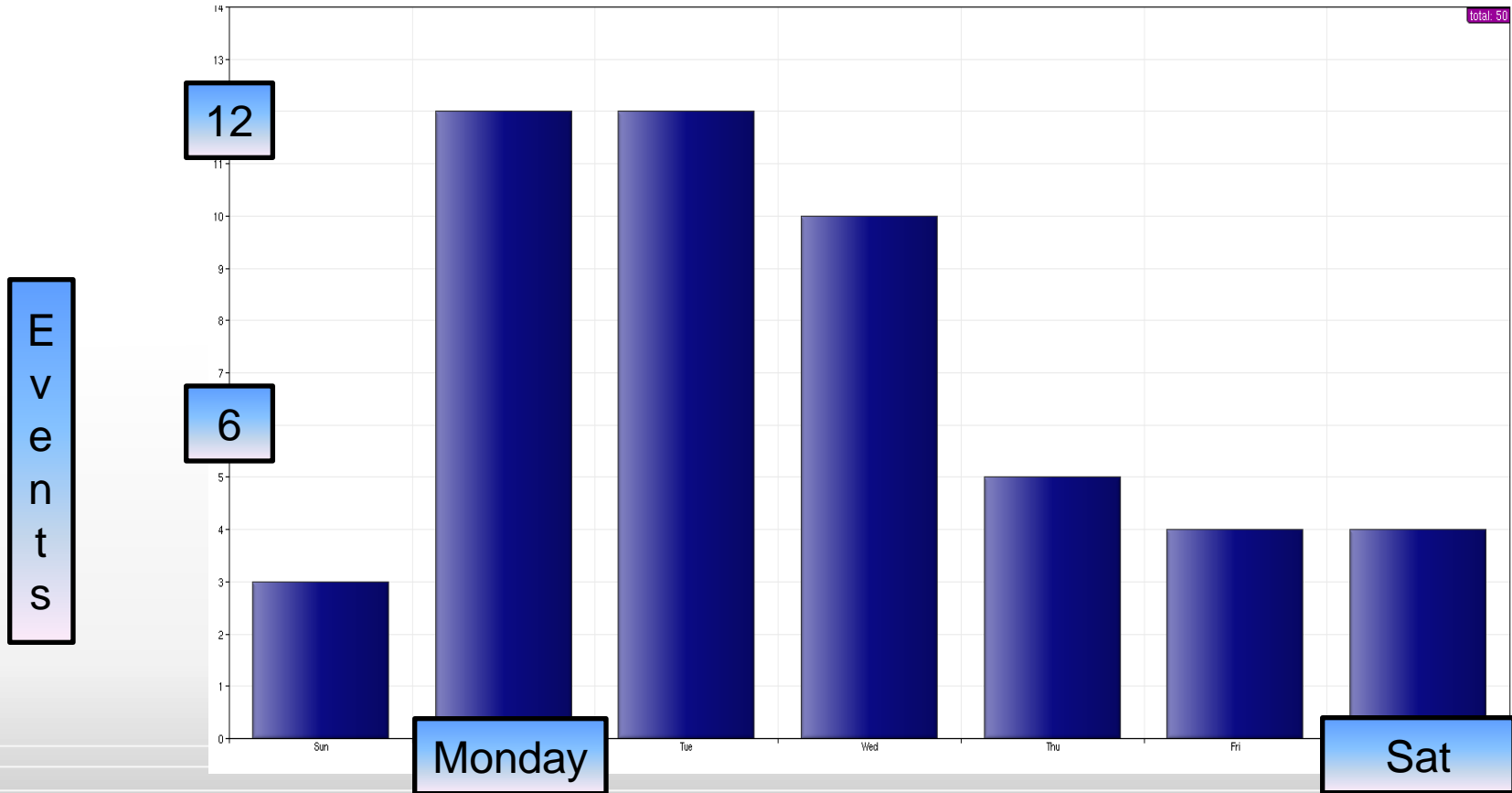
6

E
v
e
n
t
s

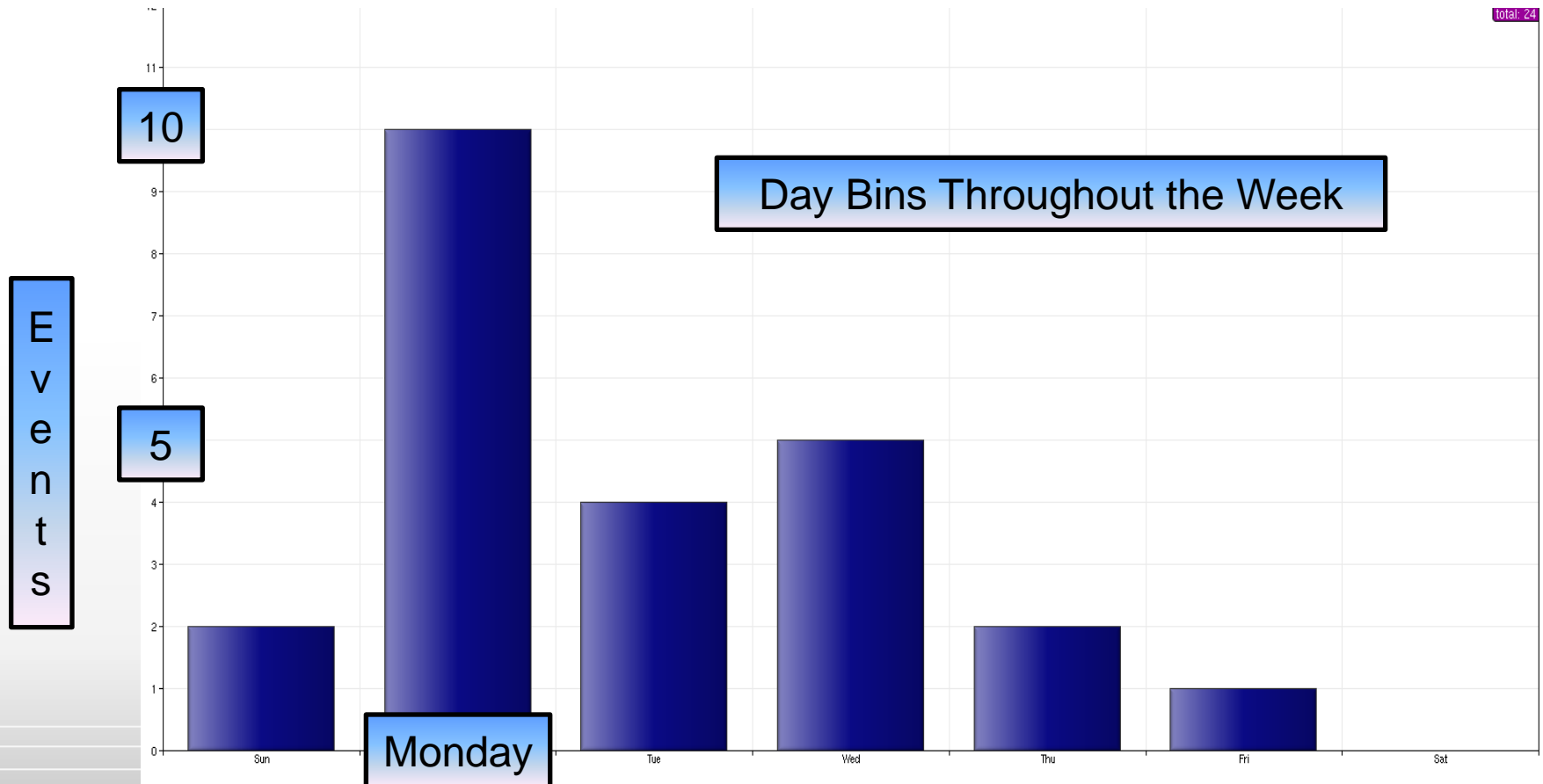
Midnight

12:00

“A” - Day Bins During Week



“A”- 11am-2pm – End June 2011



Sit and Wait!

**Hand Held
GPS Jammer
Detector**



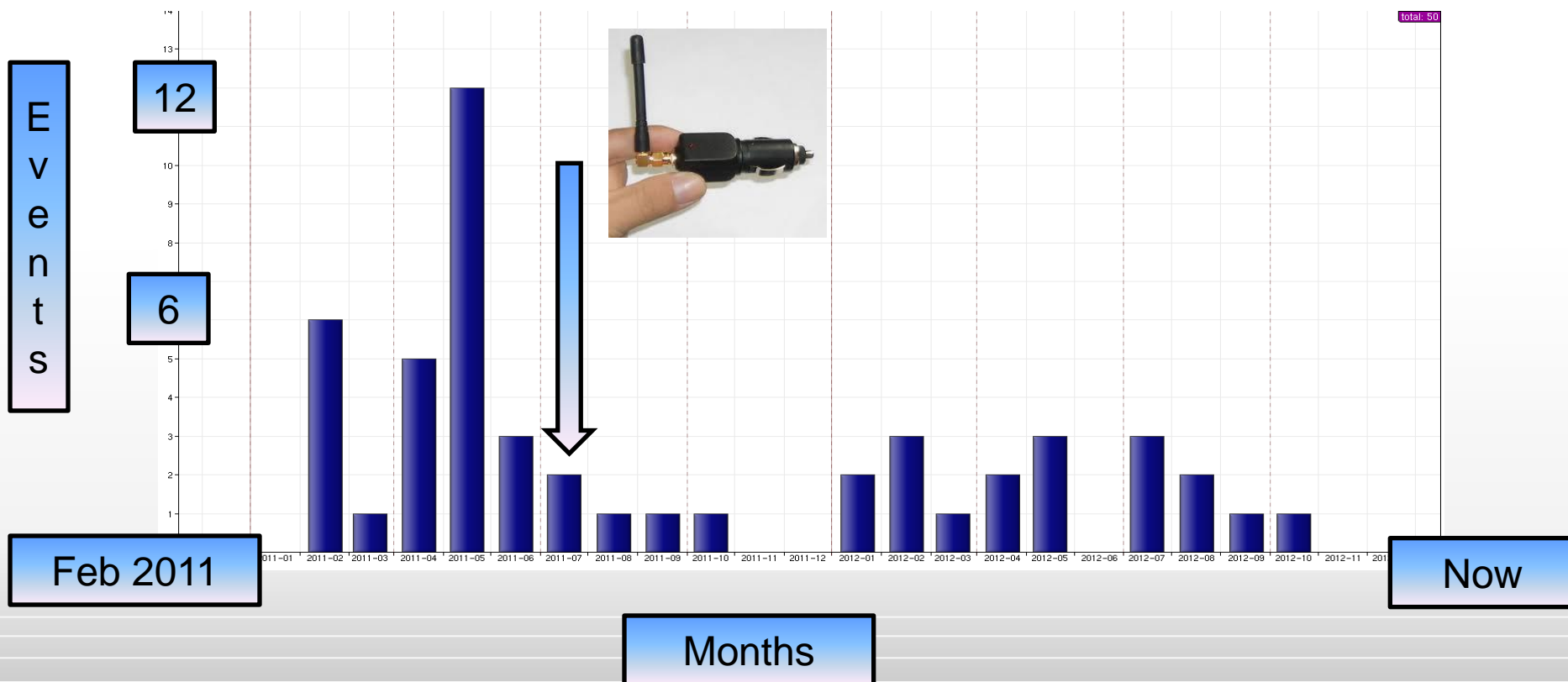
**Along comes
“White Van
man” at 2:15**

**Investigations
lead to police
seizing a device!**

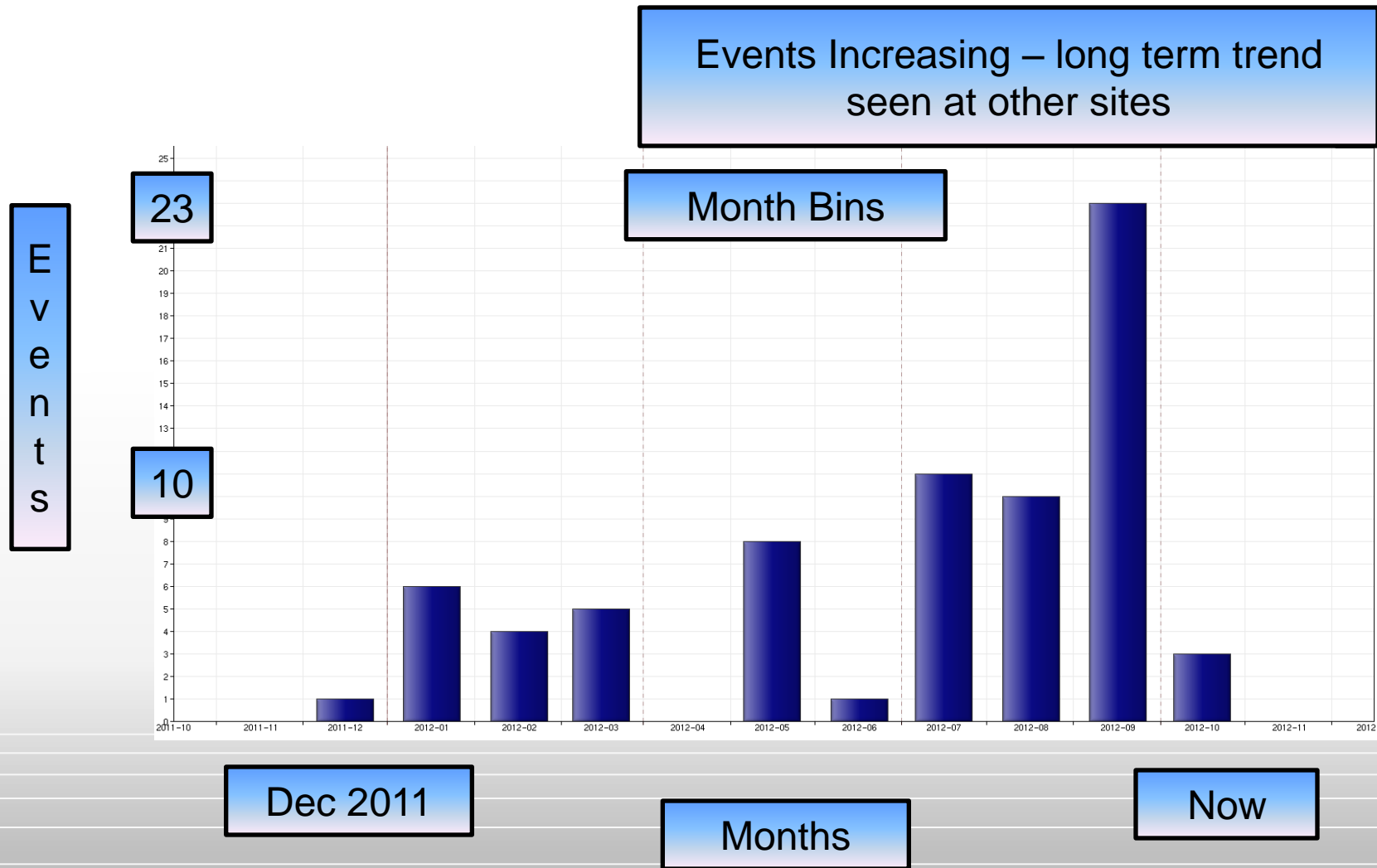


“A” - 12 Months of Data

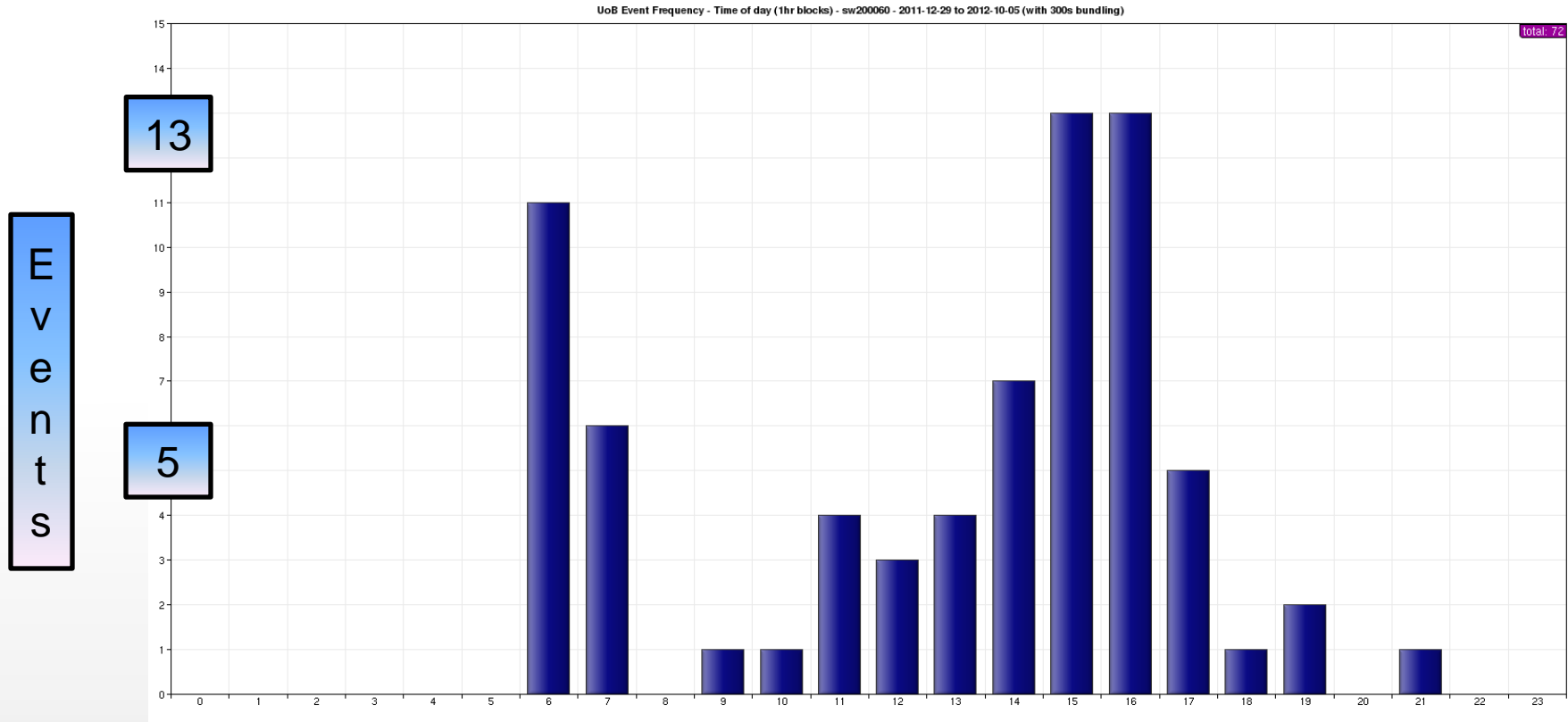
When was the device confiscated?



“B” City & Docks 2 Lane Motorway



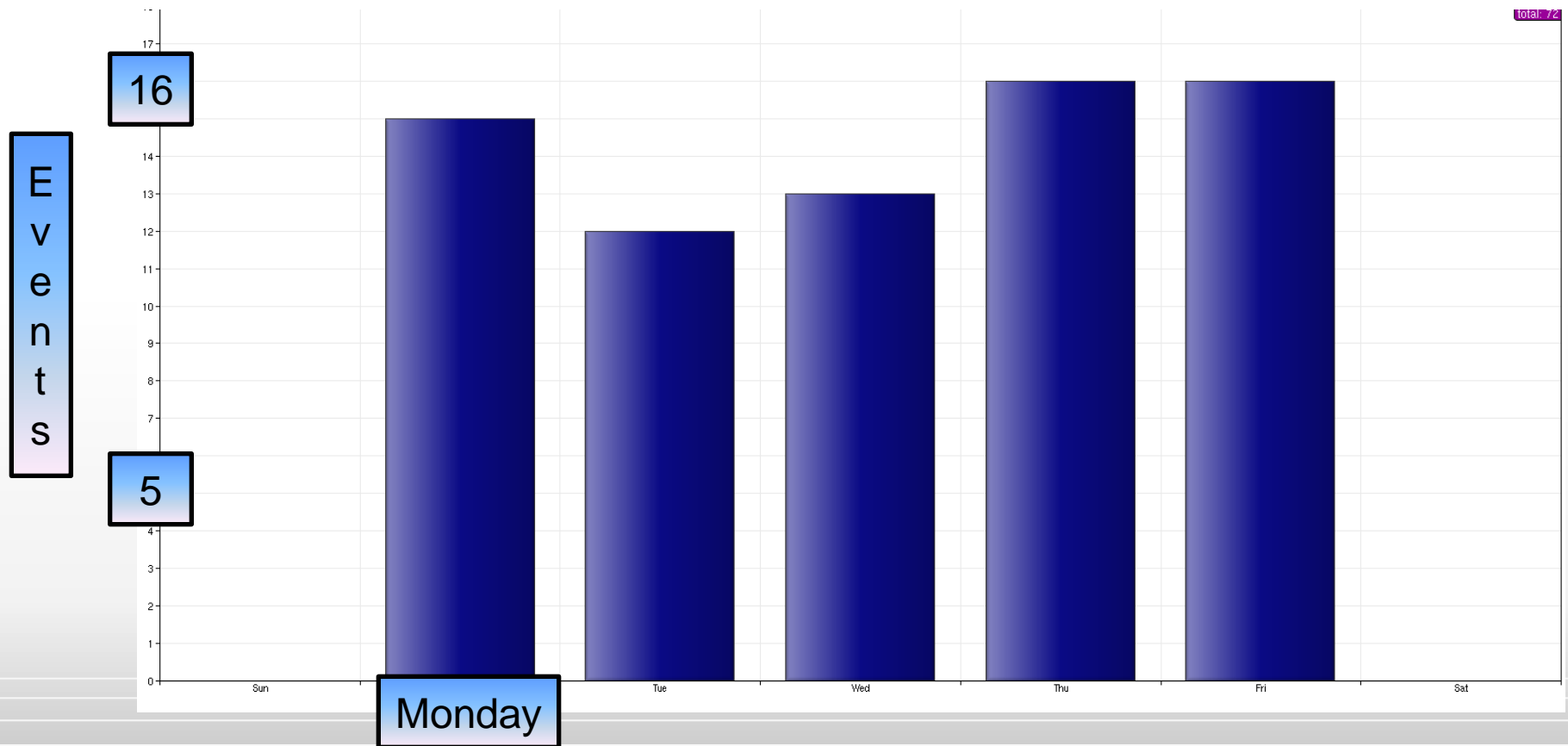
“B” – Hour Bins Through Day



Midnight

15:00

“B” – Day Bins Through Week



2012 New & Pending Deployments

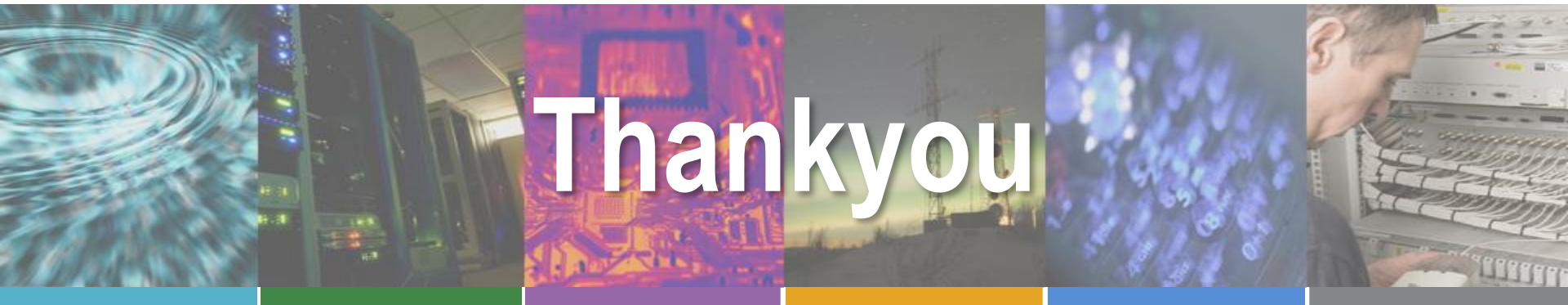
- Roads – Co-Located with ANPR
- Tactical ANPR Vans
- Airport Runway
 - Co-located at ILS cabin near motorway
- Electricity Grid Sub-Station Installations
- UK Port Entry Locations with Europe
- Tunnel Entrance under Thames
- London Financial District
- More arterial roads



Conclusions

- SENTINEL project has proved that deliberate jamming exists and events are increasing
- This is a real Vulnerability!
- Space Weather?
 - For ToD and Phase/Time Use Rb (3 days holdover)
 - If “Carrington” Event Bull's-eye - Goodbye!
- Appropriate mitigation activity must be adopted
 - For mission/safety critical applications
- Appropriate receiver technology must be used
 - For full service resilience

Questions?



www.chronos.co.uk

www.gpsworld.biz

www.gaardian.co.uk

charles.curry@chronos.co.uk