

Developing Aoristic Network Analysis on London's Transport System

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Transport for London

Introduction

- Why needed?
- Where to start?
- Current analytical capability
- Progress to date
- Limitations to be overcome
- Future developments

Why Needed?

- **It's a busy system!**
- **Nature of offending**
 - **Static v Non-Static events**
 - **% of offences that occur without defined location**
 - **High volume (e.g. Theft)**
- **Expanding network & population thereby increasing the challenge**

Where to start?

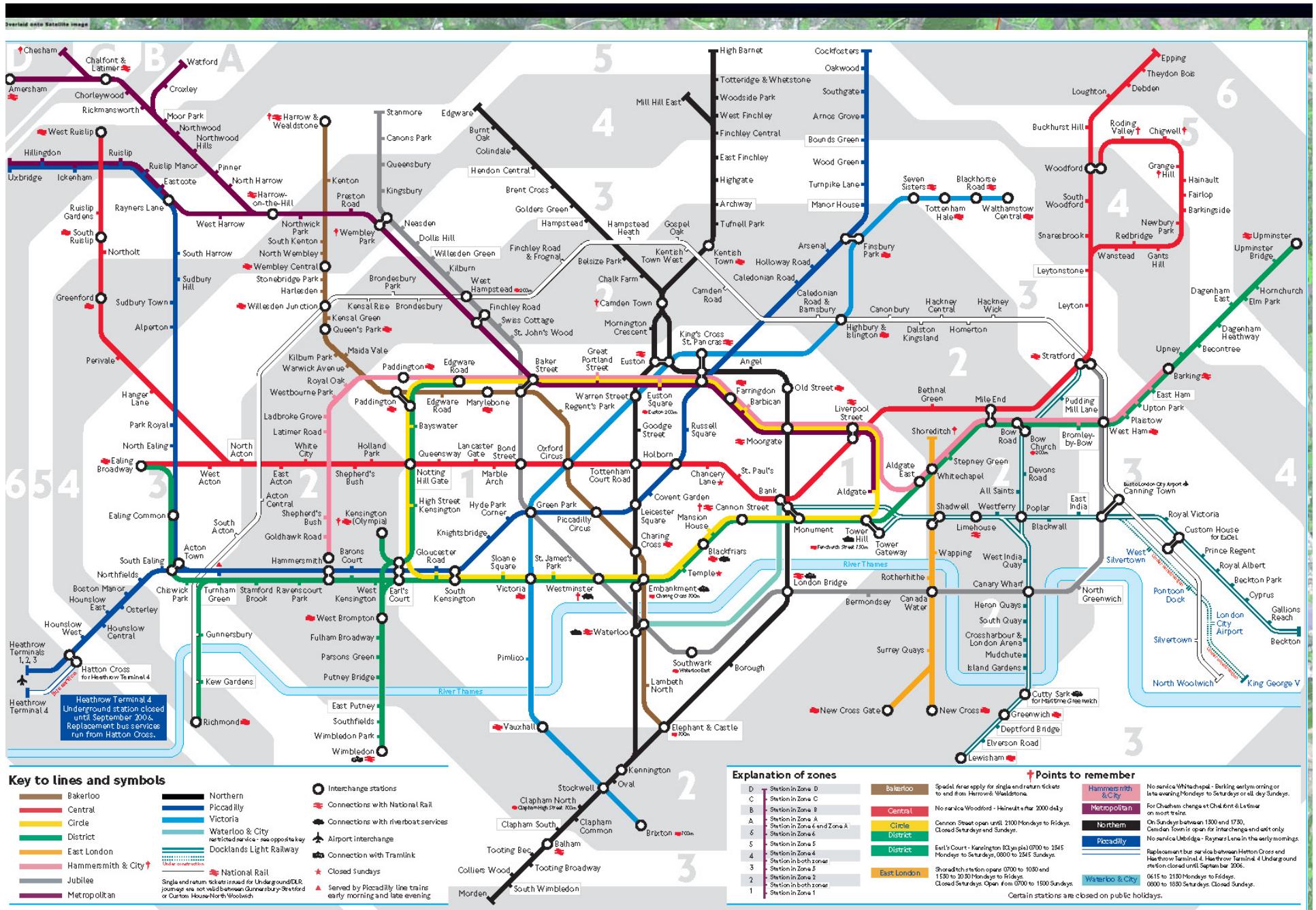
- Multi-modal approach?
- Develop proof of concept
 - Start small
 - Underground
 - Smallest Network
 - Supplementary information
 - Theft
 - Highest volume offence
 - Lowest detected offence
 - On train / on route offending
 - Opening of European borders
 - Possible change of offending

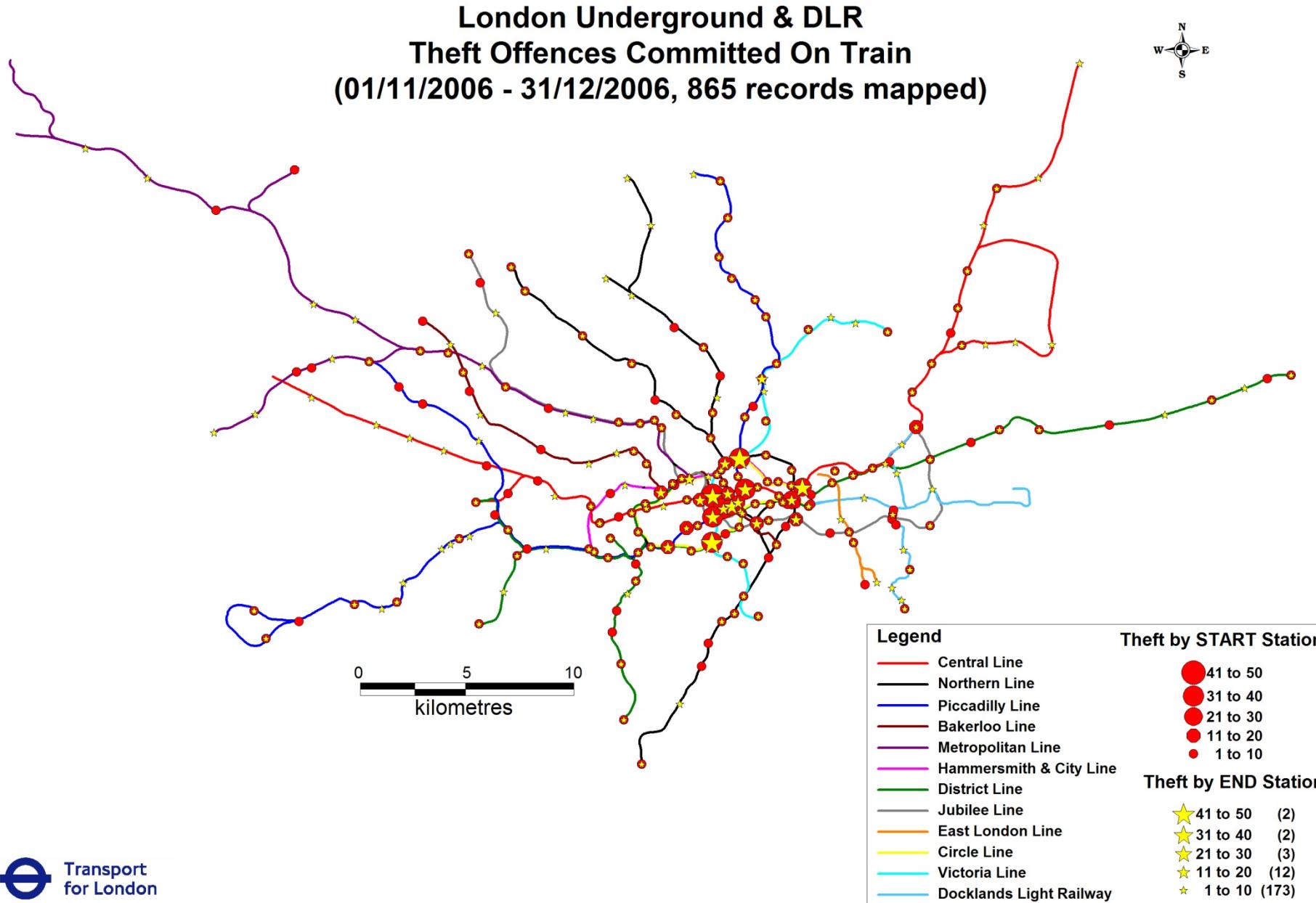
Where to start?



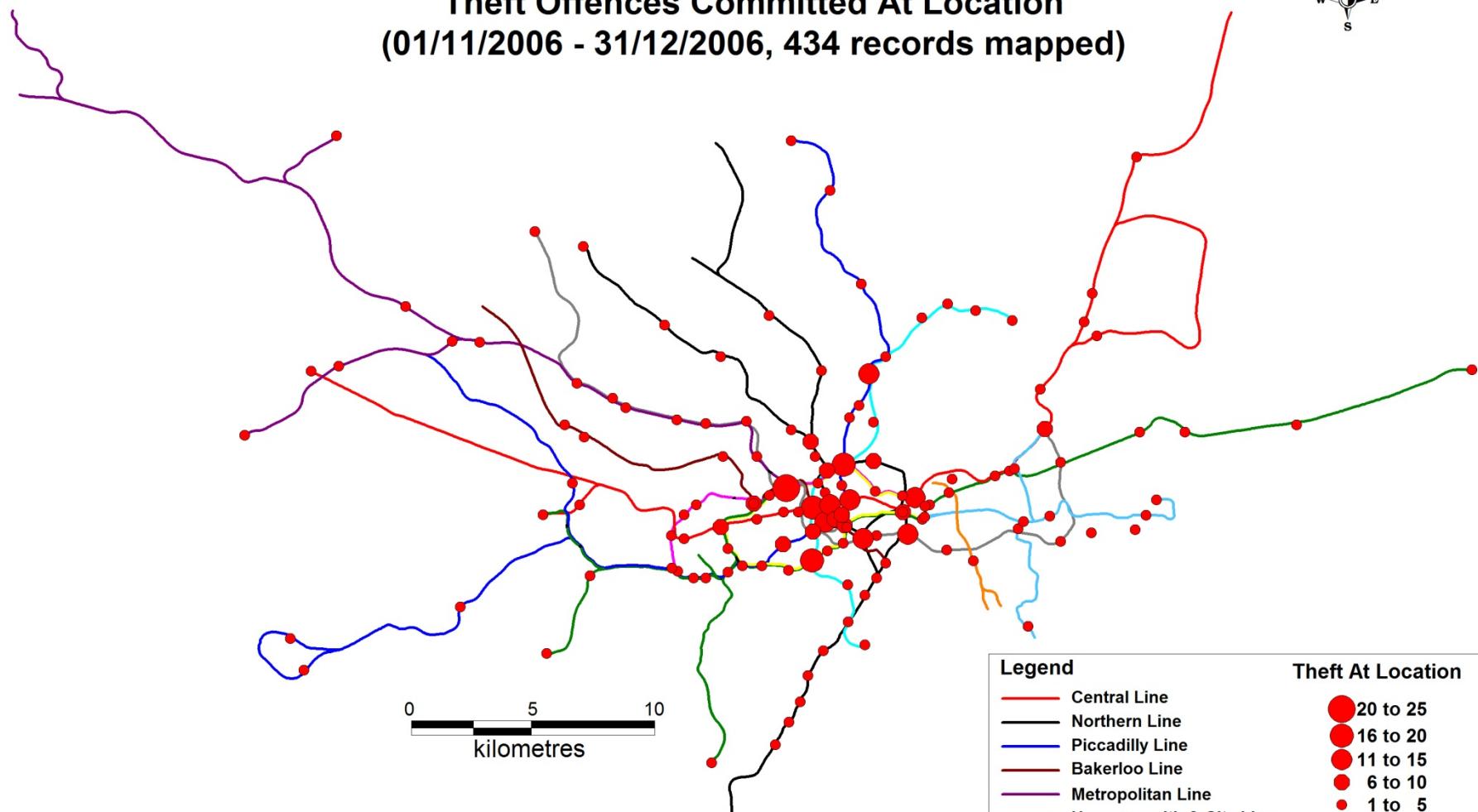
How is this currently analysed?

- Fortnightly tasking meetings
- Manual process
 - ~150 offences per week (almost 8,000 p.a.)
- Start / End stations reporting
 - E.g. Edinburgh to London Victoria
- Limitations
 - Time-consuming
 - No consideration of supplementary factors
 - Lack of specialist spatial analysis capability within BTP





London Underground & DLR Theft Offences Committed At Location (01/11/2006 - 31/12/2006, 434 records mapped)



What is Aoristic Analysis?

- “Aoristic is from the Greek term *Aorist*, defined in the Shorter Oxford English Dictionary as "without defined occurrence in time.”
- “One of the problems with analysing crime is achieving **temporal** accuracy **when** the exact **time and date** of many crimes is unknown. This can occur if a family goes on holiday for two weeks and return to find their home burgled. Not knowing the exact date can be a problem for analysing crime accurately, but an aoristic search can help, and can also reveal different patterns not seen in other types of analyses.”

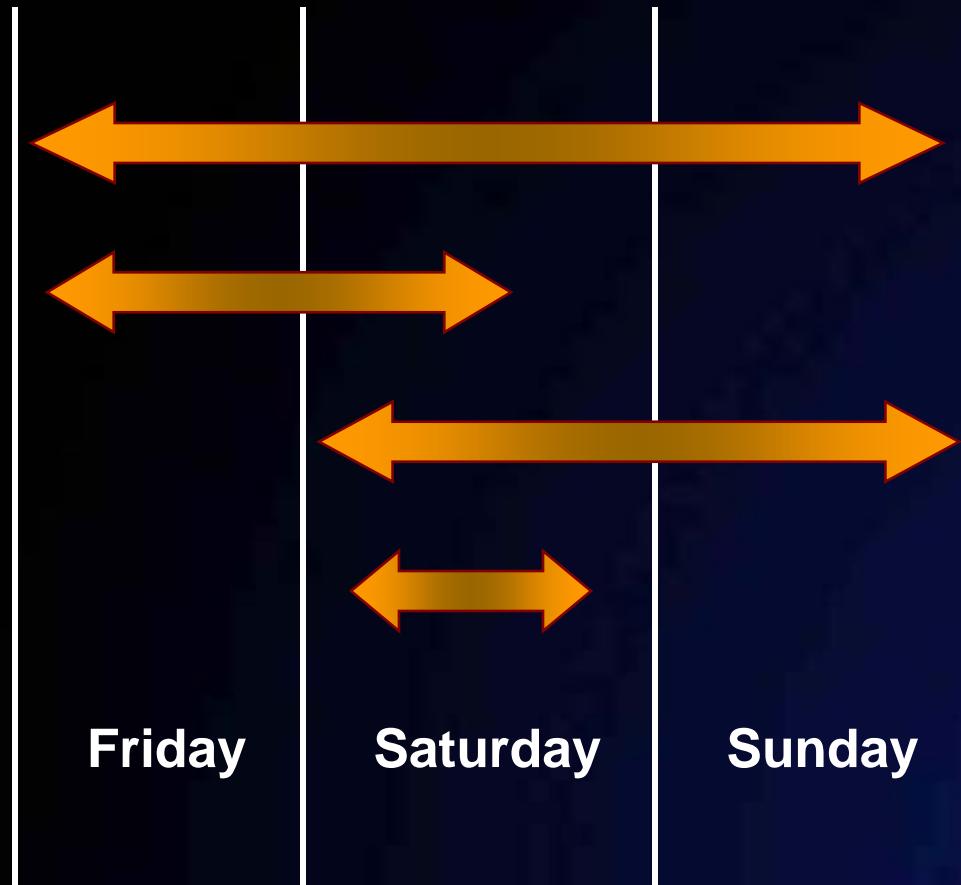
What is *Aoristic* Network Analysis?

- “One of the problems with analysing crime is achieving ***spatial*** accuracy ***where*** the exact ***location*** of many crimes ***upon a network*** is unknown.”

Time spans

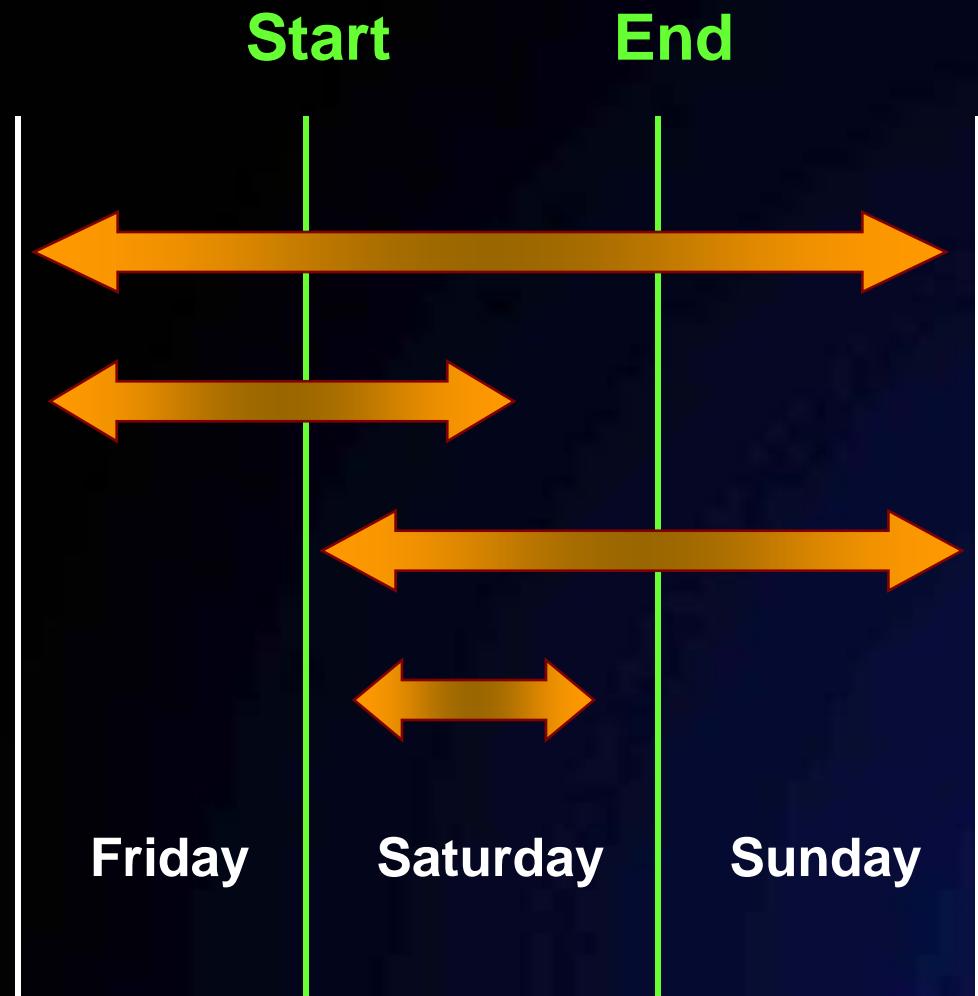


Temporal options

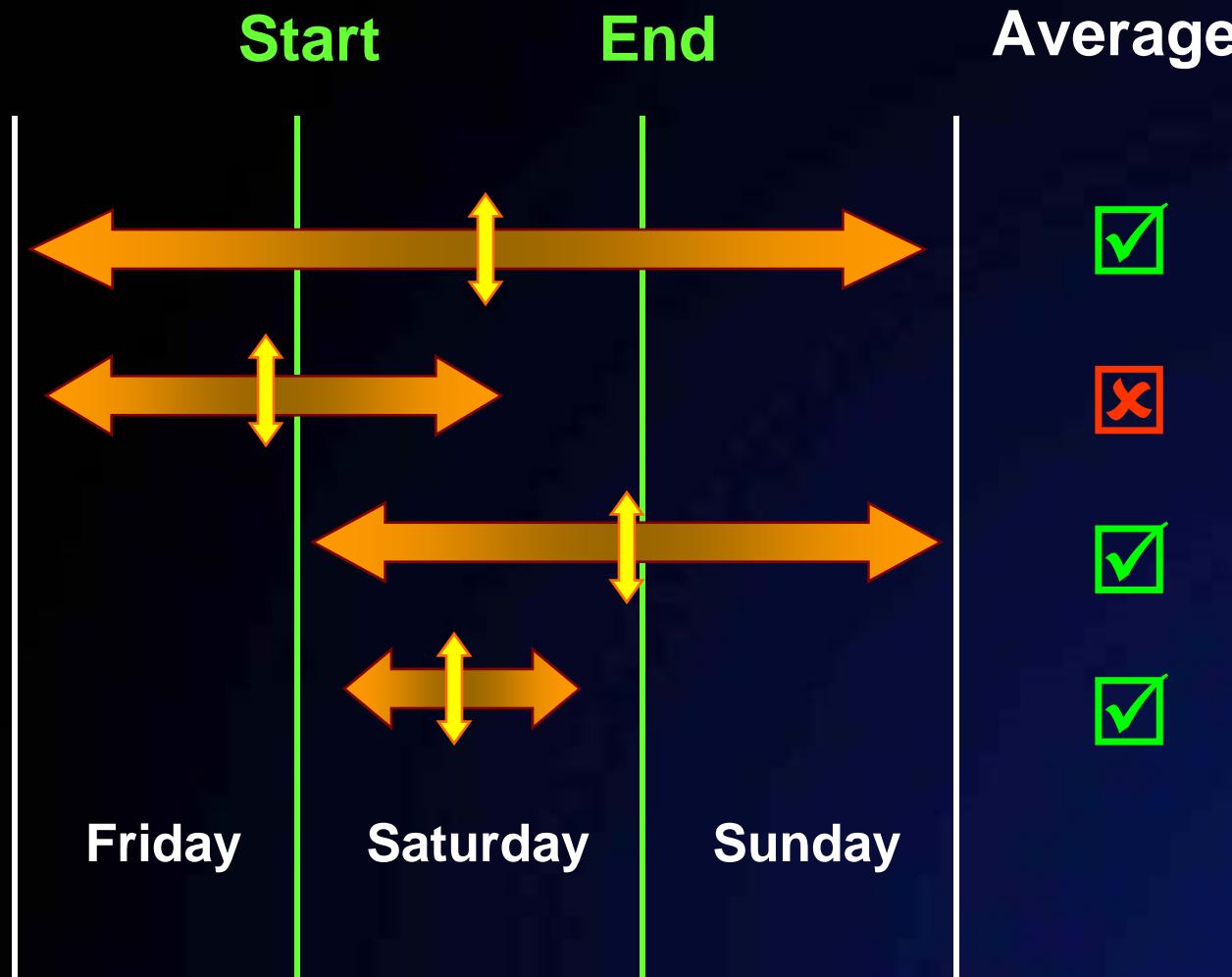


Which
burglaries
occurred on
Saturday?

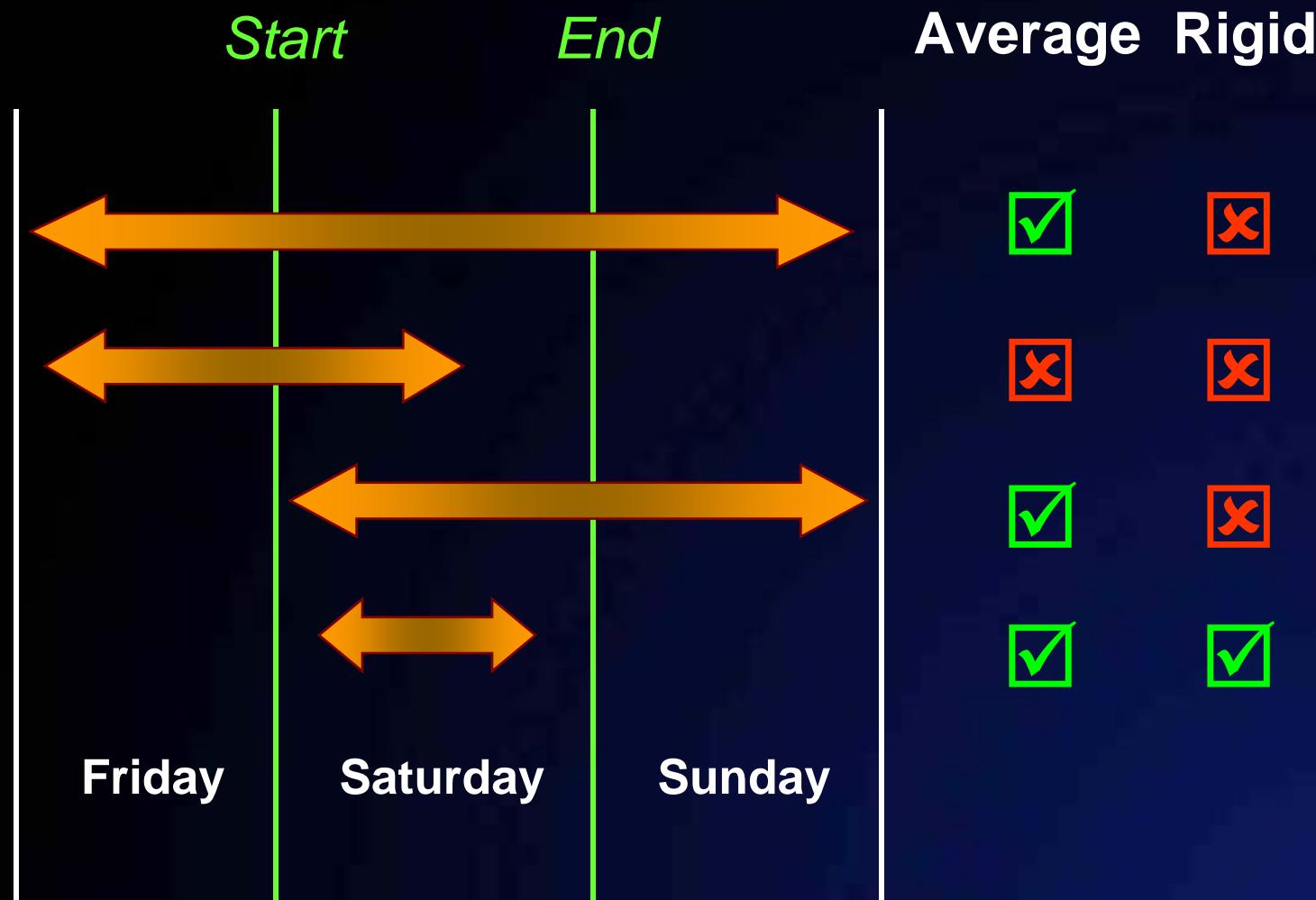
Temporal options



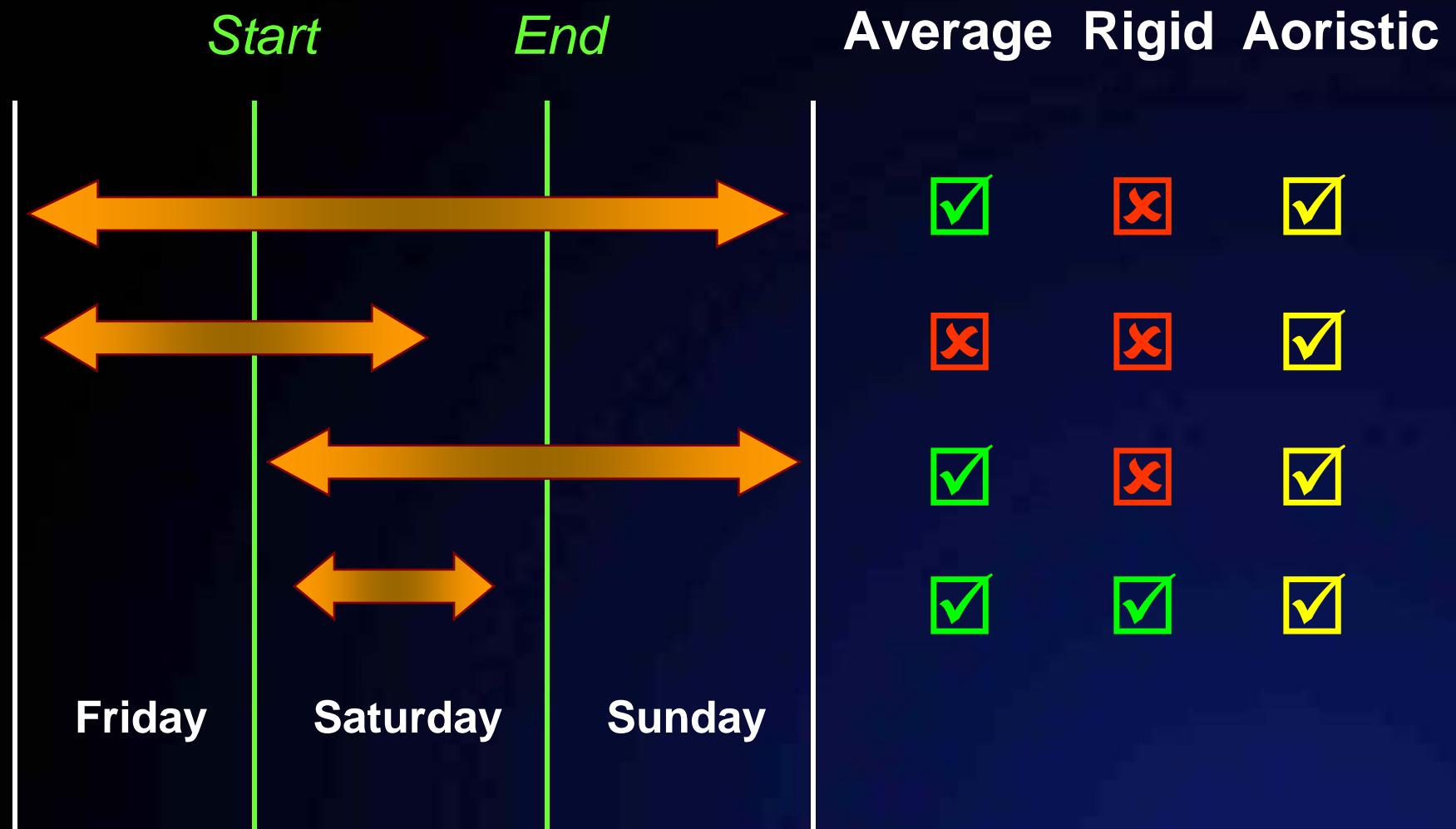
Temporal options



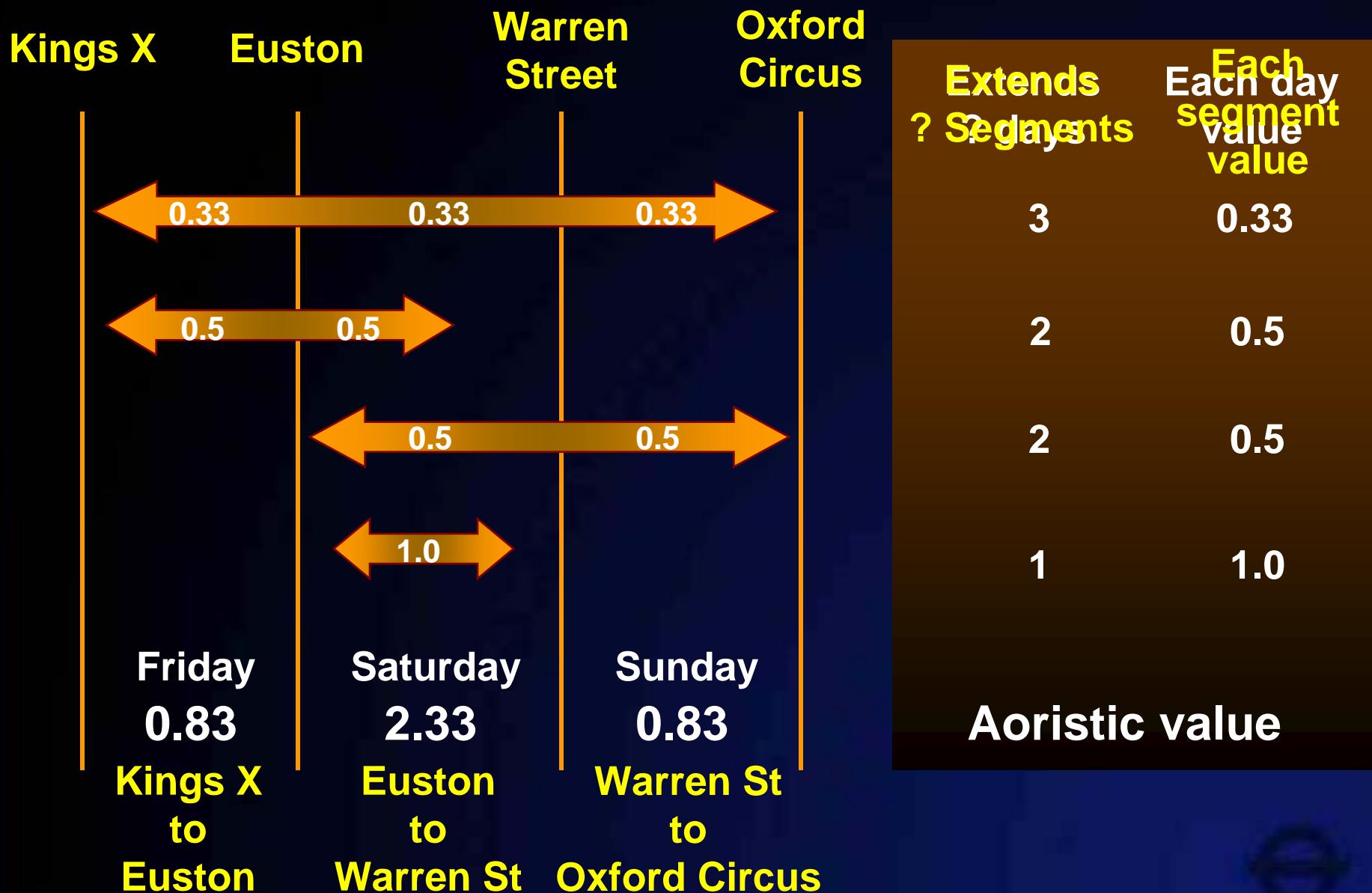
Temporal options



Temporal options



Aoristic values



What is Aoristic Network Analysis?

- Doesn't make sense to analyse by
 - Specifically defined sections of the underground
 - Average / mid-point of the journey
 - Start / end locations

What is Aoristic Network Analysis?

- Aoristic value (AV)

$$AV = \text{journey}/\text{total segments}$$

- My journey to work
- Kings Cross to Victoria (Victoria Line)
 - *6 stations with 5 segments, therefore*
 - *Value per segment = 1 / 5*
 $= 0.2$

What is Aoristic Network Analysis?



- But is this truly reflective?
 - Time taken to travel on a segment
 - Number of passengers travelling a segment
 - Time of day / day of week

What is Aoristic Network Analysis?

- Aoristic value (additional factors)

$$AV = (journey/no. \ of \ segments) \times T \times P$$

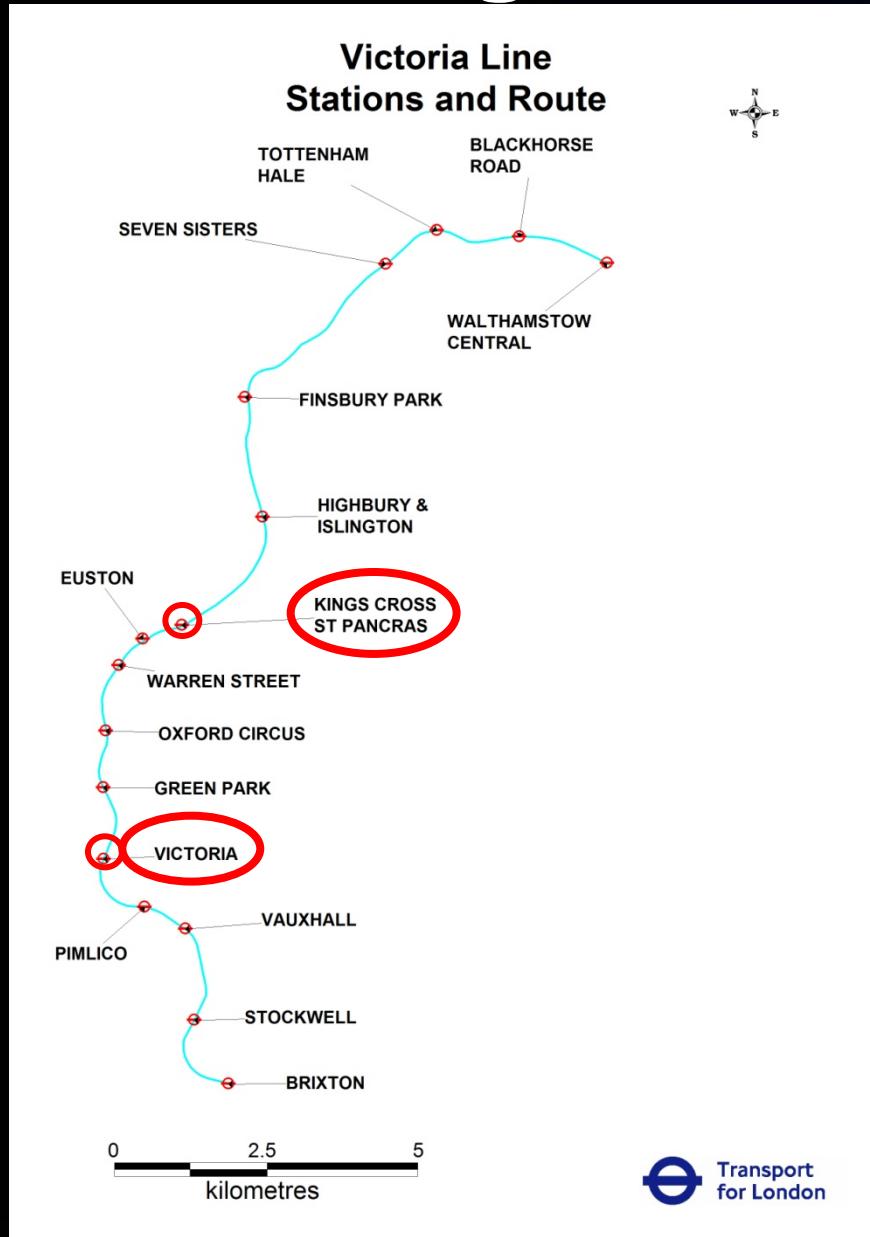
- *Where*
 - T = time taken to travel the segment**
 - P = passengers travelling the segment**

What is Aoristic Network Analysis?

Route	London Underground Network Map					
	King's Cross St. Pancras	Euston	Warren Street	Oxford Circus	Green Park	Victoria
Circle						
Hammersmith & City						
Metropolitan						
Northern	Northern	Northern				
Piccadilly				Bakerloo Central		
Trains to Gatwick & Luton					Jubilee Piccadilly	
Circle District						Trains to Gatwick

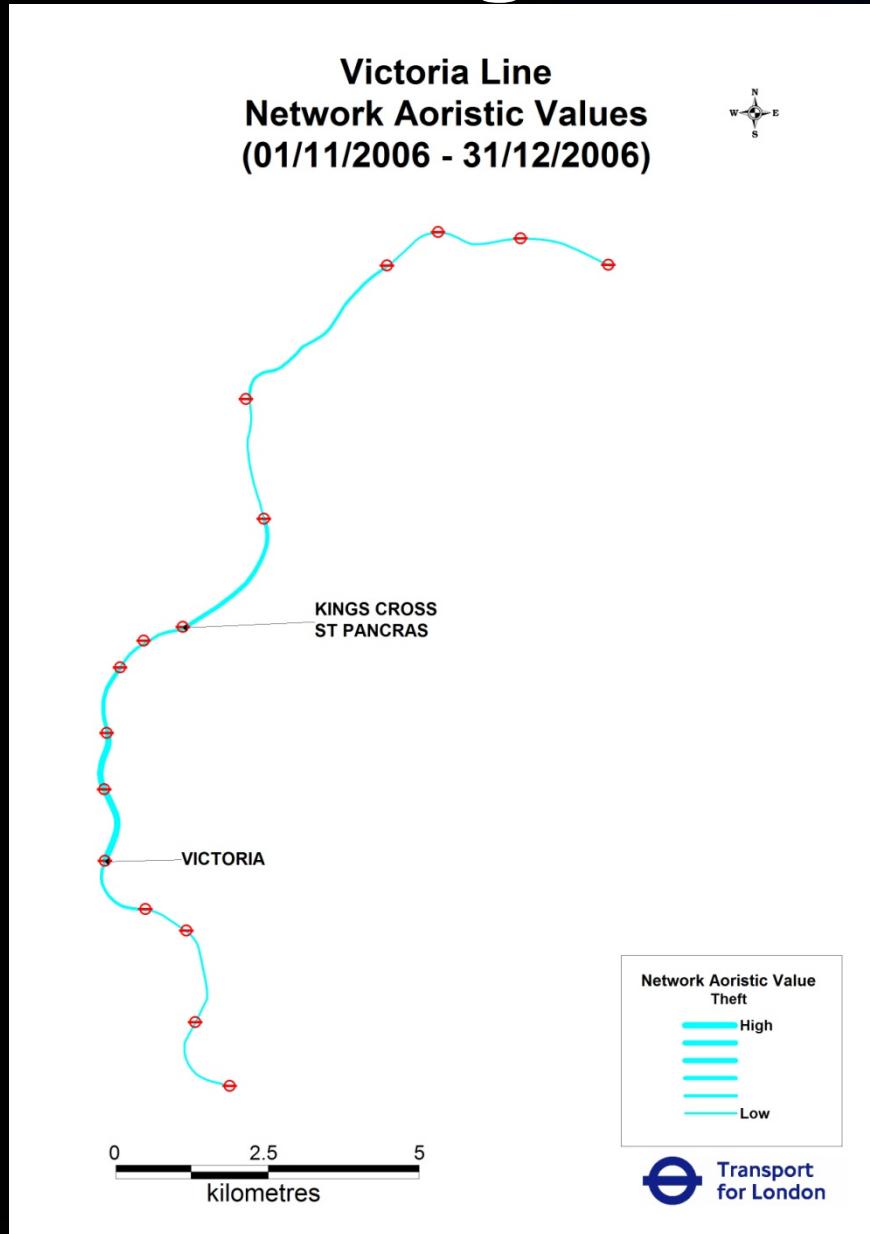
	Segment 1	Segment 2	Segment 3	Segment 4	Segment 5
Aoristic Value	0.20	0.20	0.20	0.20	0.20
Time Weight	1	2	2	2	2
Passenger Weight	19.9	11.1	49.7	21.1	54.3
Network Aoristic Value	3.98	4.44	19.88	8.44	21.72

Visualising Aoristic Network Values



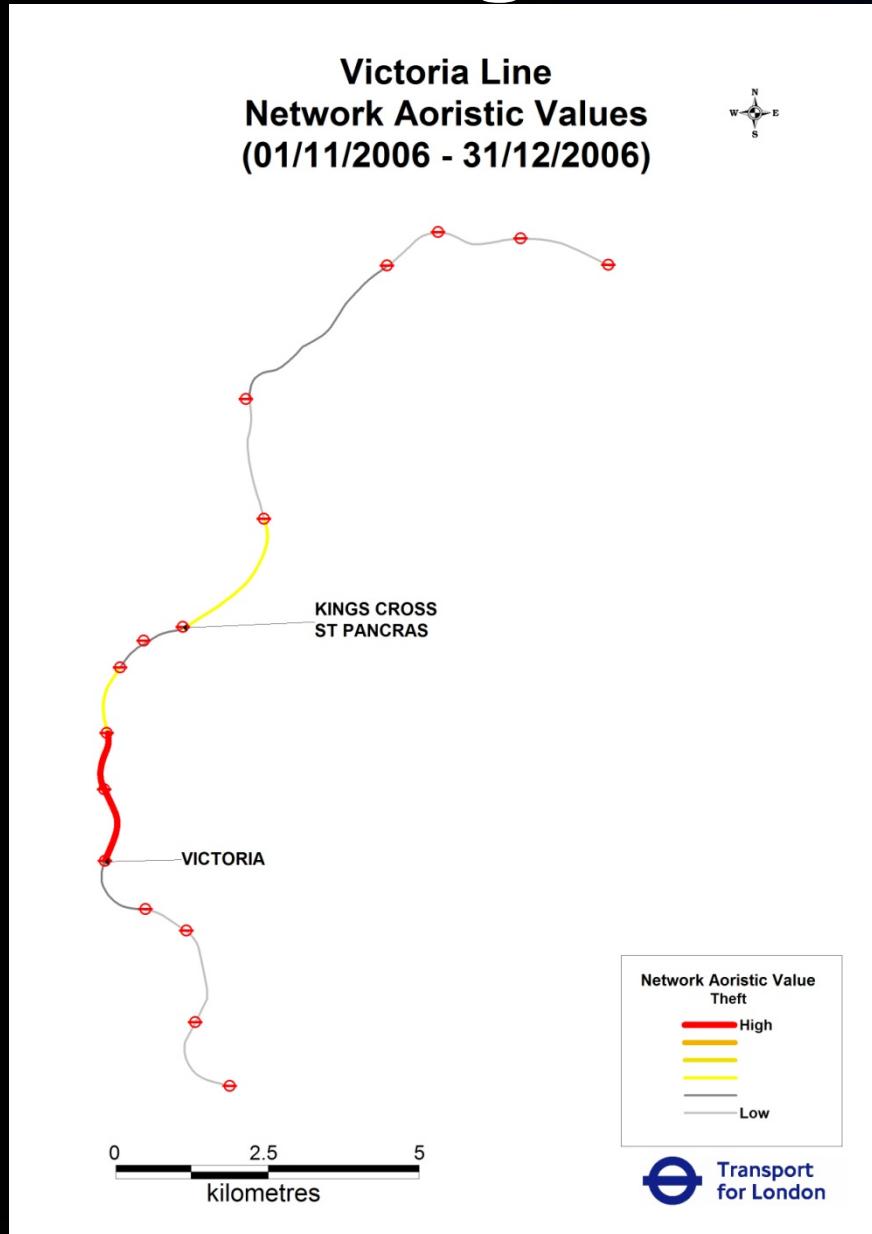
- My journey to work
- Thematic line map indicating weighted network of where offences occurred

Visualising Aoristic Network Values



- My journey to work
- Hmm looking less safe....

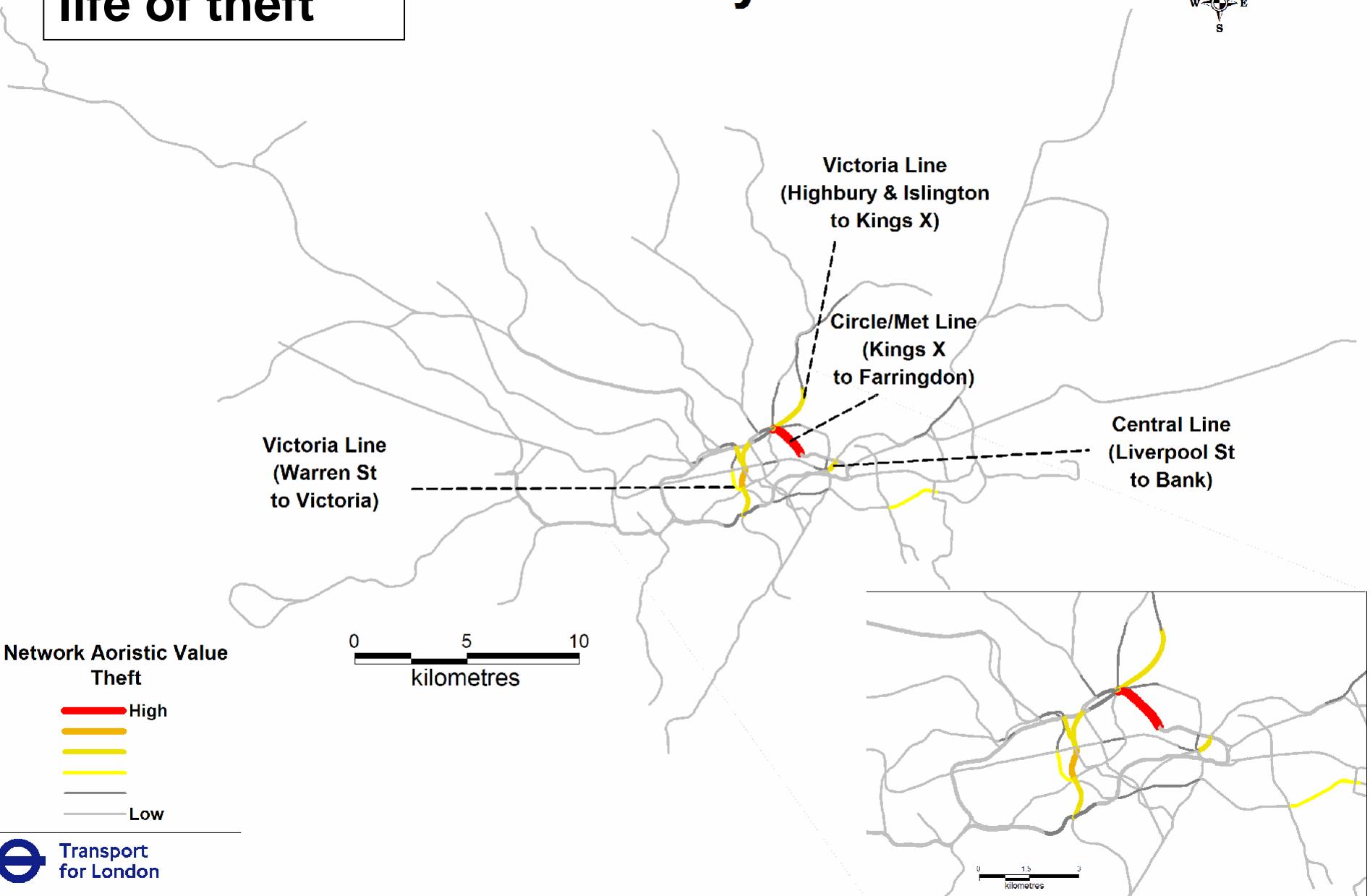
Visualising Aoristic Network Values



- My journey to work
- I'd better watch my pockets!

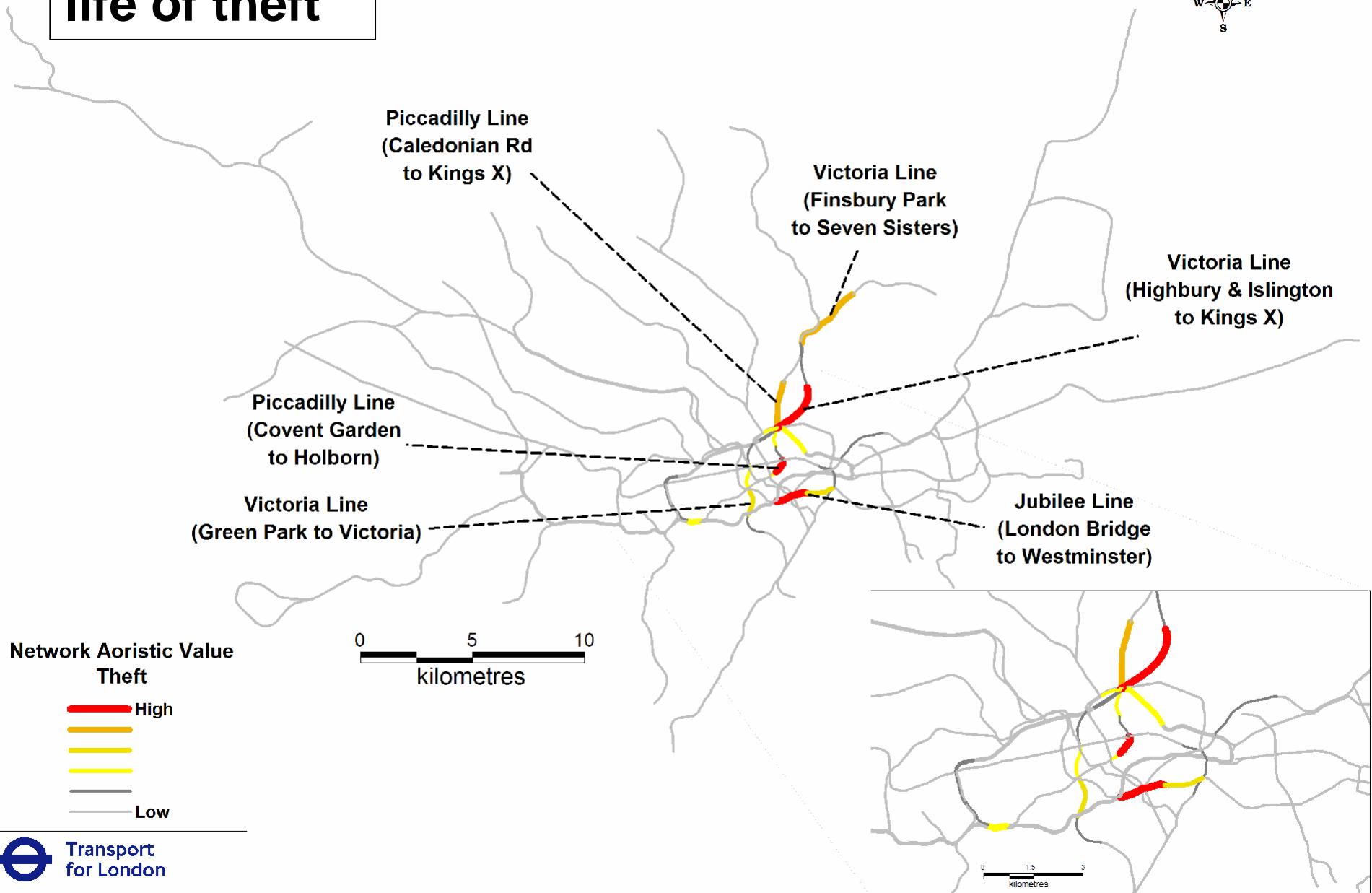
A week in the life of theft

Monday



A day in the life of theft

00:00 - 00:59



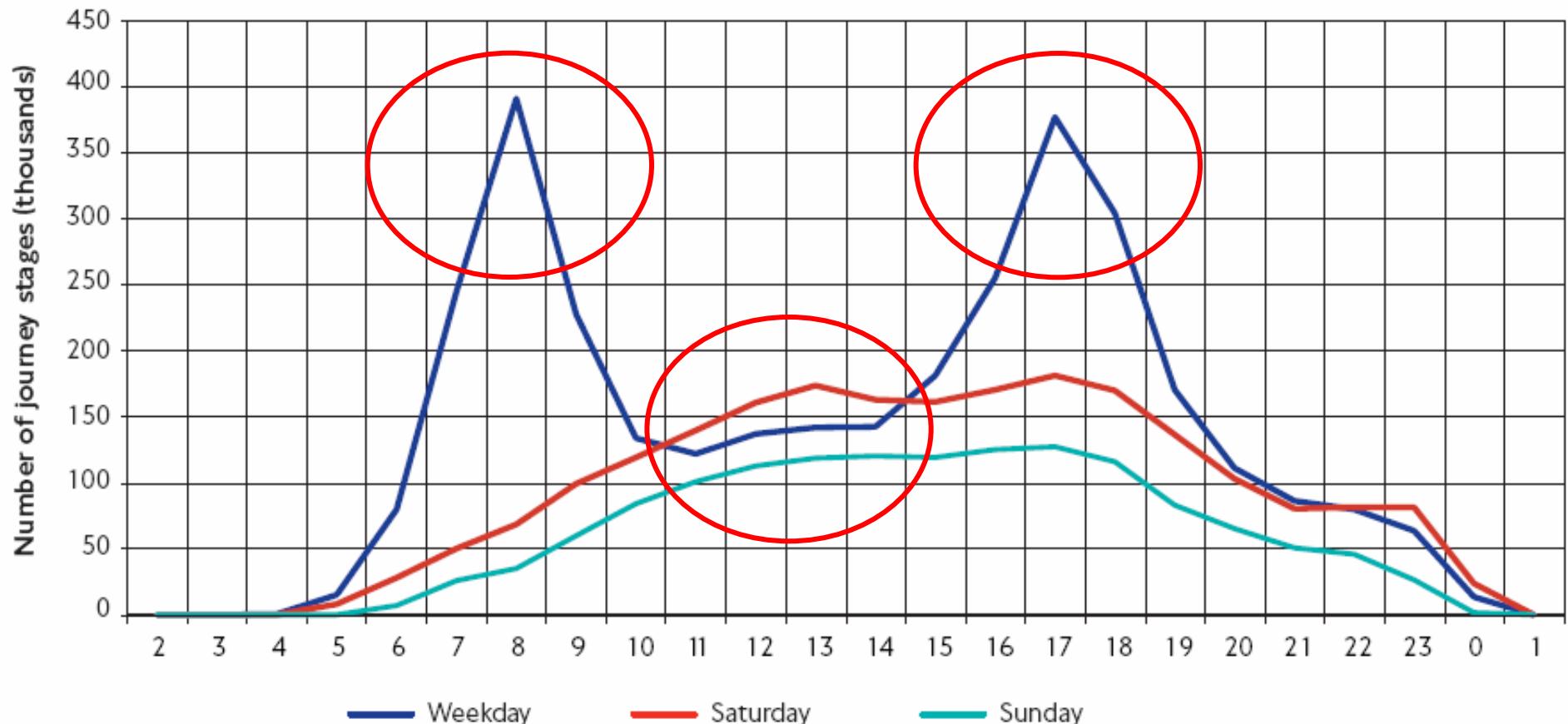
Limitations

- Not automated
- Untested
- Not multi-directional
- Segment time data
- Passenger data

Passengers

Chart 2.4.4 Weekday and weekend Underground journey stages by hour of departure (2005/06)

Source: LUL Entry Counts
Enquiries: 020 7918 4492



Benefits

- Complements intelligence / analysis
- Other offences besides theft
- Feedback mechanism – data quality
- Refined understanding of crime

Evaluation

- Automated tool
- BTP to deploy officers against suggested areas
- Refinement of process

Future Developments

- Phase 1: Underground
- Phase 2: Overground network
 - *BTP policed also*
 - *But adds complexity*
- Phase 3: Bus network
 - *Not as easy to utilise as due to non-landmark nature of bus stops and multiple bus services operating along same route/roads.*

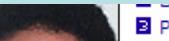
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Notting Hill was "good eating, but a bit hot" - a reference to the relatively heavy police presence there.

Neasden was marked "fight back", an acknowledgement that victims tended to resist.

Colindale was a clear favourite, with "++". The gang knew the location of CCTV cameras at the stations, and would on occasions clamber over fences to avoid them.

Police said the gang was responsible for up to 70



— Britney Spears back into rehab
 PM denies road toll 'stealth tax'



Internet

- Monday, 19 February 2007, 18:06 GMT BBC News Website
- <http://news.bbc.co.uk/1/hi/england/london/6376853.stm>

Thank You

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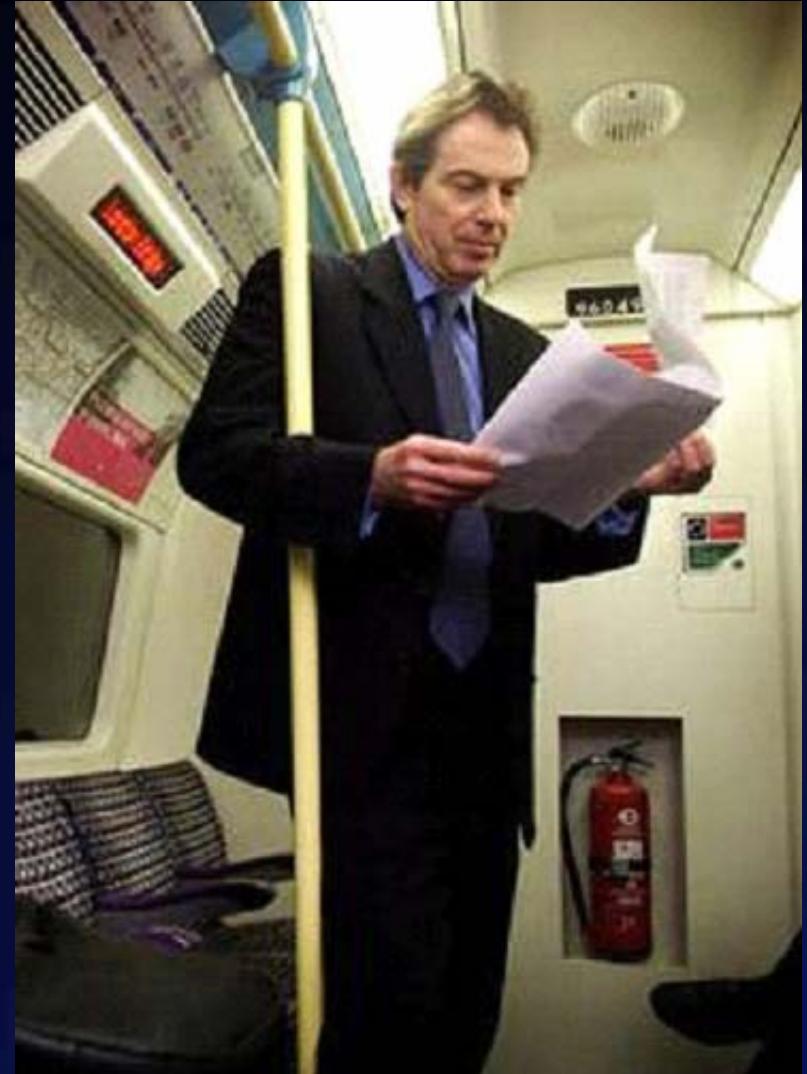
Useful Links

Jerry Ratcliffe

www.jratcliffe.net

Andrew Newton

<http://wcr.sonoma.edu/v5n3/manuscripts/newton.pdf>



www.tfl.gov.uk

9th Crime Mapping Research Conference