



# GPS Jamming – Quantifying the Threat



WSTS – April 16-18<sup>th</sup>, 2013

San Jose

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Managing Director

Chronos Technology Ltd

# Presentation Contents

- Background
- What, Who and Why?
- Latest SENTINEL Jamming Detections
- Conclusions

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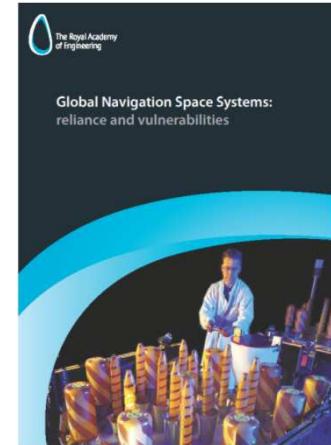
# Background

- 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](http://www.raeng.org.uk/news/publications/list/reports/RAoE_Global_Navigation_Systems_Report.pdf)

- Space Weather
  - Royal Academy of Engineering Report
  - Published 2013

[http://www.raeng.org.uk/news/publications/list/reports/space\\_weather\\_full\\_report\\_final.pdf](http://www.raeng.org.uk/news/publications/list/reports/space_weather_full_report_final.pdf)





# The SENTINEL Project



- GNSS **S**ervices **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



ASSOCIATION OF  
CHIEF POLICE OFFICERS



UNIVERSITY OF  
**BATH**



**Thatcham**



# SENTINEL Research...

- Can we detect?
- Can we prove it's a jammer?
- Can we locate, identify, seize?
- Can we determine extent of problem?
- Can we create actionable intelligence?
- Can we mitigate the threat once detected?

# 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....”*

 **DiscoveryNews** 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.....”*



# More Headlines!



**W TechWeek europe**  
Enhancing business with technology – in association with eweek.com

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22 February 2012 Last updated at 00:01

 **Illegal GPS Jammers Are Widespread, Study Finds**  
Research by the Government-backed Sentinel consortium shows dangerous GPS jammer use in the UK is on the rise

On February 23, 2012 by Max Smolaks 26

Illegal systems which jam GPS are widely used in the UK, according to a new study conducted in...

The Sentinel study, a £1.5m government project run by a consortium that includes the police and the National Physical Laboratory, found 60 violations in six months by monitoring just 20 roadside locations, according to a paper presented at the *GNSS Vulnerability 2012: Present Danger, Future Threats* conference held at the National Physical Laboratory yesterday.

**Sentinel project research reveals UK GPS jammer use**

By Chris Vallance  
BBC News

**The illegal use of Global Positioning System (GPS) jammers in the UK has been revealed in a groundbreaking study.**

GPS jammers are believed to be mostly used by people driving vehicles fitted with tracking devices in order to mask their whereabouts.

In one location the Sentinel study recorded more than 60 GPS jamming incidents in six months.

The research follows concern that jammers could interfere with critical systems which rely on GPS.



The project was the work of a consortium which included Acpo and the National Physical Laboratories

Related Stories

# Presentation Contents

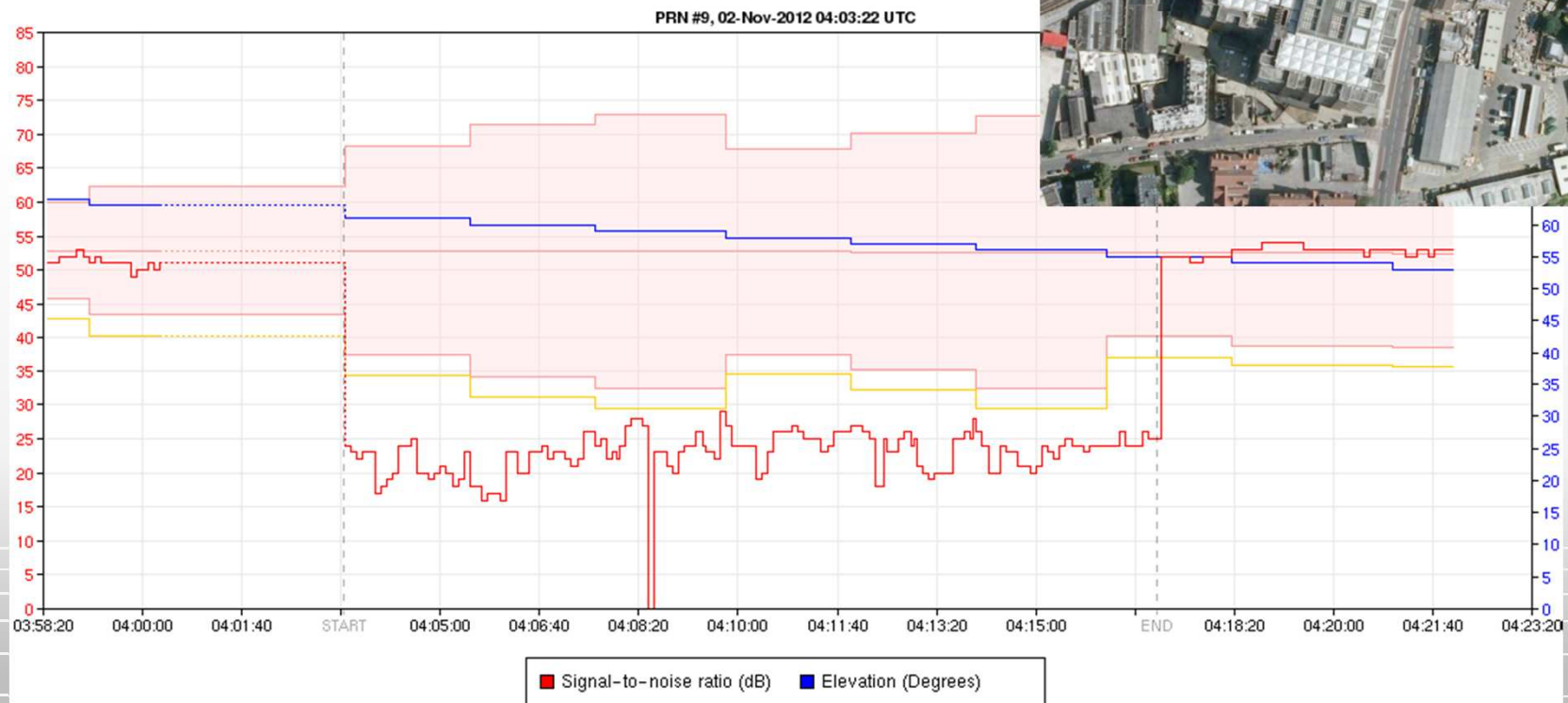
- Background
- **What, Who and Why?**
- Latest SENTINEL Jamming Detections
- Conclusions

# What, Who and Why?

- Interference to GNSS
  - Unintentional Jamming, e.g. RFI at L1
  - Serious Multipath
  - Space Weather
  - Poor Workmanship
- GNSS Jamming
  - Deliberate jamming
  - Unintentional consequence of jammer use
  - Spoofing & Meaconing

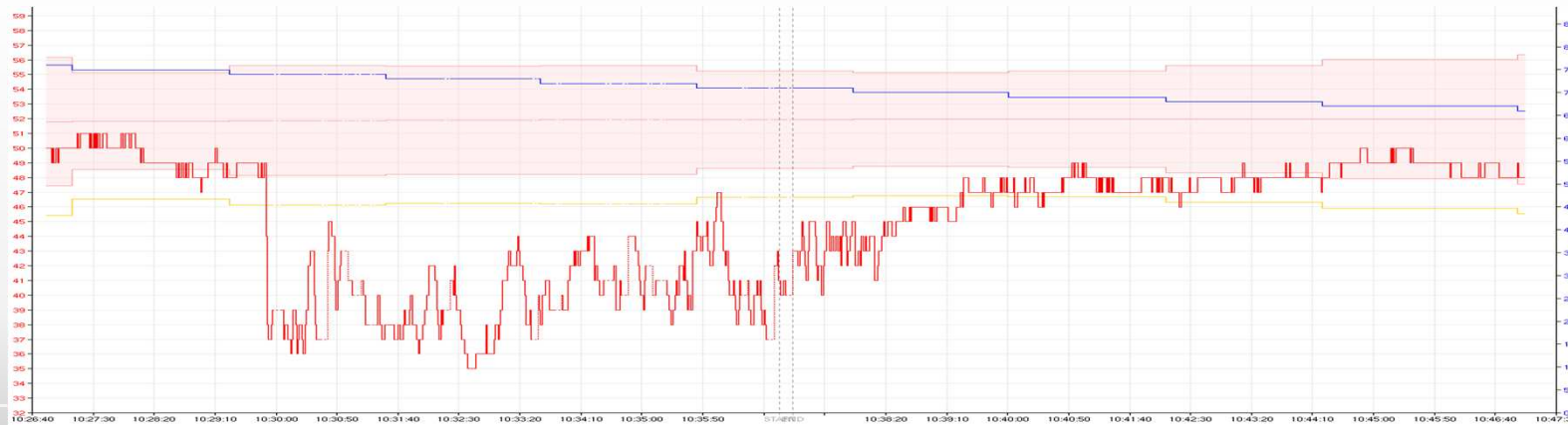
# Example of RFI

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



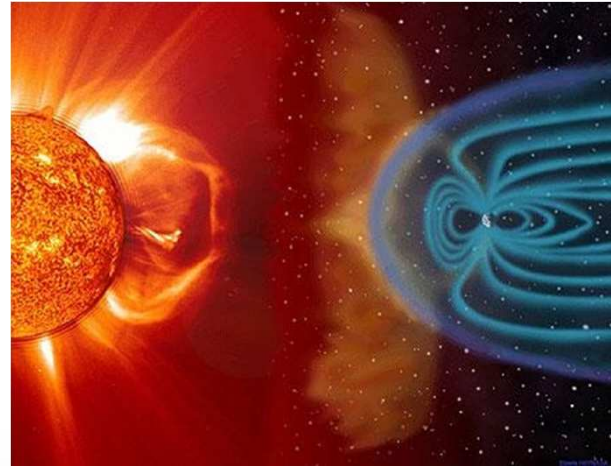
# Example of Serious Multipath

- Gantry over highway
- Adjacent to big reflectors
- 15 Minute compromise

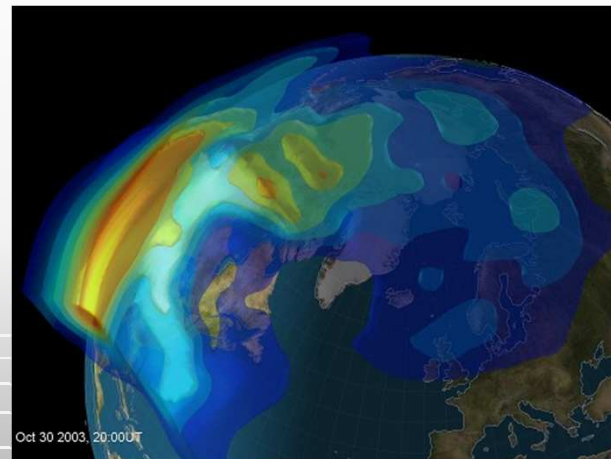


# Space Weather

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



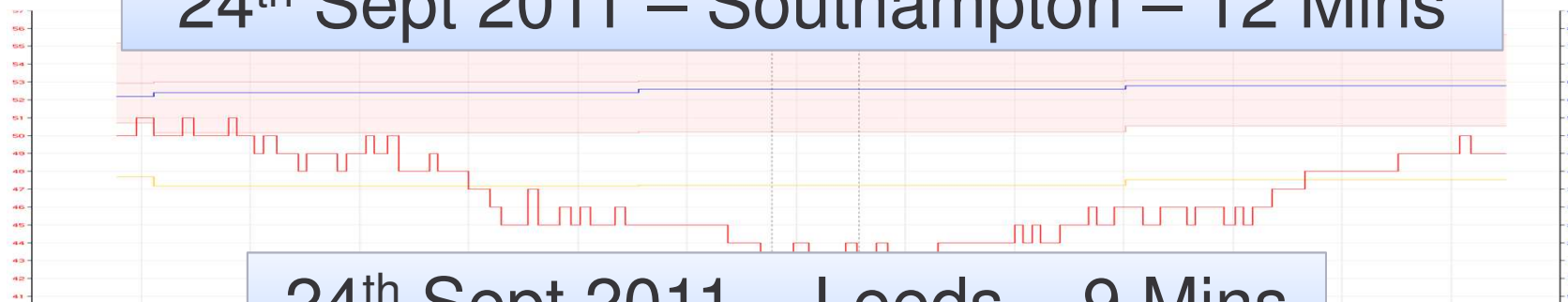
Nasa



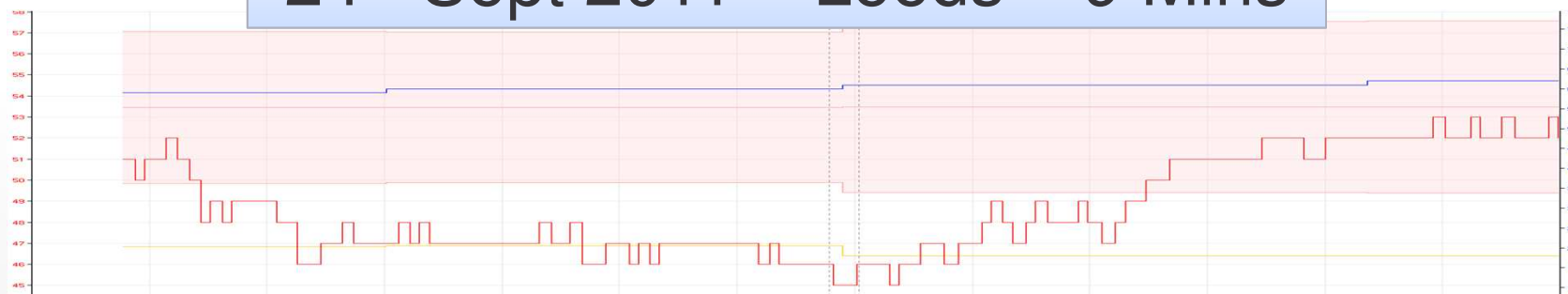
Univ of Bath

# Example of Space Weather

24<sup>th</sup> Sept 2011 – Southampton – 12 Mins



24<sup>th</sup> Sept 2011 – Leeds – 9 Mins



**Solar Activity and the Effect on Positioning Systems - The first Examples of Disturbances in Solar Cycle 24**

*European Navigation Conference*

*London, 29 Nov. – 1 Dec. 2011*

*Ole Ørpen - Fugro Seastar, Oslo, Norway*

24<sup>th</sup> Sept 2011 – Global Events



# Poor Workmanship



What you get if you ask an Electrician to install your GPS Antenna!



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# Who does Jamming?

- ***Civil, Criminal, Terrorist and State***
- Evasion of GPS tracked car insurance
- Evasion of Company Vehicle Tracking Systems
- Evasion of Road User Charging Schemes & tachographs
- Stealing High Value Assets, Cars, Vans, Loads
- Evasion of Covert Tracking
- Securing Off-Site Meetings
- Evasion of Criminal Tagging
- Intentional attack by foreign power or non-state

# GPS Tracked Car Insurance



- Pay as you drive insurance
- Young driver insurance
- Fleet insurance
- “Black box” insurance
- Telematics insurance



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# GPS Company Vehicle Tracking



**Approved Vehicle Tracking.co.uk**



# GPS Asset Tracking

## The Telegraph



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### Barbour jacket shortage after 1,000s stolen

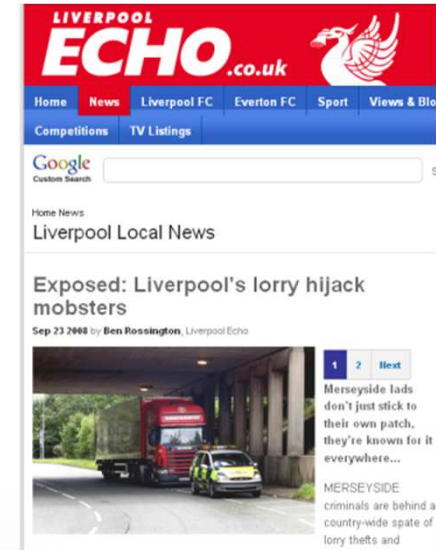
Barbour jackets, sported by everyone from the Queen to Peaches Geldof, could be in short supply in the coming weeks after thousands were stolen from a lorry.

### Asset & Plant GPS Tracking System



Blackbox Telematics clients tell us that they require ultimate protection of their equipment by providing them with accurate GPS real time location, efficient use and accurate servicing of their assets & plant machinery as this vital to the day to day success of their construction or plant hire businesses. [Find out more...](#)

Stop asset & plant theft, by insuring your tracking your equipment now



# Criminal Tagging



## The Telegraph

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### Tagged criminals may be tracked by GPS satellite 24 hours a day

Convicted criminals will be monitored 24 hours a day by satellite under moves being considered by ministers.



Convicted criminals will be monitored 24 hours a day by satellite Photo: NASA



### Criminal intelligence: GPS tracking for community sentences



You've been tagged: Electronic Tag



# GPS State Based Jamming



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Microsoft

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## TECHNOLOGY LAB / INFORMATION TECHNOLOGY

### North Korea pumps up the GPS jamming in week-long attack

Taking out its frustrations with its failed satellite launch?

by Sean Gallagher - May 9 2012, 11:53pm GMTDT

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2 May 2012 Last updated at 11:19

### 'North Korea jamming' hits South Korea flights

Jamming signals thought to be from North Korea have affected GPS navigation on at least 250 flights, South Korean officials say.

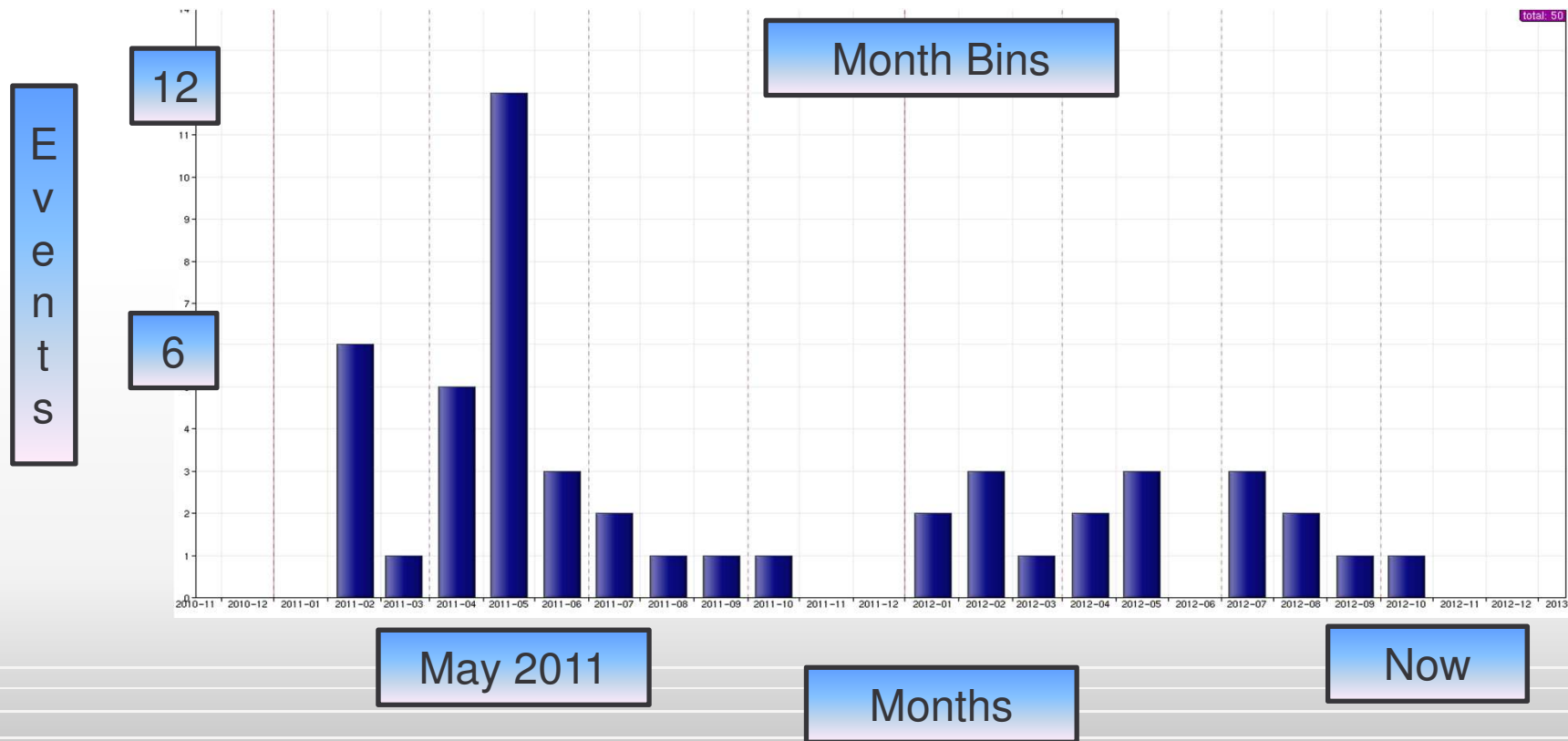
Nine South Korean and nine foreign airlines have been affected since Saturday, the Transport Ministry said.

The flights had to rely on alternative navigation systems but were in no danger, the ministry added.



South Korean officials said that the jamming affected at least 250 flights

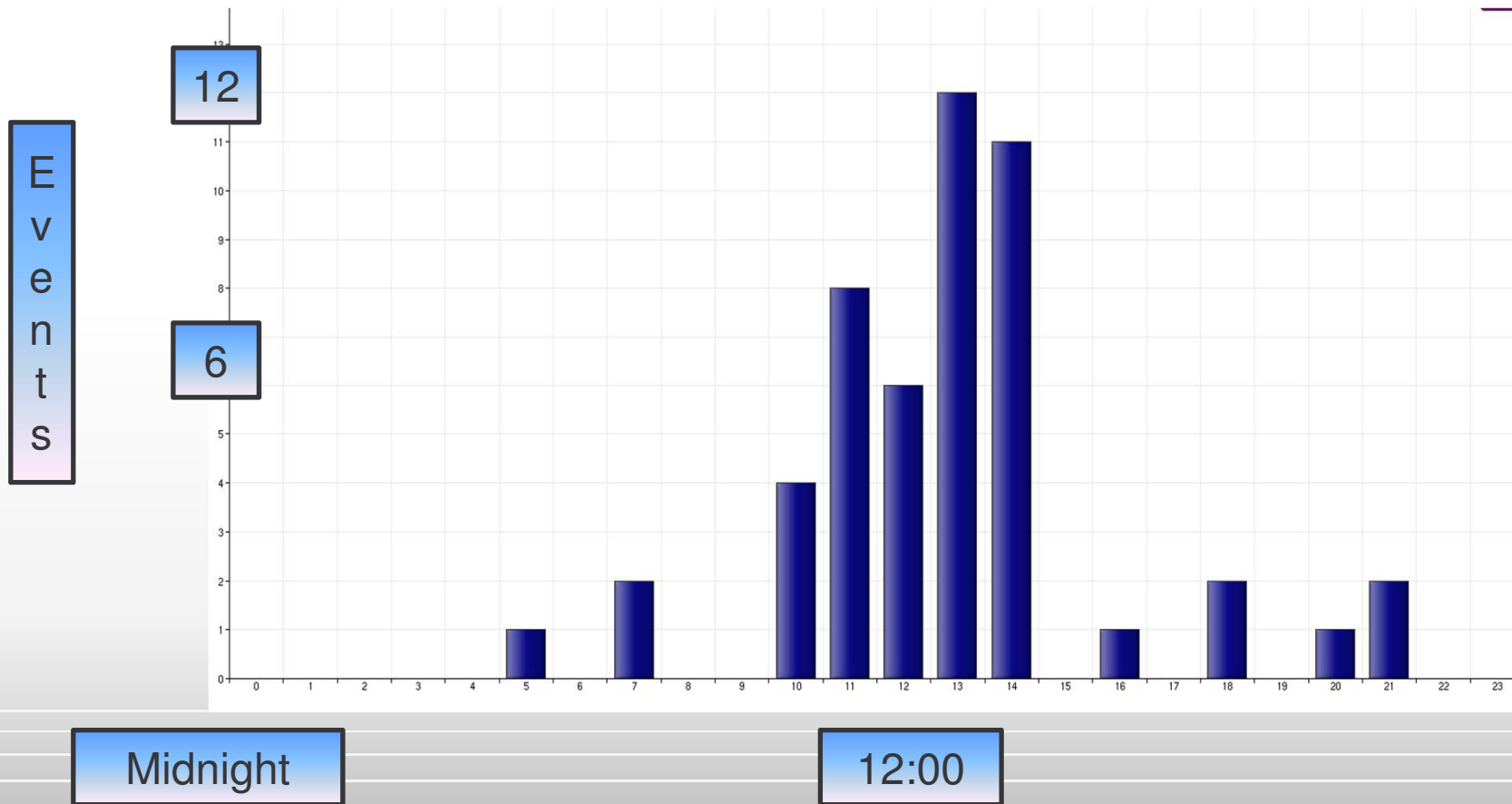
# Case Study – White Van Man



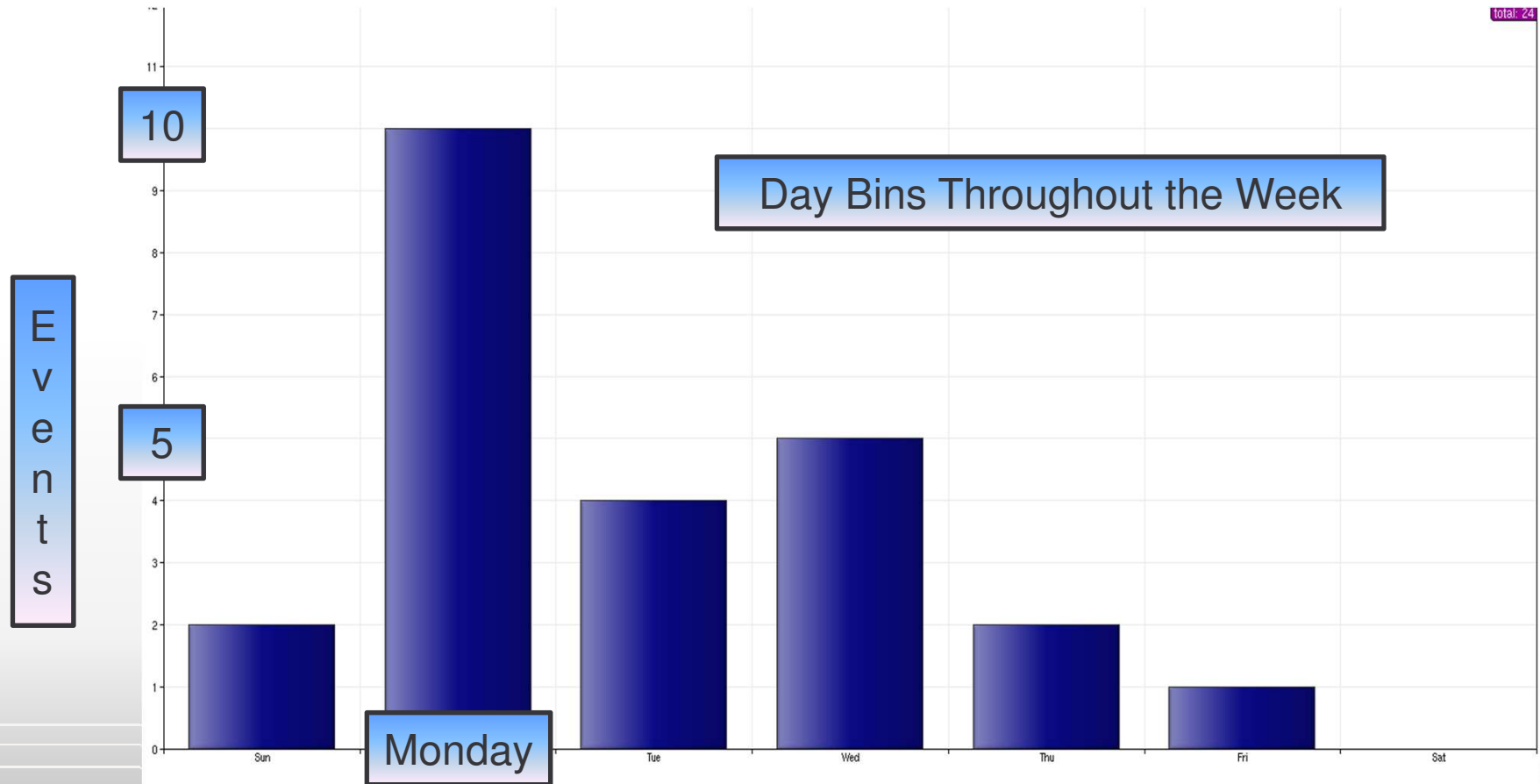
Can we detect a pattern?



# “A” - Hour Bins Through Day



# “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?

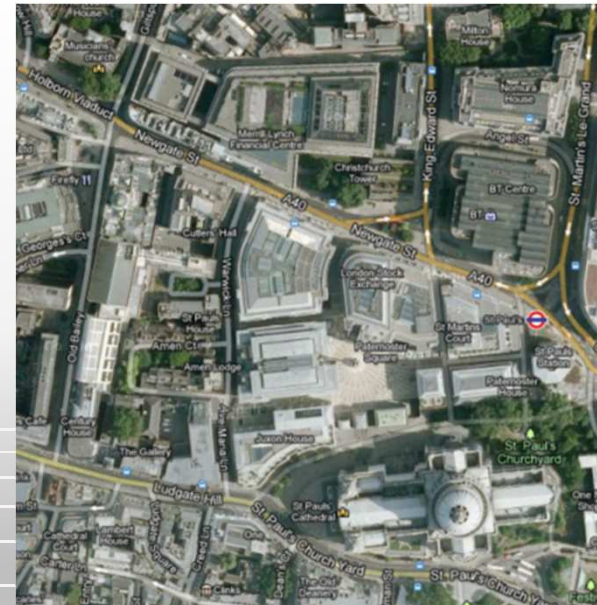


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# Locations

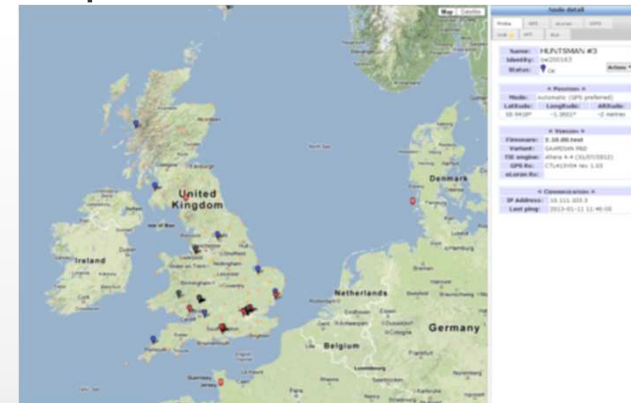
- Airport
- Financial district
- Dual Carriageway Gantry



# Overview of Analysis Process

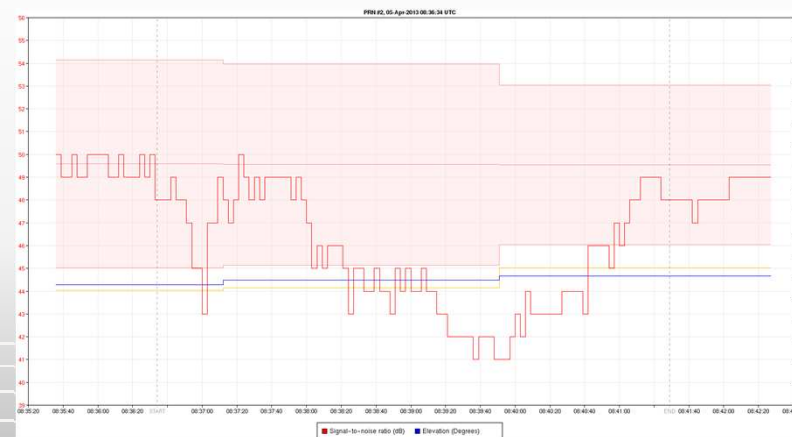
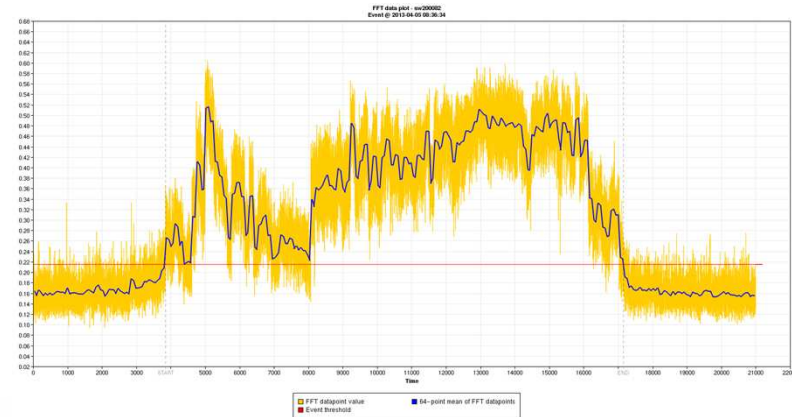


- Probe hosts 2 independent sensor techniques
  - Power in L1 (GPS – 1.575 GHz) Spectrum
  - Susceptibility of our GPS Sensor to increased power
    - Discrimination between serious multipath and RFI
- Data Analysis
  - Events per day/month
  - Events through the day
  - Events by day of week
    - This indicates non-natural event patterns
- Available via secure web based GUI



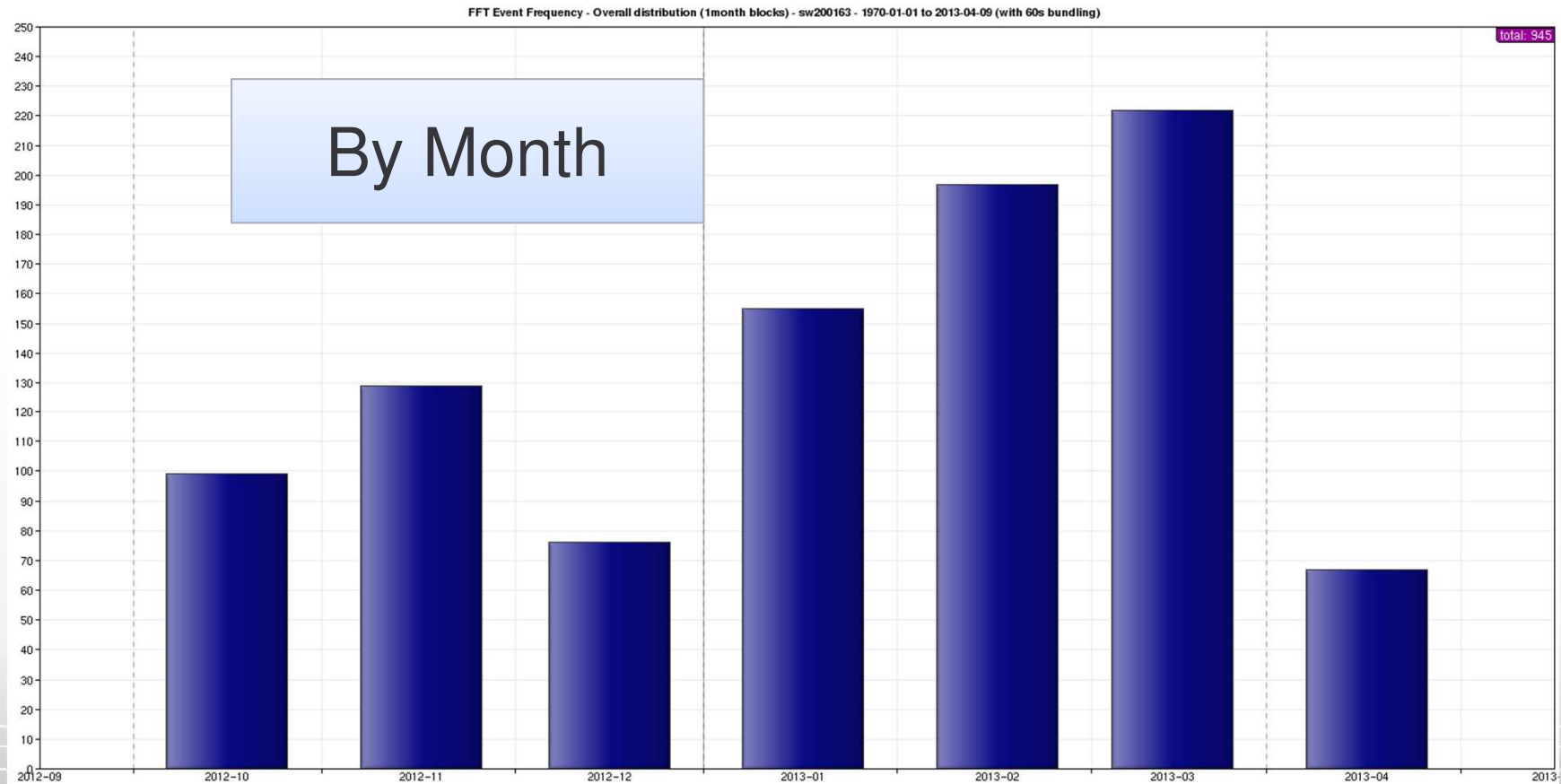
# x2 Detection Techniques

- A recent 4.5 minute “event”
- Power in L1 Spectrum using FFT
- Susceptibility of GPS by measuring C/No

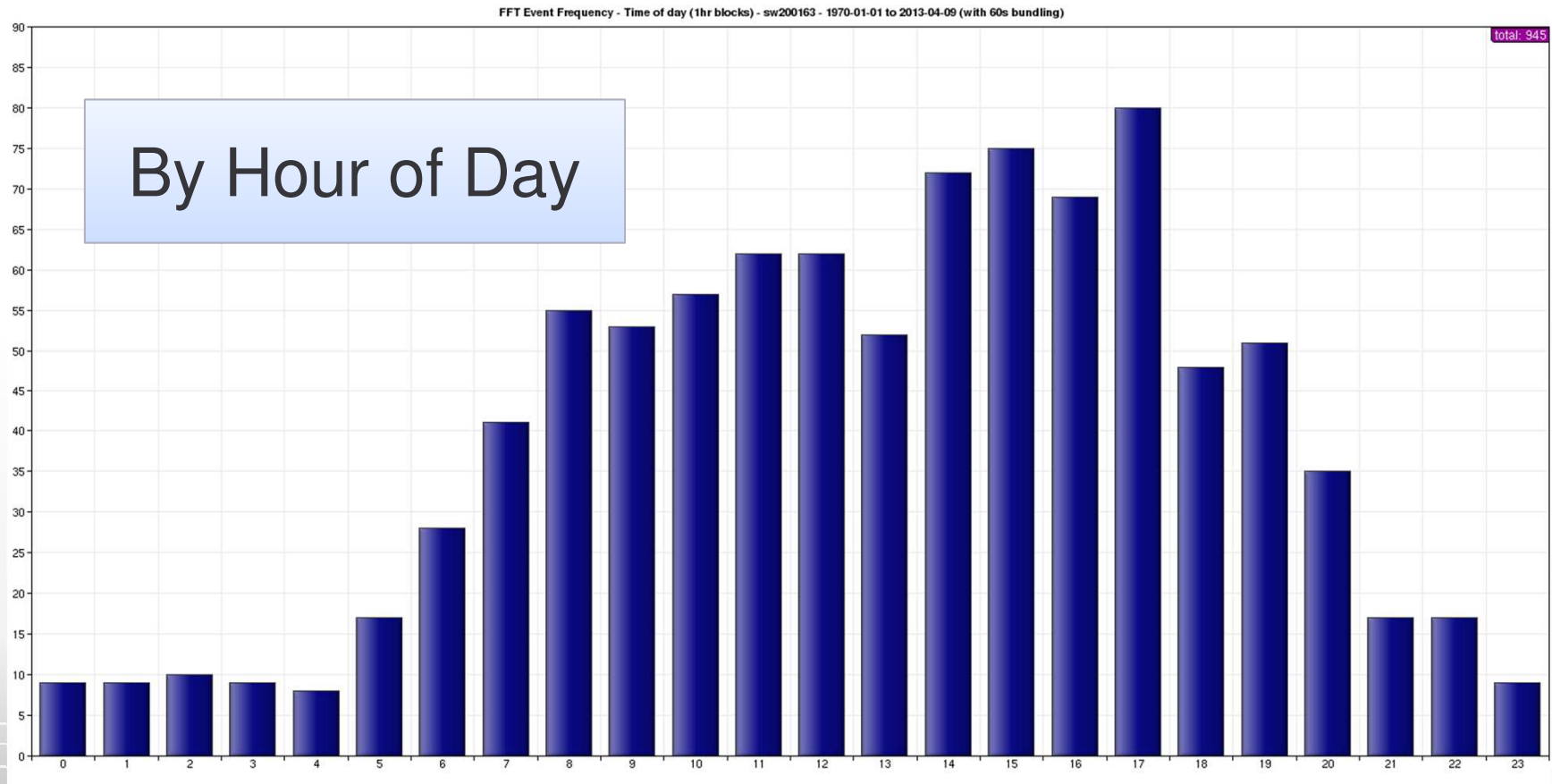




# Airport – Data Analysis



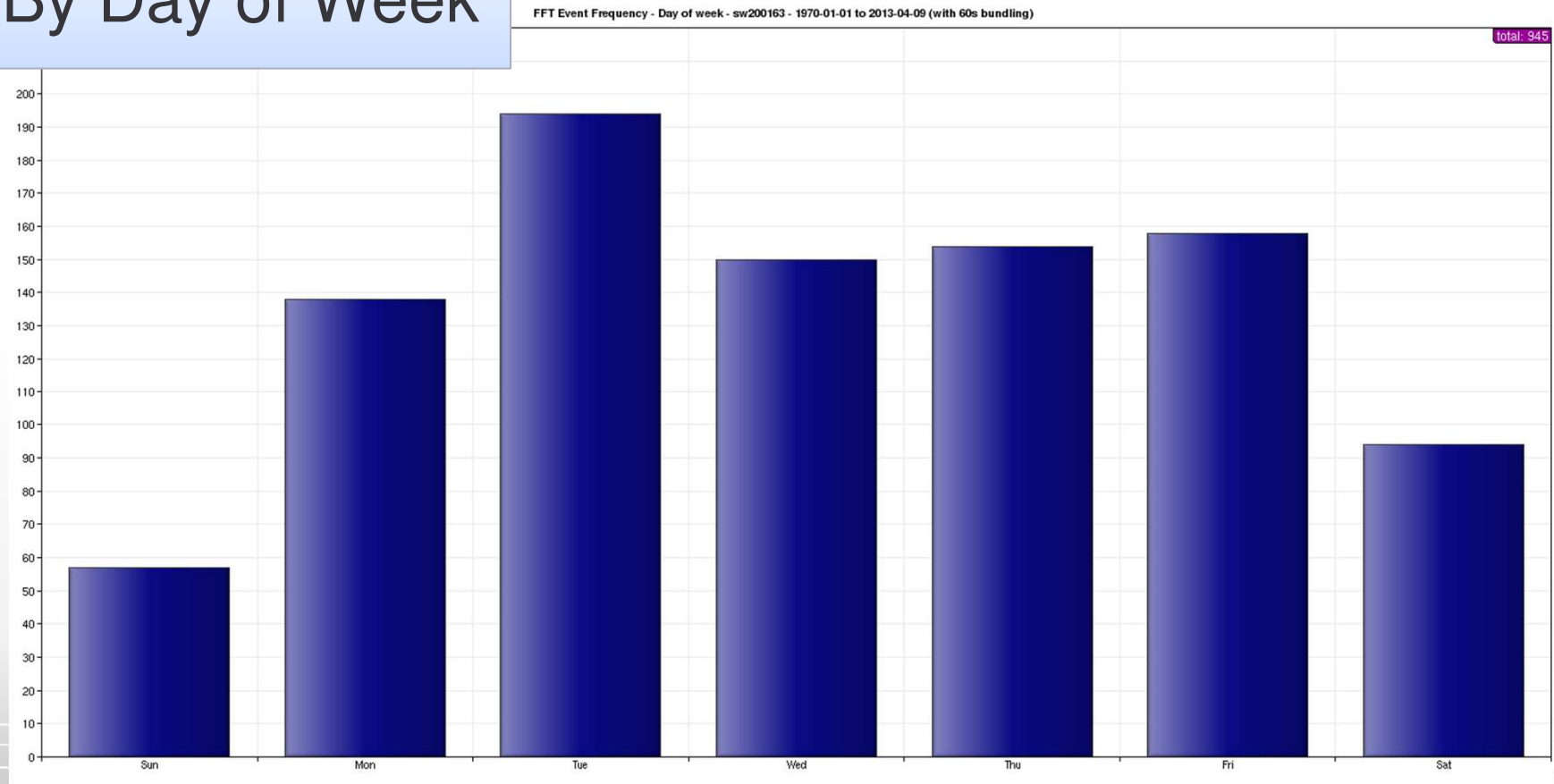
# Airport – Data Analysis



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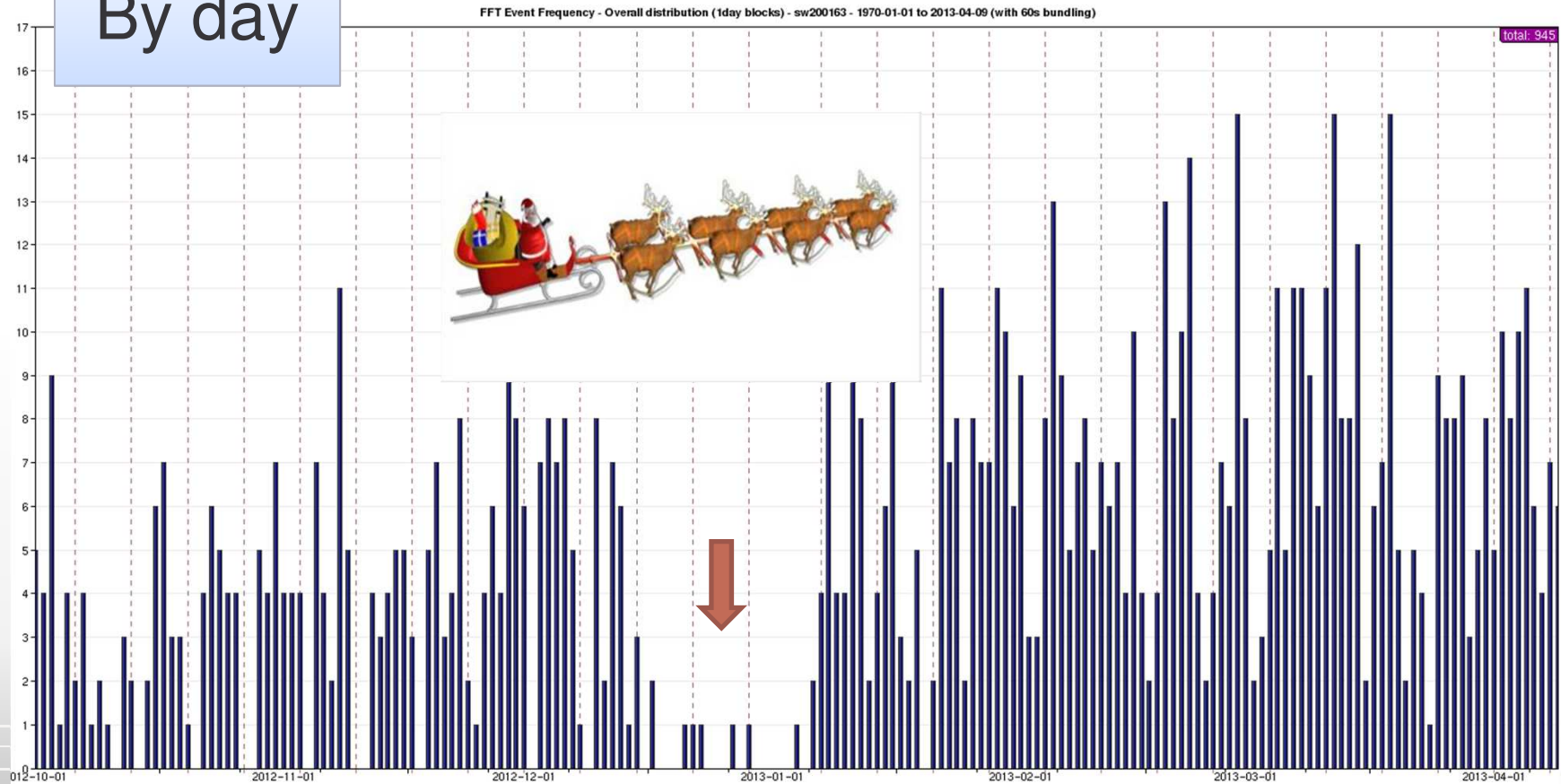


## By Day of Week

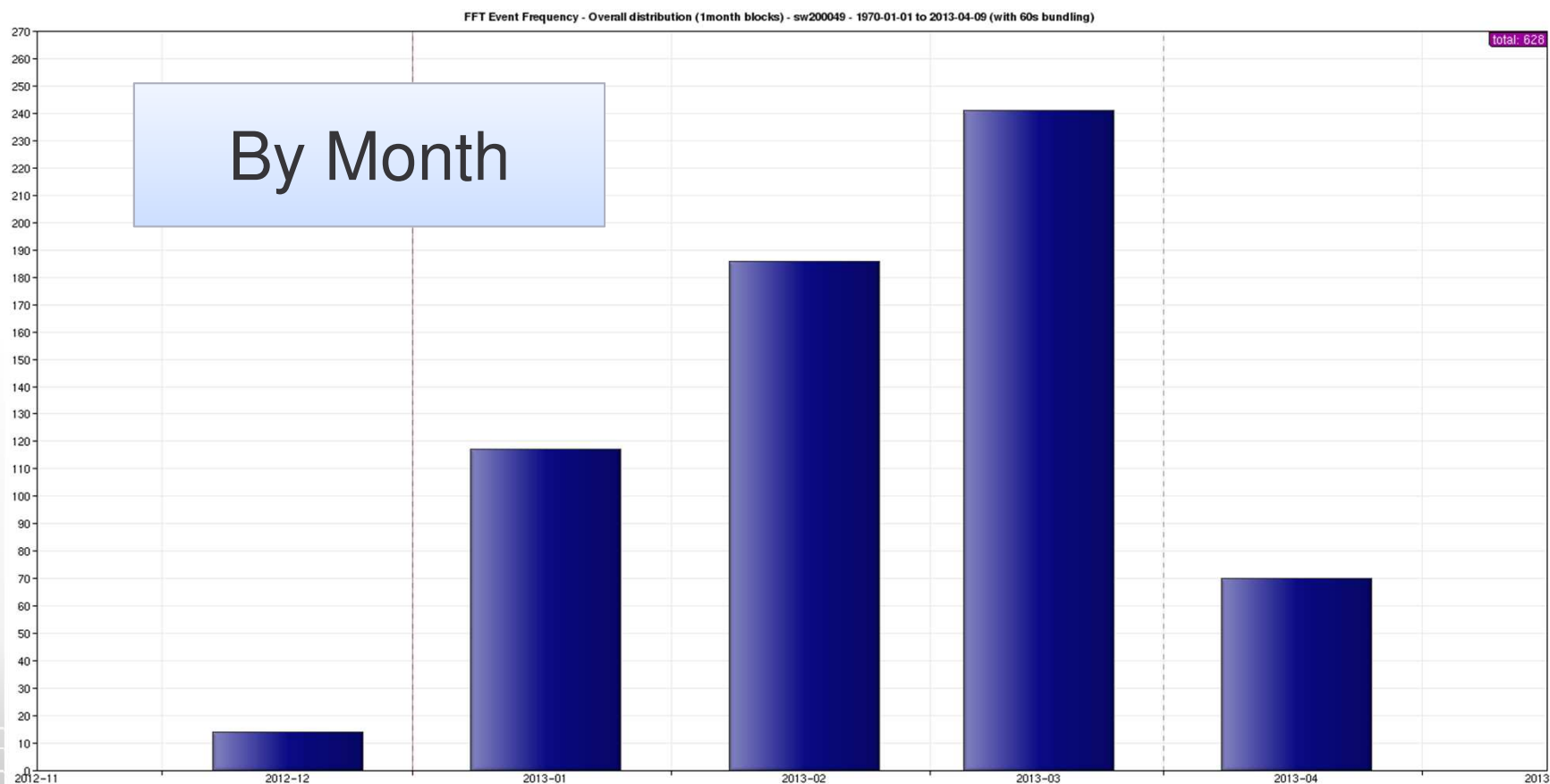


# Airport – Data Analysis

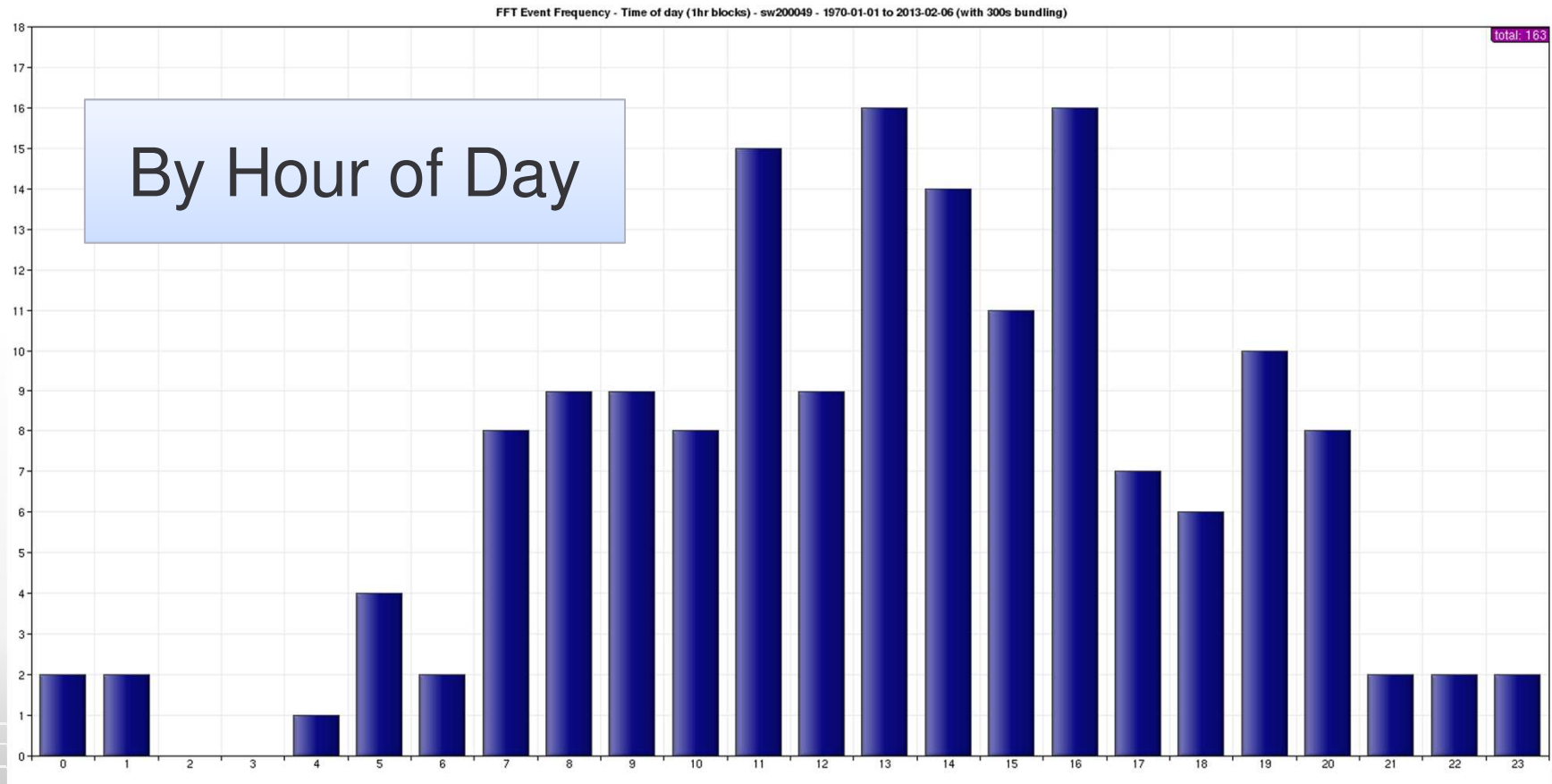
By day



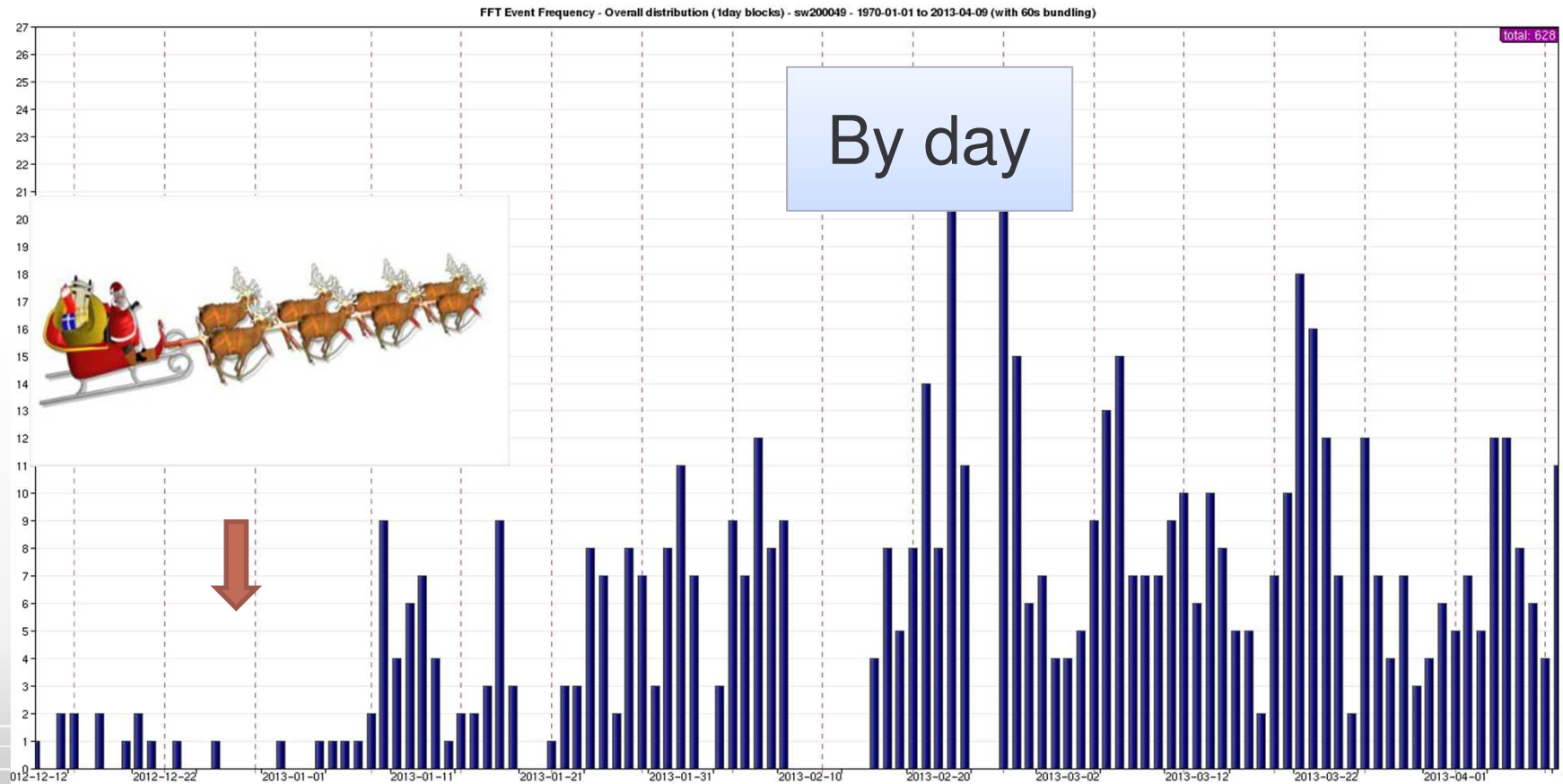
# Dual Carriageway – Data Analysis



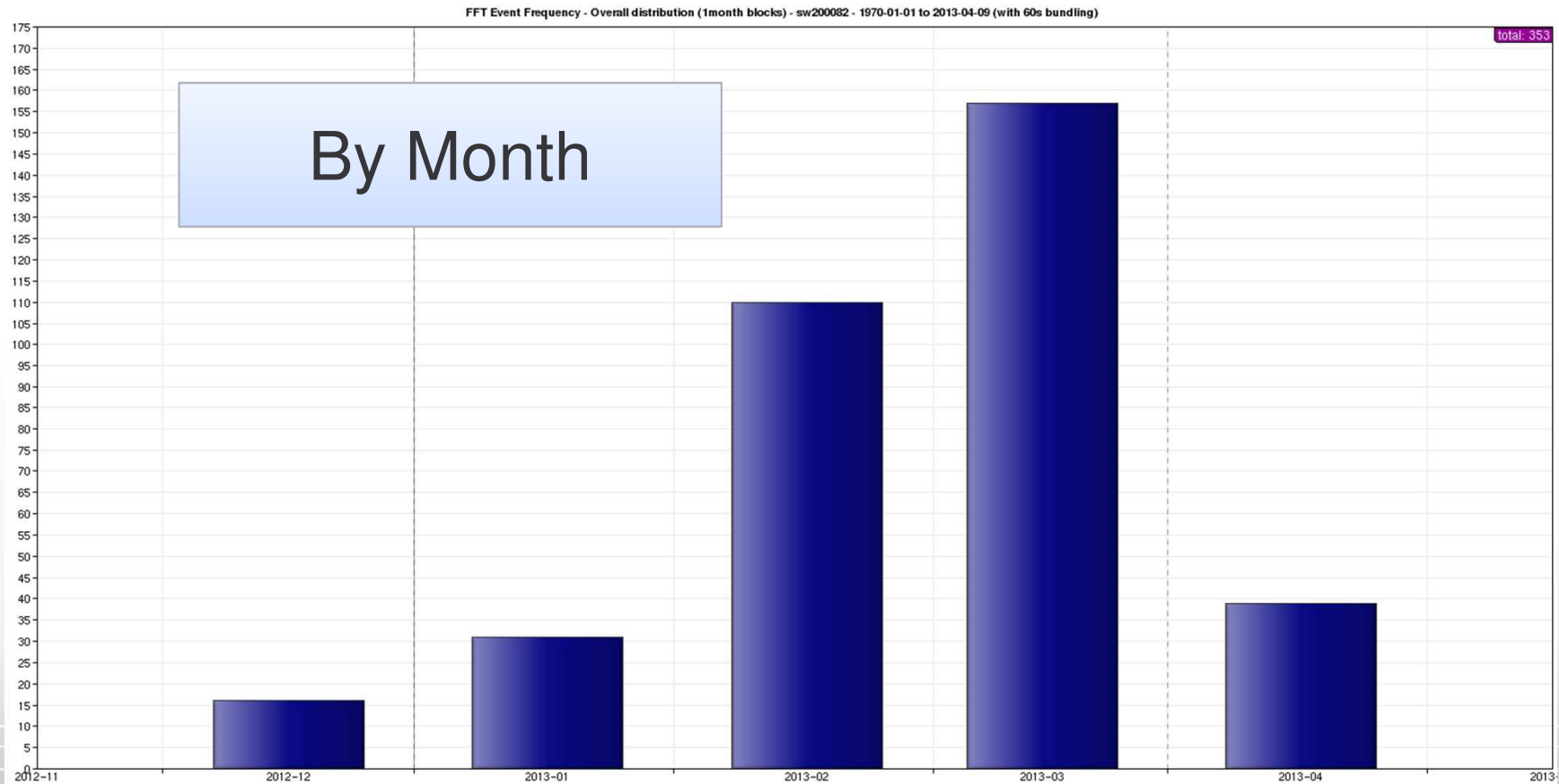
# Dual Carriageway – Data Analysis



# Dual Carriageway – Data Analysis

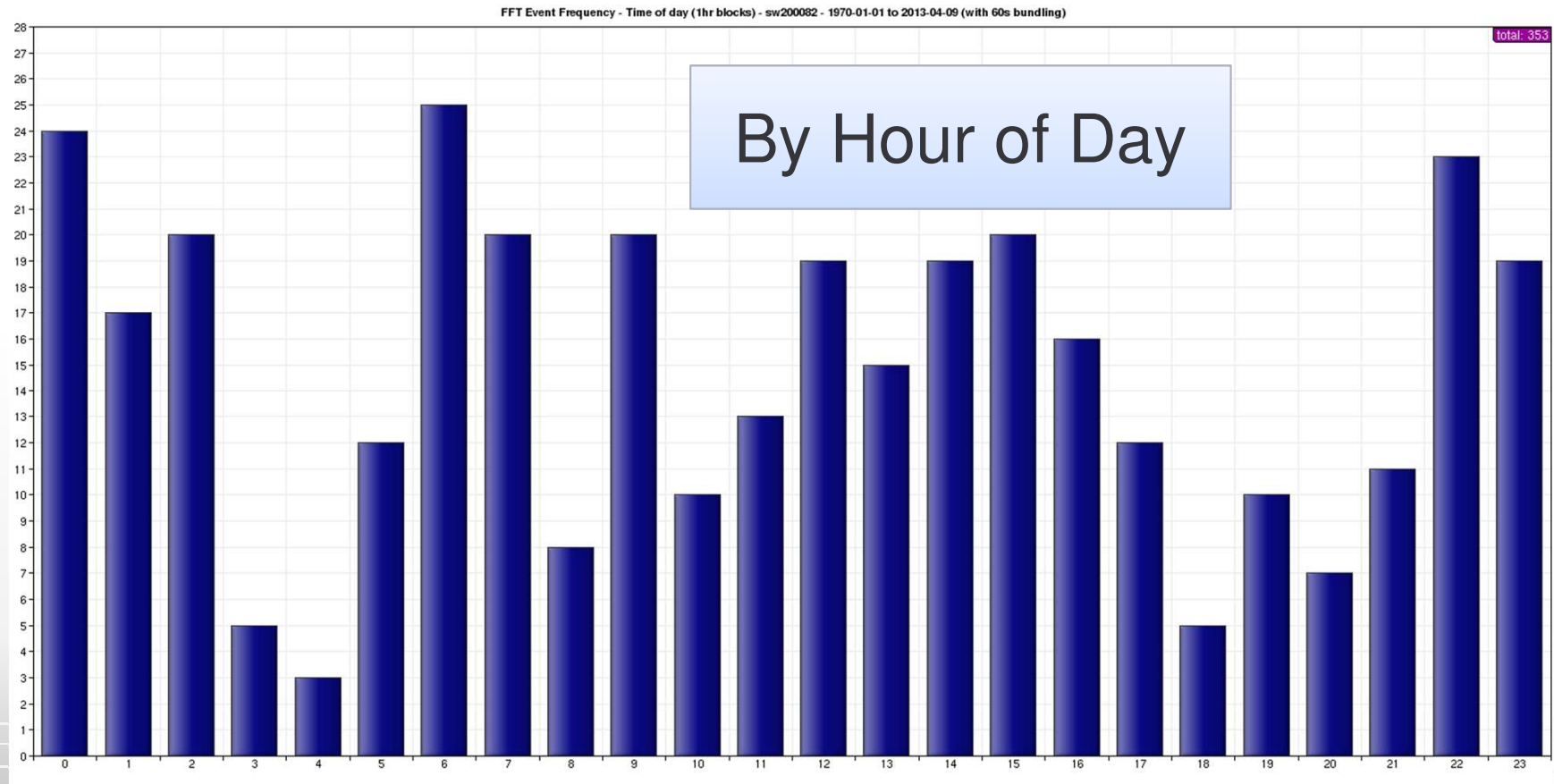


# City – Data Analysis



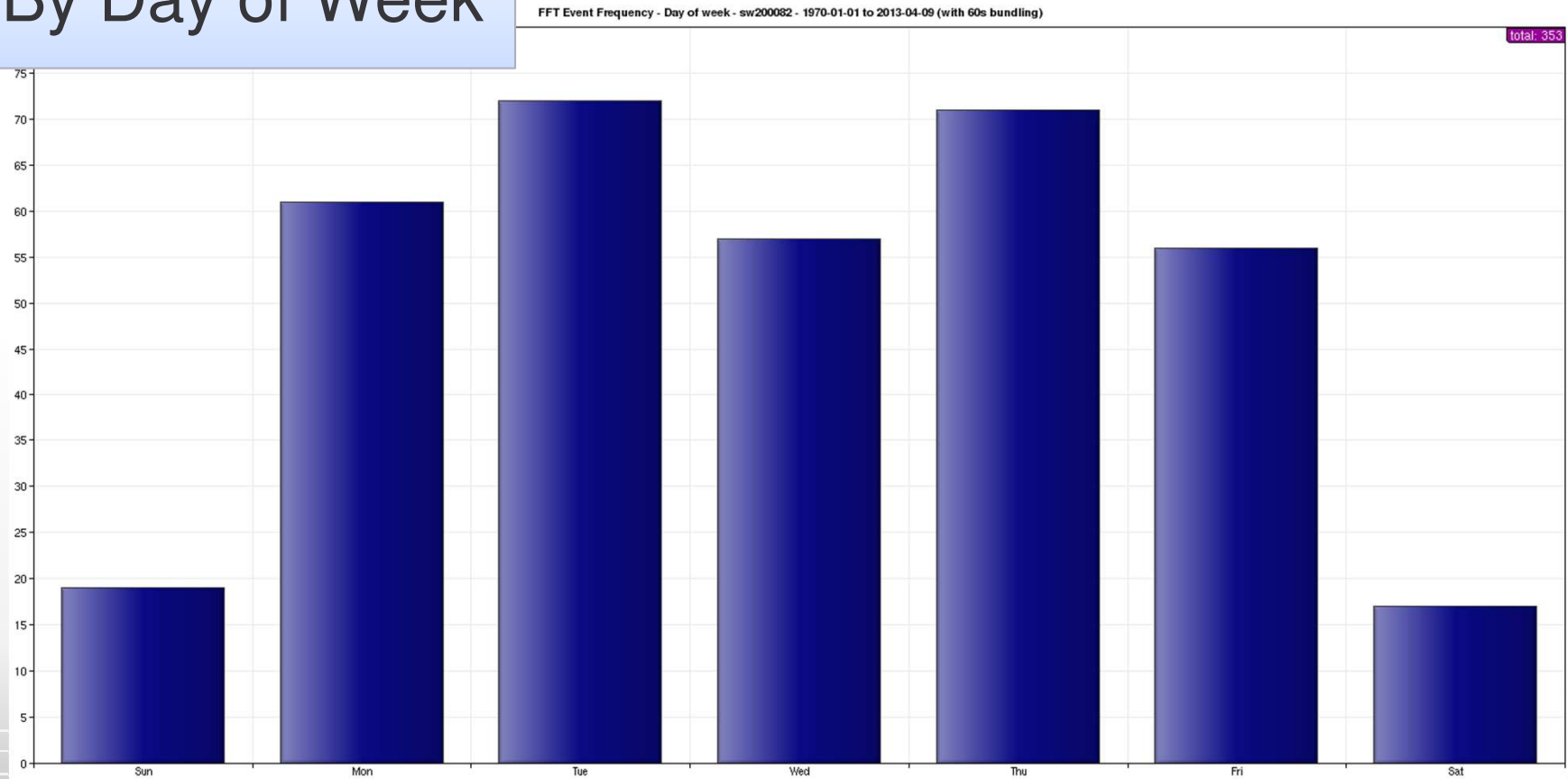


# City – Data Analysis

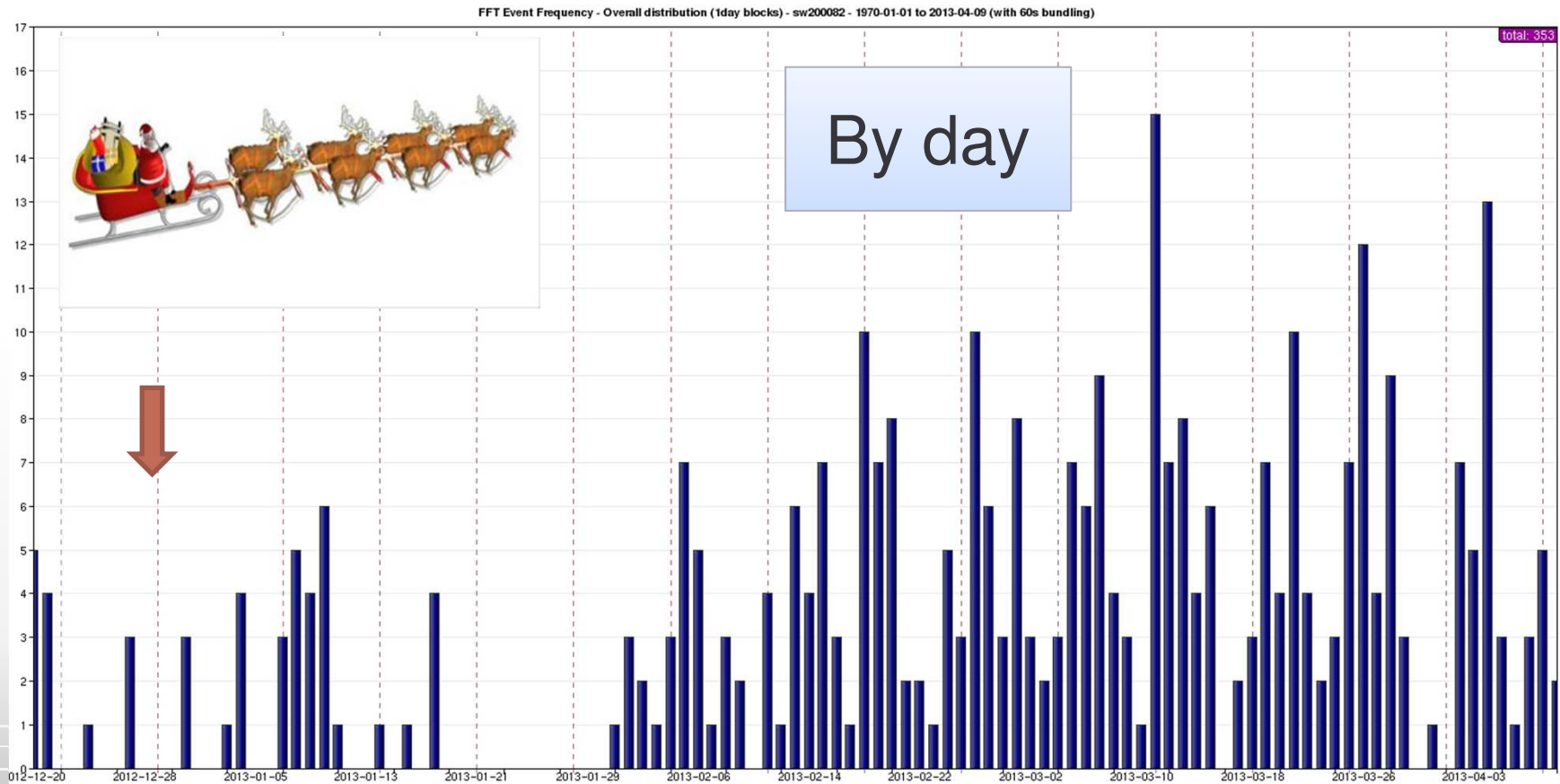


# City – Data Analysis

## By Day of Week



# City – Data Analysis



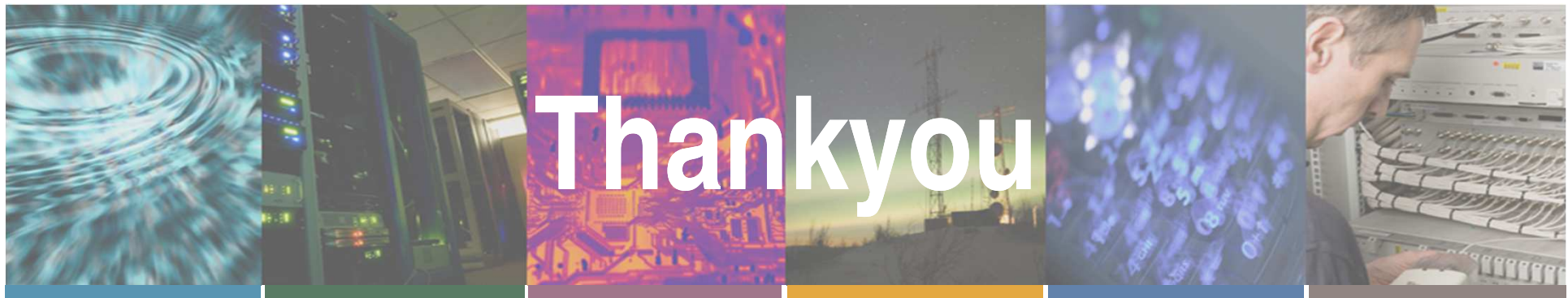
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# In Conclusion

- GPS jamming exists, it is a clear and present danger
- **Any low cost \$50 jammer within 200m will compromise any GNSS based application**
- What are you doing about it?

# Questions?



[www.chronos.co.uk](http://www.chronos.co.uk)

[www.gpsworld.biz](http://www.gpsworld.biz)

[www.gaardian.co.uk](http://www.gaardian.co.uk)

[charles.curry@chronos.co.uk](mailto:charles.curry@chronos.co.uk)