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RSSB

Estimating the Approach Frequency to Red Signals – A Big Data Approach

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Introduction

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- The industry places great emphasis on understanding and controlling risks from SPADs
- Knowing the number of trains which approach signals displaying a red aspect is fundamental to:
  - Understanding SPAD risk at individual signals
  - Normalisation data for trending and benchmarking of SPADs
- Previous attempts have estimated the number of red aspect approaches nationally using driver surveys
  - These are considered to have significant shortcomings.
- Can industry data be used to improve this understanding……..?

Background

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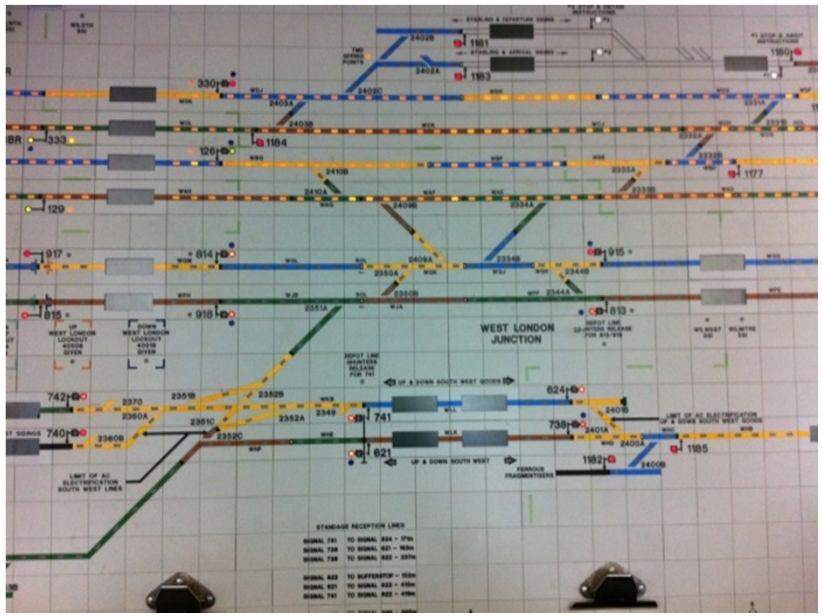
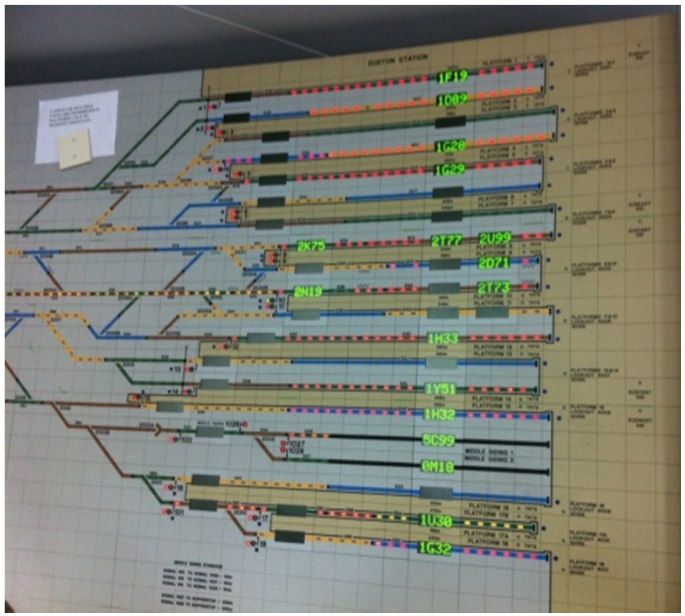
- Knowing the location of trains, and the aspect displayed by signals is fundamental to the operation of the railway.
- A Train Describer (TD) on each signalling panel provides a description of each train in the berth it currently occupies





The Data

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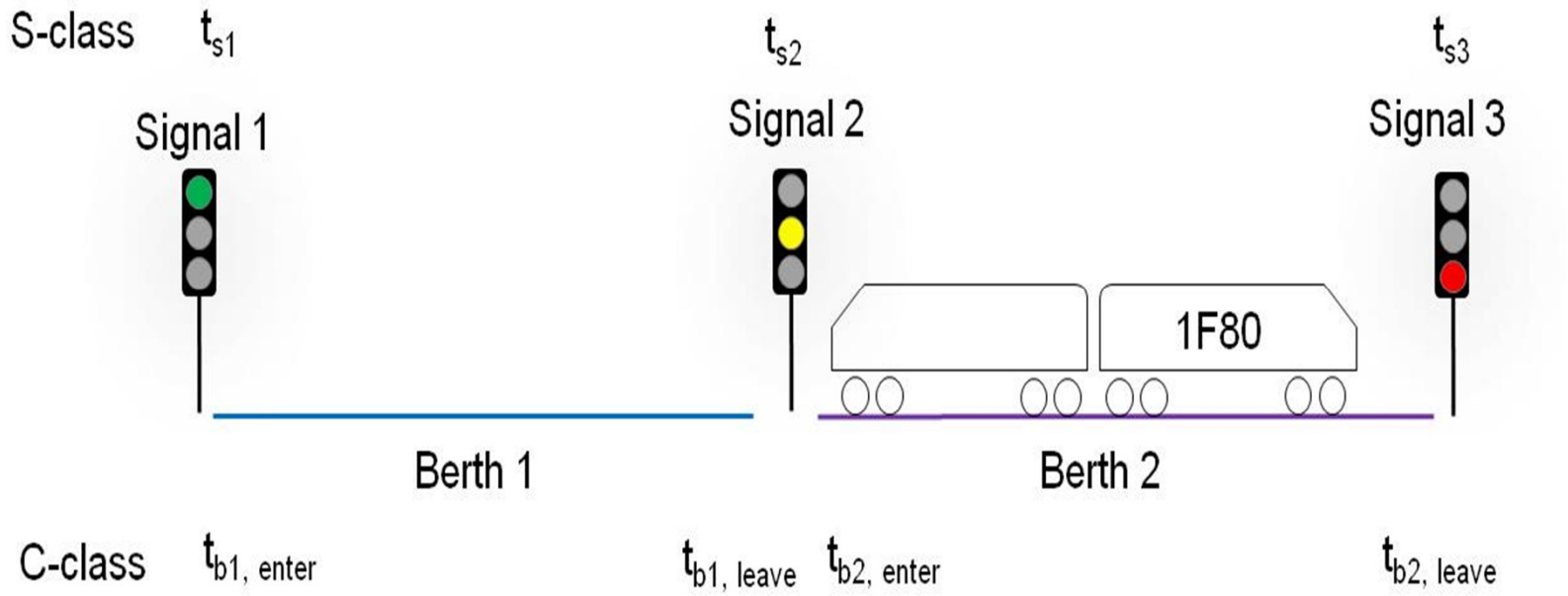
- TD data is publicly available under Network Rail's open data initiative www.networkrail.co.uk/data-feeds
  - S-class messages give signal states (on/off)
  - C-class messages give train movement data through 'berths'



The Data

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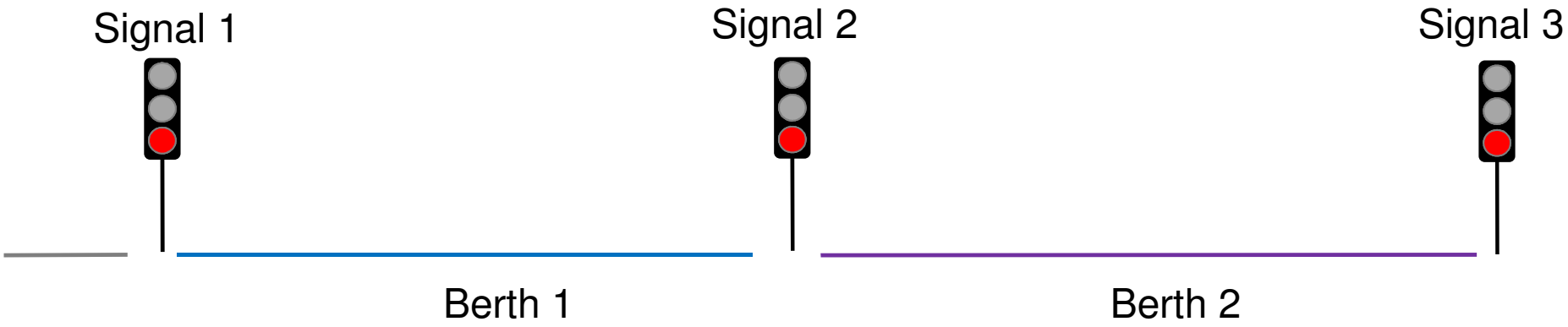

S-class

Time	Signal 1	Signal 2	Signal 3
16:45:00	1	1	1

C-class

	Berth 1		Berth 2	
Train	Enter	Exit	Enter	Exit

The Data

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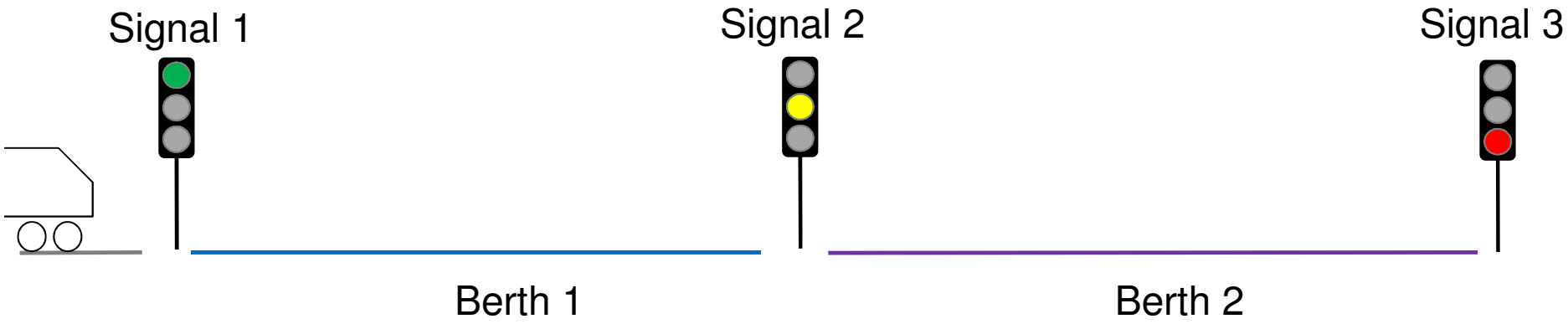

S-class

Time	Signal 1	Signal 2	Signal 3
16:45:00	1	1	1
16:46:00	0	0	1

C-class

	Berth 1		Berth 2	
Train	Enter	Exit	Enter	Exit

The Data

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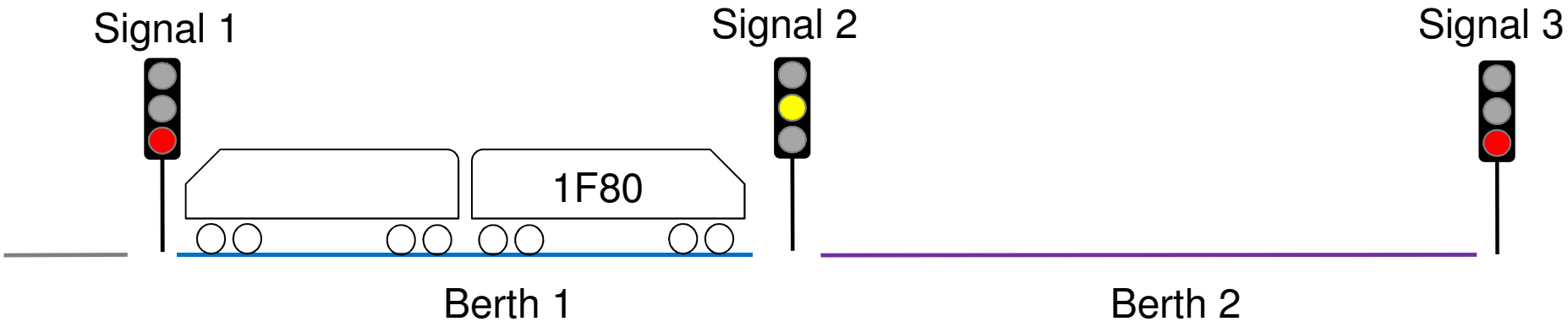

S-class

Time	Signal 1	Signal 2	Signal 3
16:45:00	1	1	1
16:46:00	0	0	1
16:50:00	1	0	1

C-class

	Berth 1		Berth 2	
Train	Enter	Exit	Enter	Exit
1F80	16:50:00			

The Data

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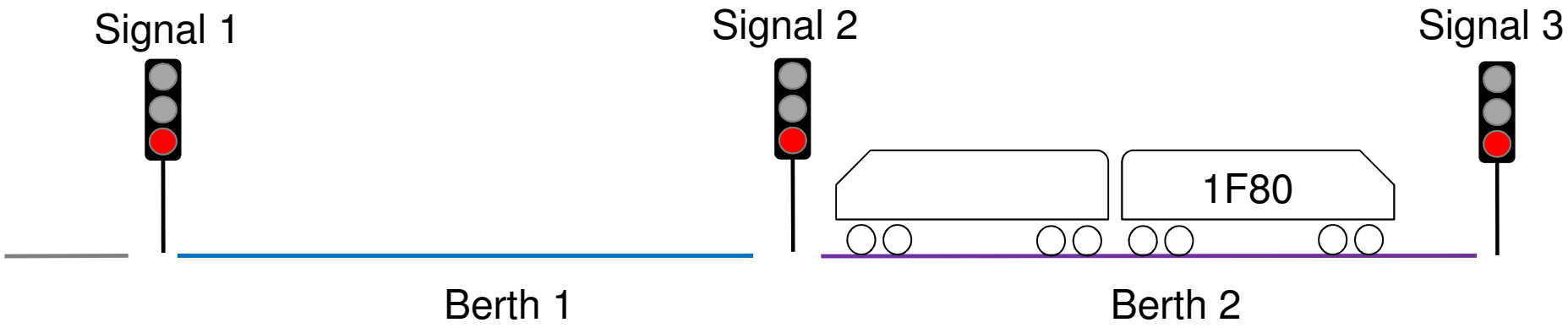

S-class

Time	Signal 1	Signal 2	Signal 3
16:45:00	1	1	1
16:46:00	0	0	1
16:50:00	1	0	1
16:53:00	1	1	1

C-class

	Berth 1		Berth 2	
Train	Enter	Exit	Enter	Exit
1F80	16:50:00			
1F80	16:50:00	16:53:00	16:53:00	

The Data

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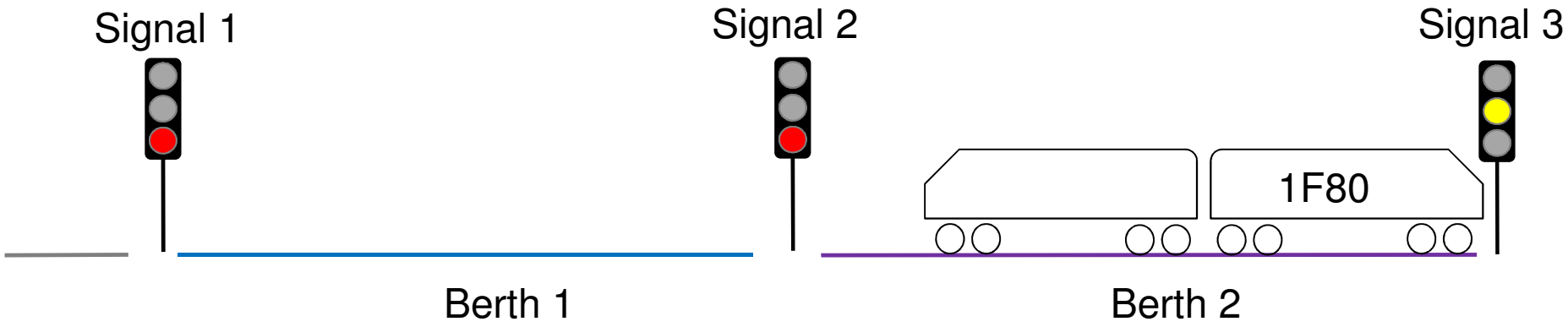

S-class

Time	Signal 1	Signal 2	Signal 3
16:45:00	1	1	1
16:46:00	0	0	1
16:50:00	1	0	1
16:53:00	1	1	1
16:54:00	1	1	0

C-class

	Berth 1		Berth 2	
Train	Enter	Exit	Enter	Exit
1F80	16:50:00			
1F80	16:50:00	16:53:00	16:53:00	

The Data

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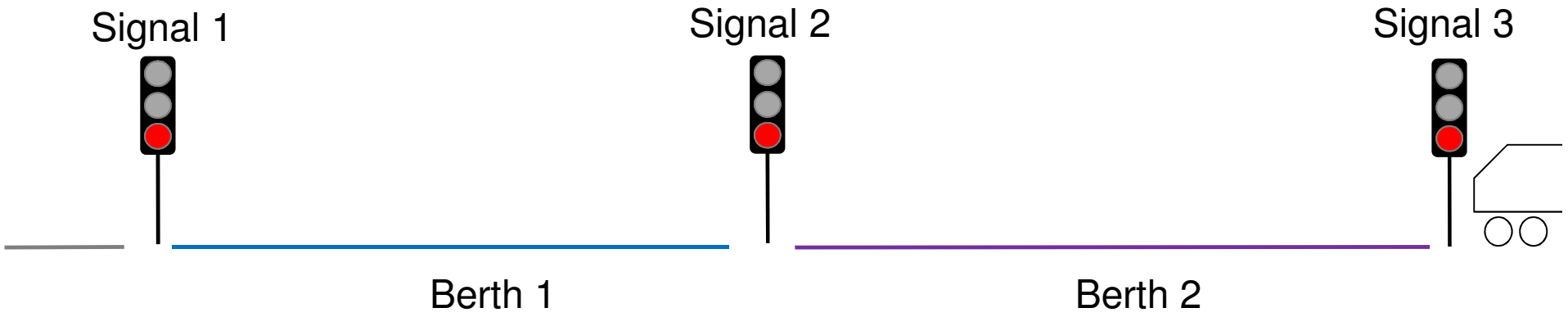

S-class

Time	Signal 1	Signal 2	Signal 3
16:45:00	1	1	1
16:46:00	0	0	1
16:50:00	1	0	1
16:53:00	1	1	1
16:54:00	1	1	0
16:54:10	1	1	1

C-class

	Berth 1		Berth 2	
Train	Enter	Exit	Enter	Exit
1F80	16:50:00			
1F80	16:50:00	16:53:00	16:53:00	
1F80	16:50:00	16:53:00	16:53:00	16:54:10

The Data – Details and Caveats

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- TD coverage
  - 146 TDs provide train movement (C-class) messages
  - Only 61 TDs provide signal aspect (S-class) messages
- Signal IDs are not directly related to berth IDs
- TD S-class decoding
  - 7 out of 61 TD areas are included in the current decoding map
  - Not all signal elements are covered in these TD areas
- The data feed doesn't provide geographic locations, info about signal type etc.

Is it Big Data?

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- Philosophically:
  - Old paradigm – small sample, limited data, extrapolate
  - New paradigm – get all the data, analyse, interpret
- Volume? ✓ Velocity? ✓ Variety? ✗
  - ~5.2 million signalling & train movement messages /day
- But:
  - It is still very structured
  - We don't really use the 'velocity'
  - It is probably only big-ish
  - Our analysis techniques are not really 'Big Data'

Analysis Model - Definitions

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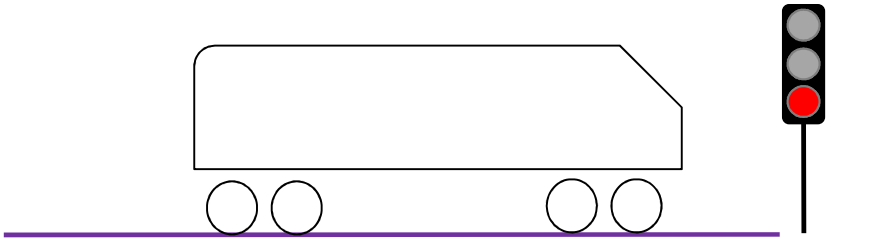
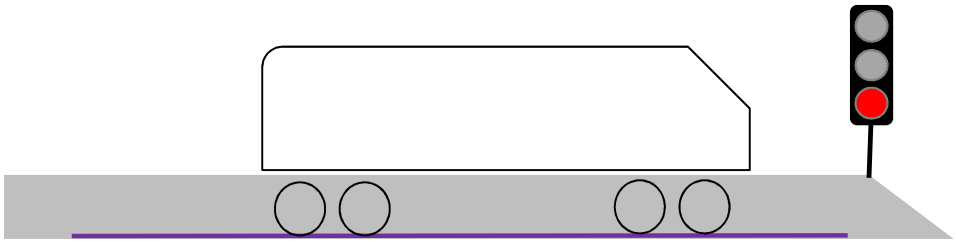


CSS – Cleared Stopped (at) Signal



CBD – Cleared Before Departure

CAS – Cleared Approaching Signal
CNV – Cleared Not Visible

CBB – Cleared Before Berth

Data Flow

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Data Receiving & Storage

- Receive data from NR live feed
- Save the data in an SQL database

Data Processing

- Join Train Movement and Signal Status messages to provide information on the movement of every train and the aspect of the signal it approaches.

Analysis Model

- Identify types of red signal approach incidents using the processed data.
- Collate data for individual signals, groups of signals etc.

GUI

- Present results to user in various formats
- Export data for external use or further analysis

RAATS Tool User Interface

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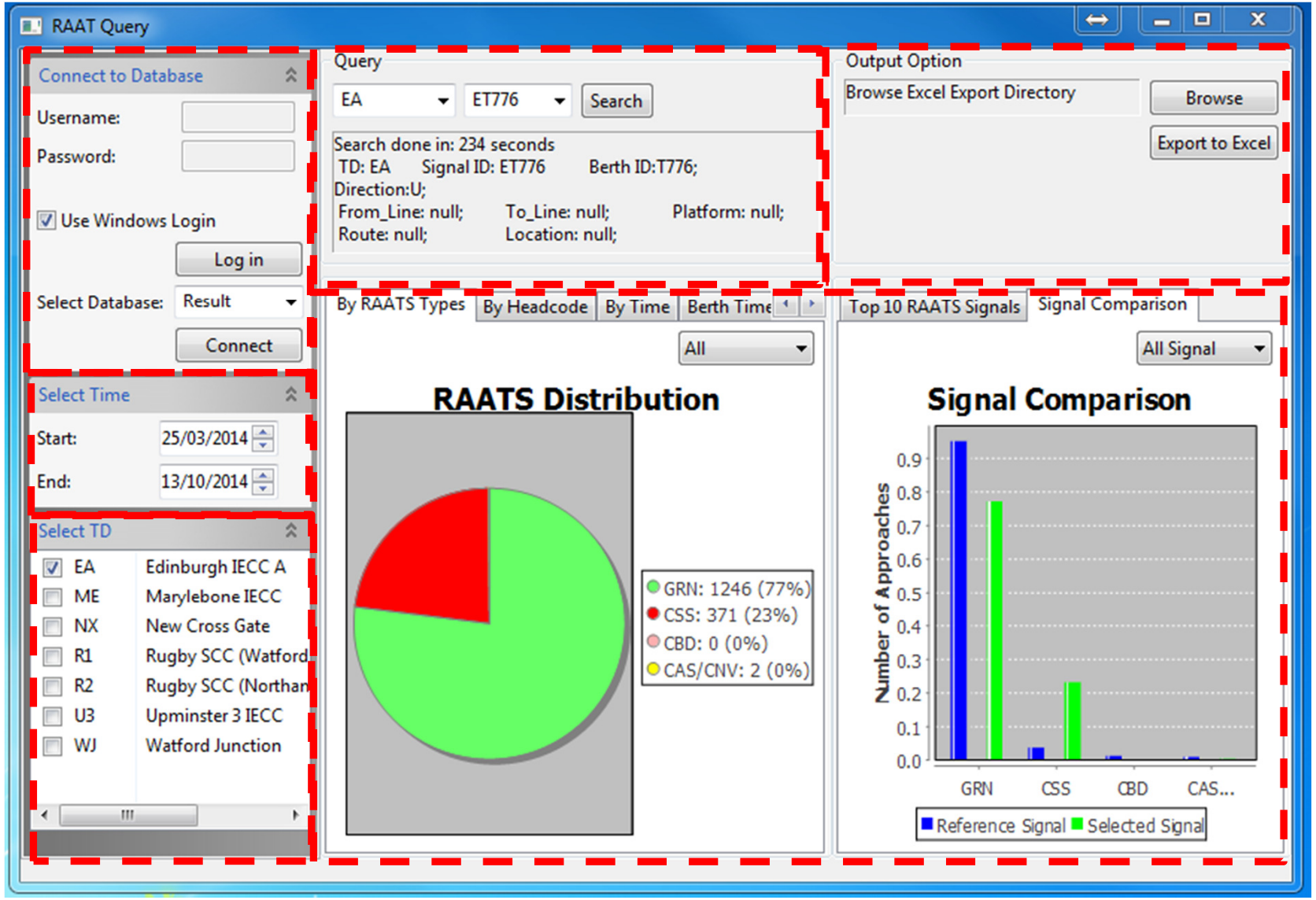

Case Study – 7 TD Areas

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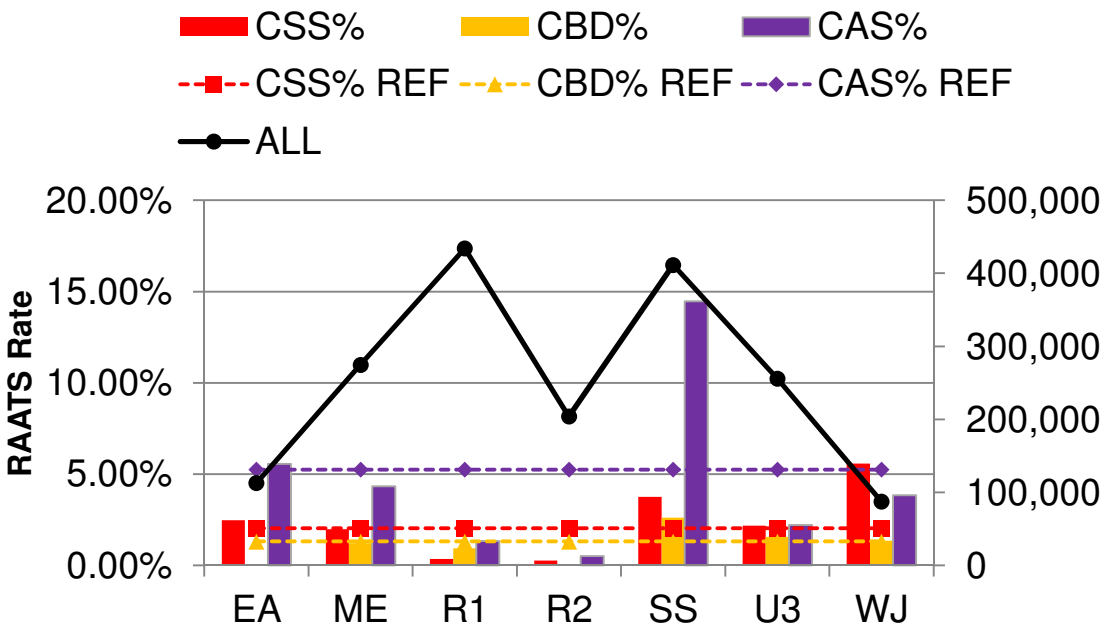

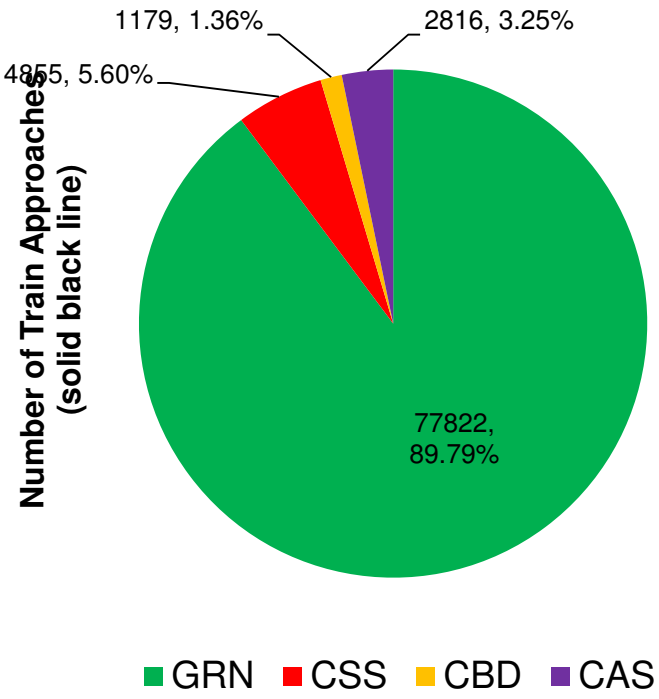

- 7 TD areas, 3 months data
- ~ 1.8M train approaches to 892 signa

TD	Name
EA	Edinburgh IECC A
ME	Marylebone IECC
R1	Rugby SCC (Watford – Bletchley ITD)
R2	Rugby SCC (Northampton – Rugby ITD)
SS	Merseyrail
U3	Upminster 3 IECC
WJ	Watford Junction

Case Study – Multi SPAD 1

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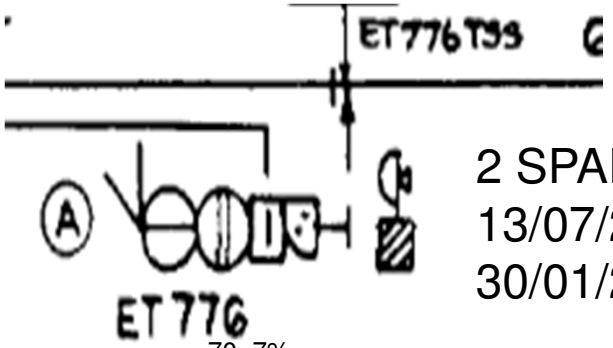
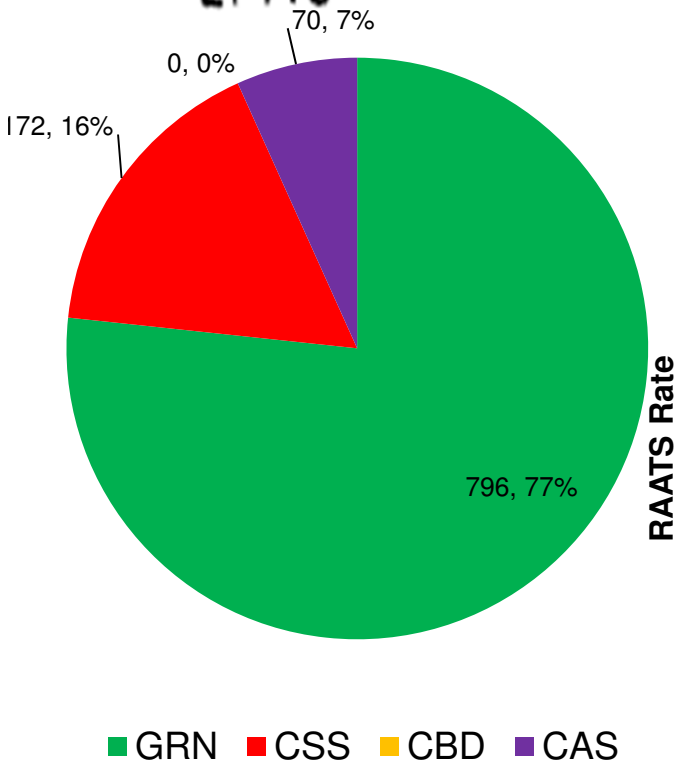
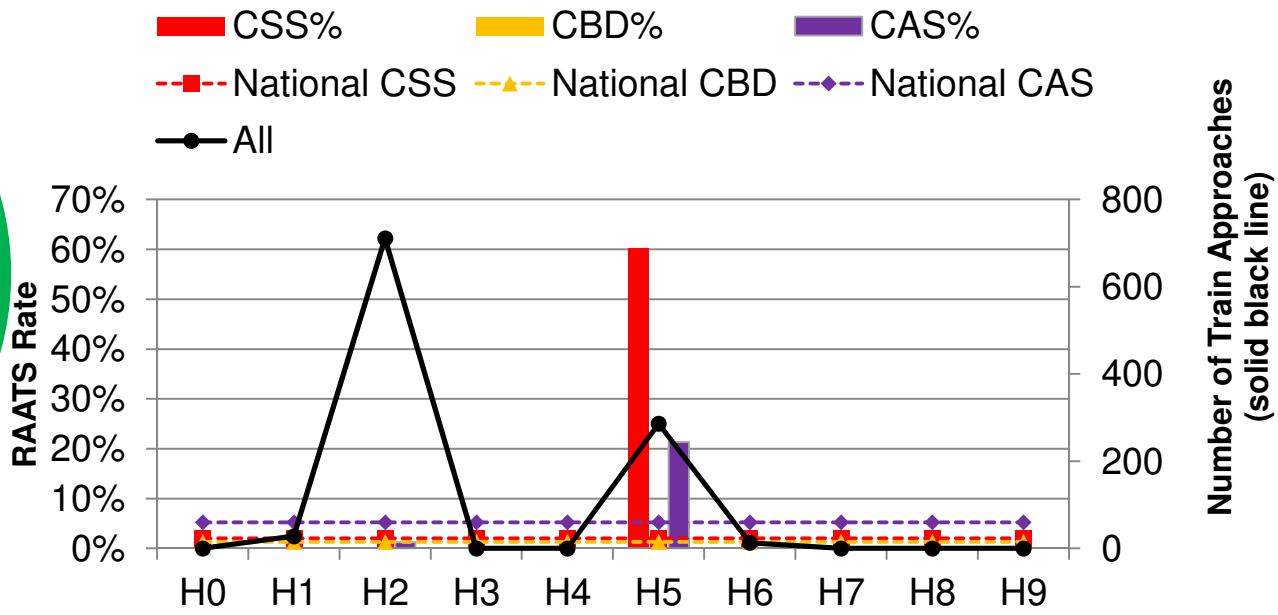


2 SPADs at
13/07/2011,
30/01/2014





Conclusions

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- An analysis model has been developed which allows the number of red signal approaches to be determined:
  - Over whole TD area or many TD areas
  - At individual signals or groups of signals
- The tool will allow:
  - Better understanding of SPAD risk at individual signals
  - Improved normalisation of SPAD data for trending and benchmarking
- An initial study of 7 TD areas showed that on average ~3.3% of signal approaches are to red signals
- There is a large variation between TD areas and between individual signals

Next Steps / Opportunities

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- **Validating the analysis model**
- Extending data availability from 7 to 61 TDs
- Improvements to the data presentation
- Studying the differences (similarities) between multi-SPAD signals
- Make the tool available via a web based interface?
- Consider using results as part of SORAT

Other opportunities:

- Info tailored to routes, TOCs, individual train services
- Timetable analysis / network operations
- Driver training
- …?

RAATS – BDRA Context

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- This is a useful stand-alone application of ‘newly available’ data for the industry

- In many senses it is still quite traditional
  - It only provides lagging information
  - It doesn’t blend several sources and types of data
  - It uses traditional IT software and infrastructure

- However, it could play a part in ‘real’ BDRA by:
  - Being real time (or close to)
  - Being one source in the safety data picture
  - Using other big data to enhance accuracy or information

BDRA – Final Thoughts

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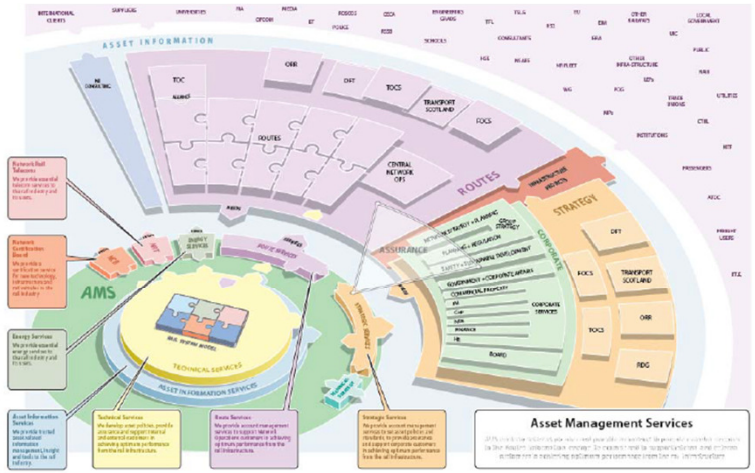
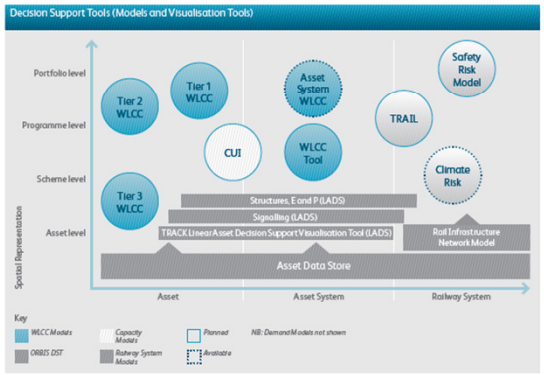
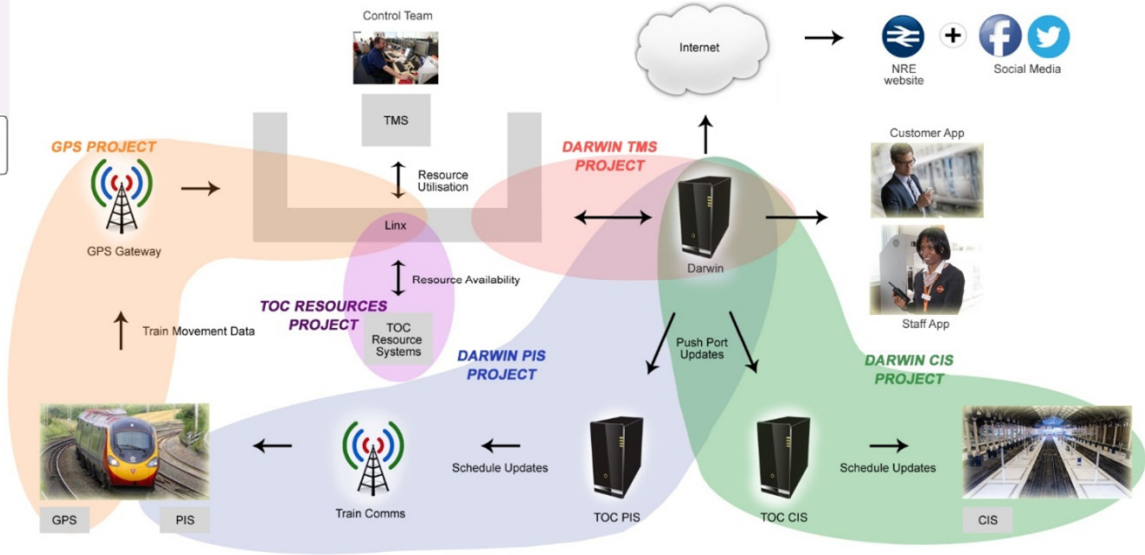
- We already have BD and more is on the way:
  - Network Rail Digital Railway
  - ATOC DARWIN







BDRA – Final Thoughts

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- We have to crack the RA part:
  - The key is how to make our data *useful*
  - How important is leading (vs lagging)?
  - How do we validate our results?
  - Will it allow us to do less, but more of the right things?
  - How will (could) BDRA make the railway safer?
  - Will it make the railway cheaper?

The only way of discovering the limits of the possible is to venture a little way past them into the impossible.

Arthur C. Clarke *Profiles of the Future: An Enquiry into the Limits of the Possible* (1962, rev. 1973), 21.

Hofstadter's Law: It always takes longer than you expect, even when you take into account Hofstadter's Law

Douglas Hofstadter *Gödel, Escher, Bach: An Eternal Golden Braid* (1979), 152

Acknowledgements

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