Timetable Planning

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Timescales

Producing a Timetable

Capacity

Railway inherently inflexible compared to the ad-hoc nature of road transport.

Rail traffic movements must be pre-arranged to exploit the potential capacity – this is where the timetable comes in.

To the intending passenger the timetable is a statement of trains that will run on a given day, the stations served and their planned journey times.

However the timetable also dictates the type and number of trains required and the number of traincrew required to work them

Timetables

Train/Freight Operators develop the timetable

Network Rail Co-ordinate and Validate Timetable

Timetable is updated twice per year: May and December

There is a difference between the National Rail timetable that passengers see and the Working Timetable (WTT) that includes freight movements, empty stock moves and movements on and off depots.

The WTT includes headcodes and intermediate timing points.

Timescales

16 Months Network Rail establishes what long-term engineering work will need to take place as part of its ongoing Railway Upgrade Plan during the period of the new timetable.

14 Months Train and freight operating companies give Network Rail advance notice of any significant changes they wish to make to their current timetable.

16 Months Train and freight operating companies formally submit (‘bid’) their new timetable. For the next three months, Network Rail works on developing the new national timetable from all these bids, checking for conflicts between different operators, and ensuring that trains can be run safely.

Timescales

6 Months Network Rail provides the rail industry with a national ‘base’ timetable, enabling operators to start planning logistics, produce rotas and train staff.

4 Months Operators can ‘bid’ for re-adjustments to their new timetable to take into account such things as known special events or weekend engineering work. Network Rail again works through the bids for each and every week to ensure there are no conflicts and trains can be run safely.

3 Months The new timetable for each week is finalised and the railway industry formally publishes the timetable to passengers. Advance tickets go on sale.

Timescales for disruptive Possessions

Rules of the Route Rules agreed with train operators under which speed restrictions or temporary line closures can be imposed for maintenance purposes.

Disruptive Possessions need to be consulted and agreed with Operators prior to 16 months before the planned works.

The **schedule 4** regime compensates operators for the financial impact of planned possessions – where they can't access the **network** because of **Network Rail's** engineering.

Sectional Running Times

The running time between stations depends on features of the trains and the routes on which they will run. A further factor is whether the train is to stop at or pass each station. Naturally running from A to B takes longer if starting from rest and running to a stop than if covering the distance at full speed. So for each pair of stations (which, together with junctions, are known as “timing points”), up to four different “point to point timings” are quoted:

start to stop;
start to pass;
pass to pass;
pass to stop.

Timing load for each type of train, taking into account acceleration and braking characteristics.
SRTs may vary in different directions due to gradients

Timing a train on the basis of its full capabilities leaves no margin to recover from adverse events on the journey.

The base simulation may assume that only a proportion of the nominal tractive effort is used, and that the braking rate is typical of actual practice rather than being the full emergency rate.

With the adoption by Train Operators of ‘Professional Driving’ standards, it is essential that the calculation of sectional running times reflects how trains are actually driven, through observations and timing runs.

It is also normal to add some “allowances”, or additional time over and above the SRTs, at critical points, and for a variety of reasons.

Engineering Allowances

Engineering Time: allows for recovery from temporary speed restrictions, or for loss of speed incurred when crossing between lines to avoid engineering works.

The Planning Rules will lay down the amount of time to be allowed, and the arrangements for planning engineering work will then limit the number of planned restrictions or diversions to a level consistent with the total allowance;

Other Factors

Performance Time: added on the approach to termini or major junctions simply to reduce the impact of delays incurred on the journey thus far.

A similar effect to Performance Time is given by “Public Book differentials”, where advertised times at intermediate stations and for arrival at the terminus are later than the “working” times.

Often referred to as an allowance is Pathing Time. This is frequently identified in the timetable on the approach to junctions, when the required timings of trains to the junction do not match the paths available across the junction. Of course should a train with pathing time be running late, the pathing time will indeed promote recovery, but that is not its purpose.

Simple Track Layouts

Single line, one train

No junctions or interaction with other services other than connections for passengers. Stourbridge to Stourbridge Jcn

Circlular Line

Most efficient layout, trains running in a continuous Circle. Glasgow Subway

Double Track Layouts

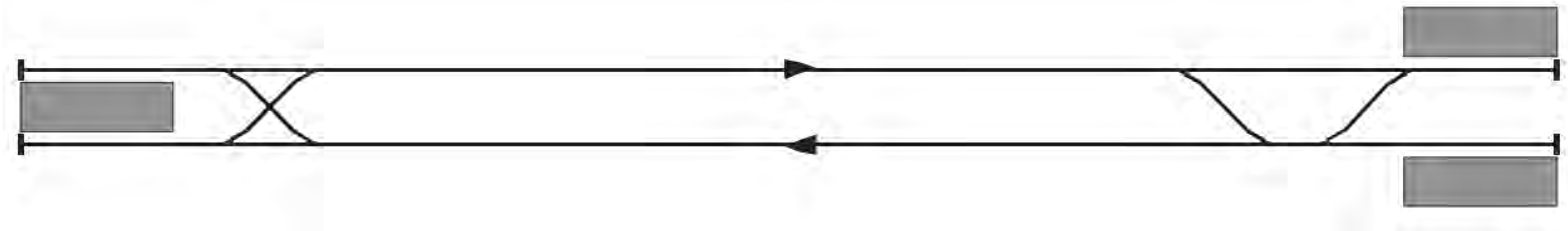
Increased capacity as trains have a dedicated route for each direction.

Complicated by crossover moves

Can’t easily overtake slower moving trains

Depending on the signalling system can carry 20-40 tph

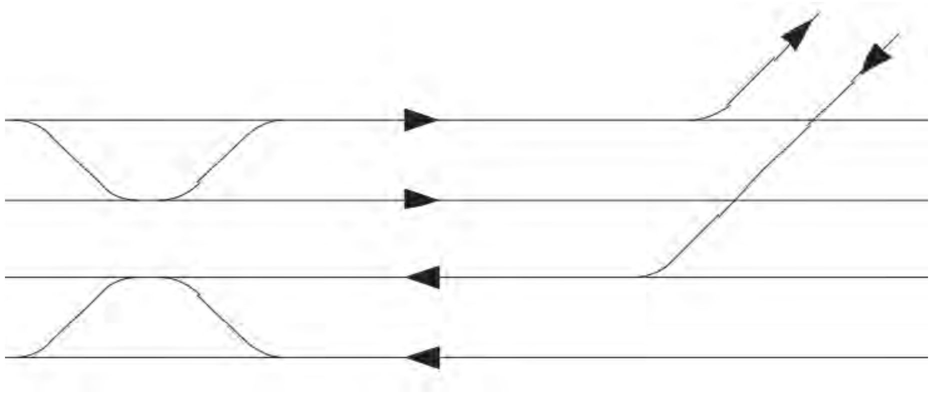
Improved capacity by “Flighting”



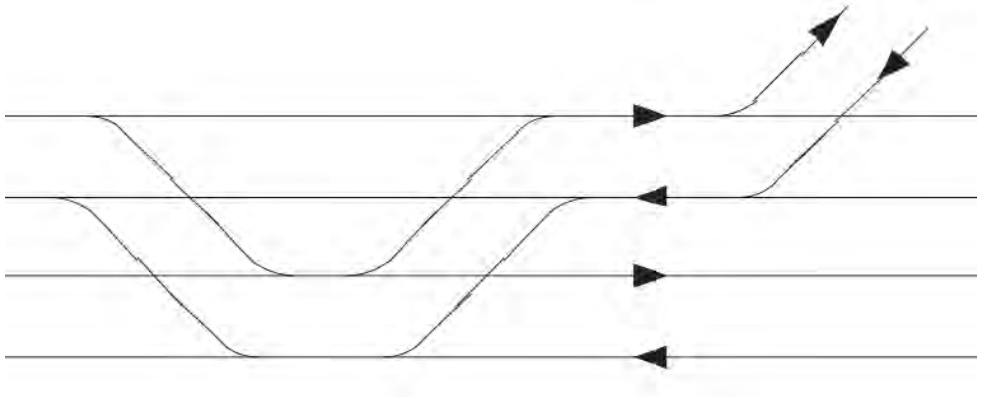
Quadrouple Track Layouts

Allow faster trains to overtake slower moving ones

Pair by Direction



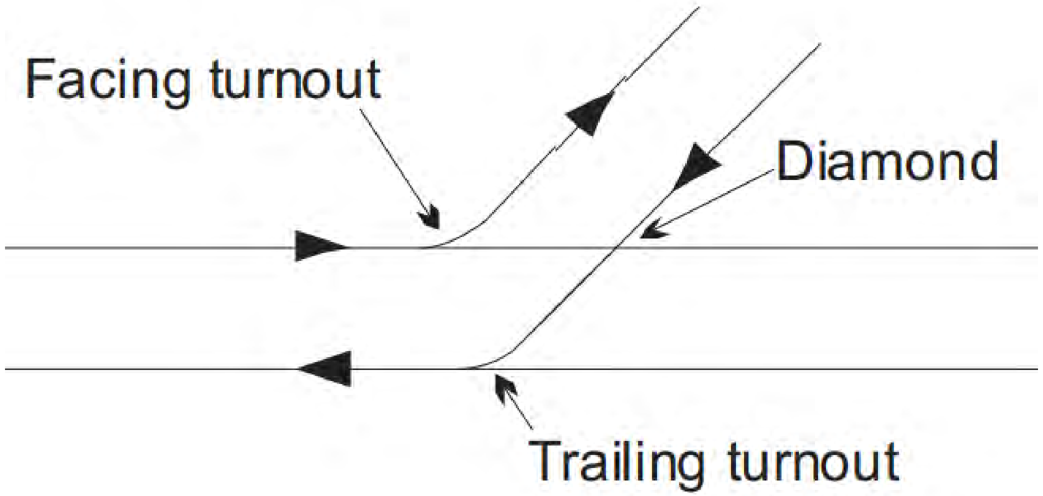
Pair by Use



Pair by direction gives the flexibility to cross from one track to the other without conflicting with trains in the opposite direction.

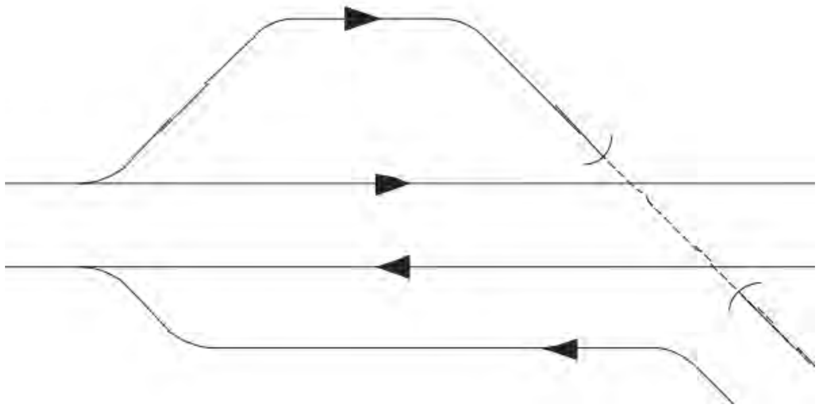
Pair by use works best where there are frequent junctions

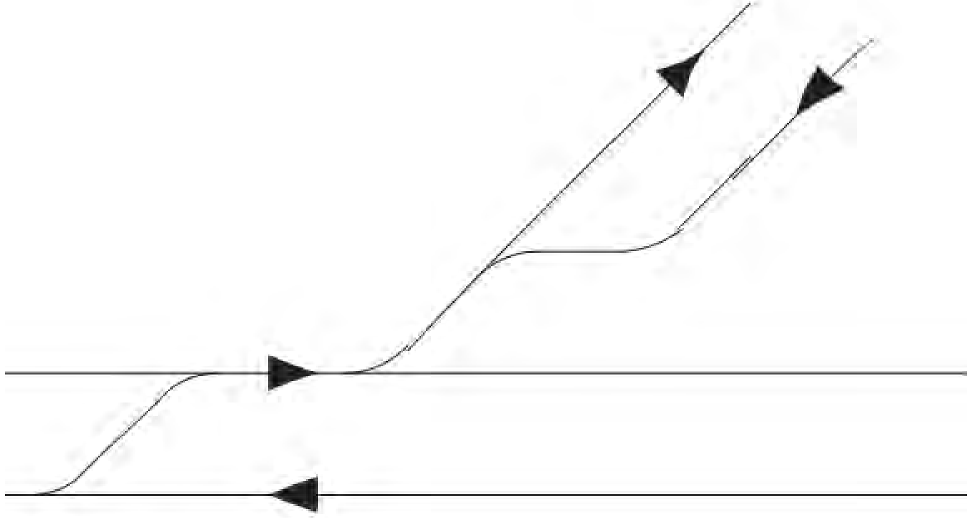
Junctions



The signalling will prevent collisions between trains at points of conflict, whilst the timetable will plan timings of trains that aim to ensure that trains run without the need to stop for signal checks.

One of the skills of the train planner is designing a timetable that maximises use of parallel moves, and so minimises lost opportunities to run trains.

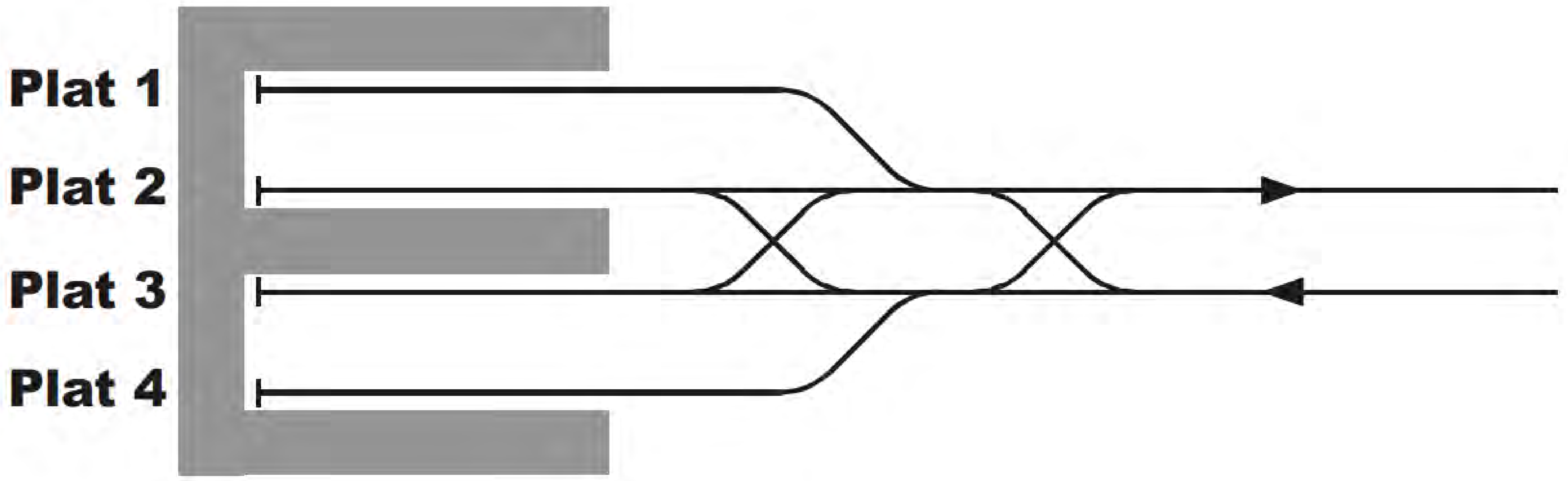




Termini

Except for a closed loop there must be facilities at the end of the lines for trains to stop and start back.

This simple but effective layout allows the maximum number of parallel moves to take place



Train Performance

How long they take to run from station to station (or timing points)

The arrangements necessary at the end of one journey in order to send a train back on another journey

How long they need to spend in stations for loading and unloading

How long they can run without servicing such as fuelling or maintenance whether they are confined to specific routes in the network by reason factors such as:

Electrification, structure gauge restrictions or axleweight restrictions.

Signalling System

Enforcing a separation between trains by means of a signalling system implies a limit on the frequency at which they can operate, and on the speed at which they can run.

The “Headway” is the minimum time interval between consecutive trains that still allows each to run at the full permitted speed without having to brake.

This time interval depends upon both the distance between trains and the speed at which they run.

Calculating headways

Formulae for calculating headways on 3- and 4-aspect signalling are given in the Institution of Railway Signal Engineer's textbook "Railway Signalling":

- $T3 = (2D + O + L)/V + 10$
- $T4 = (1.5D + O + L)/V + 10$

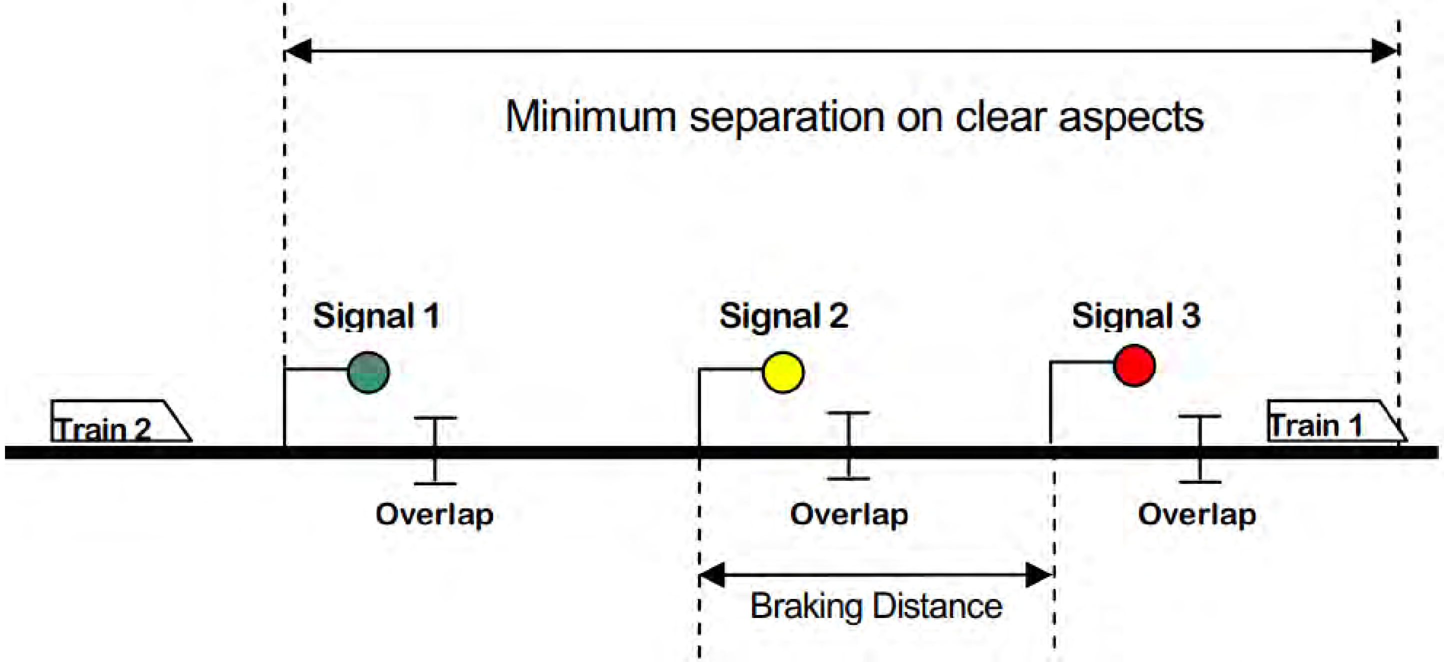
where:

- T3 is the headway time (in seconds) for 3-aspect signalling;
- T4 is the headway time (in seconds) for 4-aspect signalling;
- D is the required braking distance (in metres) from the full permissible speed;
- O is the length (in metres) of the overlap of the danger signal;
- V is the train speed (in metres per second)
- L is the length (in metres) of one of the trains
- 10 is the Sighting Time in seconds.

3-Aspect Signalling System

To maintain running on green aspects, the distance separating the leading ends of two consecutive trains, termed the Separation Distance, must be at least:

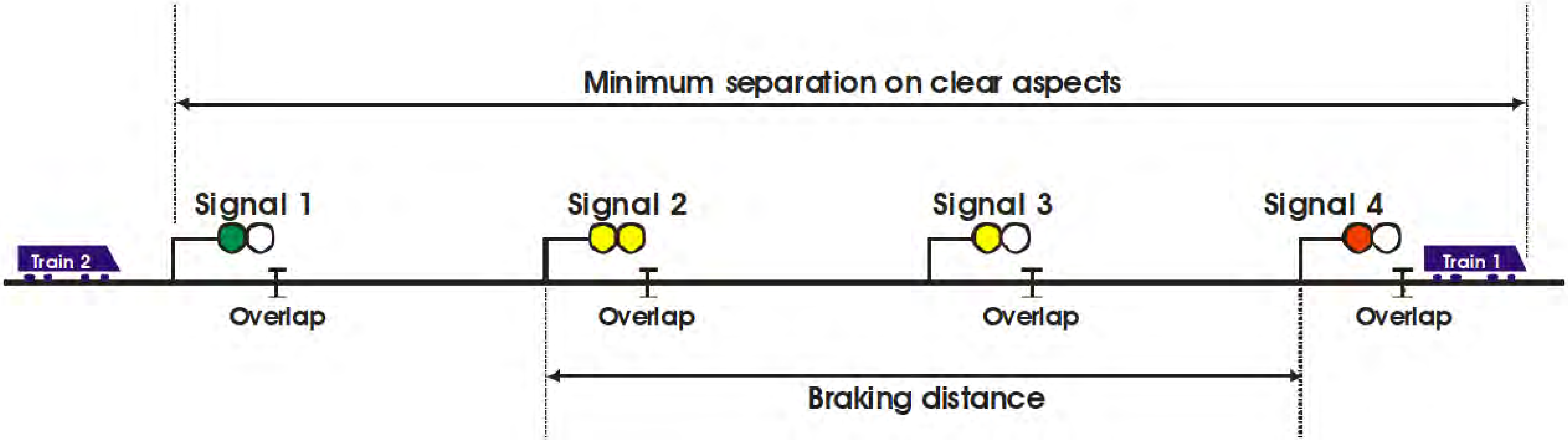
- the total of the lengths of the intervening sections, plus:
- the length of the overlap of the red signal; plus
- the length of the first of the trains.



4-Aspect Signalling System

To maintain running on green aspects, the distance separating the leading ends of two consecutive trains, termed the Separation Distance, must be at least:

- the total of the lengths of the intervening sections, plus:
- the length of the overlap of the red signal; plus
- the length of the first of the trains.



Headways

This bare minimum separation time is known as the Green-to-Green time, meaning the time elapsing between a given signal (in this case Signal 1) being passed at Green and again showing Green for the next train.

Headway times

To give the Headway Time (known as the Signalling Headway or Technical Headway), a further element – the Sighting Time, normally 8 or 10 seconds
- Is added to the Green-to-Green time to ensure that each signal is within the view of a driver for long enough for it to be noticed and interpreted correctly

Compiling the Timetable

The factors driving development of a timetable will vary with the type of railway in question. For instance:

An intensively-worked suburban railway or Inter City type operations will probably structure its timetable to exploit capacity efficiently

A rural or regional railway is more likely to be driven by minimising costs, aiming for efficient use of rolling stock and crews.

In both these cases the key influence results from government requirements for capacity-provision or cost-reduction ie what have you committed to in your franchise?

This would be a consideration for a profitable open access operator though.

Compiling a Schedule for an Individual Train

Building a schedule for a single trip is straightforward.

The appropriate point-to-point timings are simply summated, with station dwell times added, and any required allowances.

The trip may be “forward timed”, that is, by deciding upon the required departure time and working forwards.

Or “back timed”, by fixing the arrival time and subtracting point-to-point times from that.

It might indeed be back-timed from a critical intermediate station and forward-timed thereafter.

Combining Schedules into a Timetable

Perhaps the most difficult thing is deciding where to start!

The starting point might be a long-standing and well-established departure time, such as the 10:00 from Kings Cross.

It might be a required arrival time – for commuters on a rural route an arrival in town at 08:35 is normally critical.

In practice, on a multi-user railway, it is highly likely that the operator who wishes to change the timetable will have to honour existing paths of other (particularly long distance) operators

Now it’s Getting Complicated!

Having fixed one train, others follow logically.

Next into the plan might be the previous or next working of the first set of vehicles, reflecting the terminal turnround time.

Otherwise the first train might be replicated on an hourly pattern, or it may have connections on route determined by its times at intermediate stations.

Key junction on route is known to be critical, and the next train into the plan might be one that makes a parallel move at that junction.

The remit to the train planner might be to get the most use out of limited resources, in which case considerations such as regular service intervals might be secondary.

Final Steps

As each trip is added, the planner checks that headways and junction margins are not infringed, adjusting timings if necessary.

As the timetable builds up, further trains will be forced into particular timings by the free slots remaining at each point on its route, eventually with resort to pathing time to make everything fit.

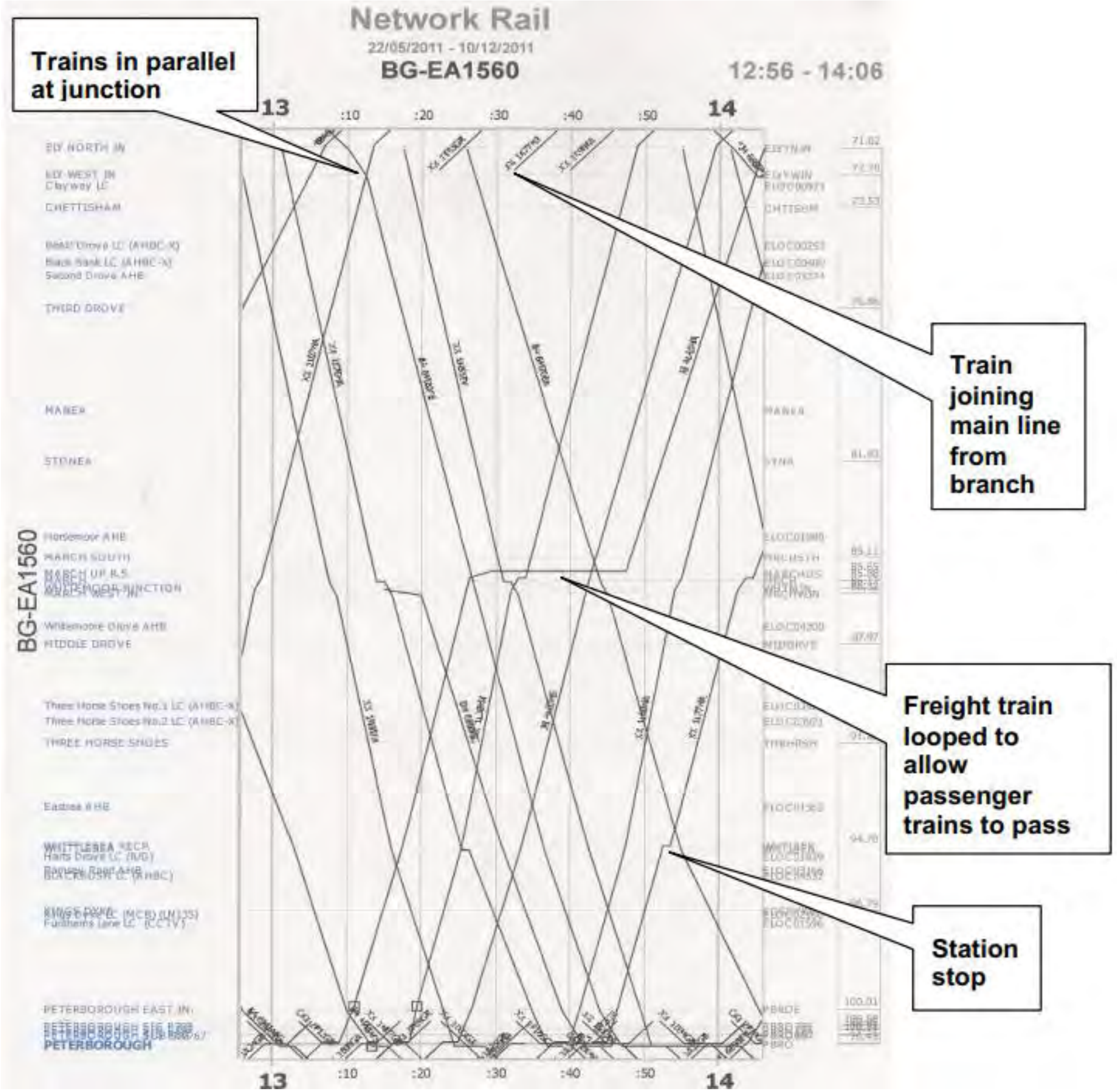
Lost capacity arising from mixing fast and slow trains on the same line can be minimised by “flighting” of trains, that is, running trains of similar speeds in groups, or planning a series of trains with the fastest first and the slowest last.

Other planning strategies to economise on capacity include harmonisation of train speeds by allocating a number of stops to each, possibly grouping the stops

Timetable Planning Tools

When individual trips have to be blended into a complete timetable, visual representations of the service are helpful. The two prime visual tools are:

- the timings graph;
- the platform occupation chart.



Development of Timetabling

The classic method of timing trains was to prepare a train graph by hand.

Since about 1990, computerised packages have been available to take the manual work out of timetable planning. These will typically store a database of point to point running times for each relevant type of train.

By specifying a key time and stopping pattern, a trip schedule is created, and translated into a graphical representation if required.

More sophisticated systems will have the capability to generate timings from stored train and route data. Facilities such as “nudge” and “drag ‘n drop” on a graph can be expected. Electronic data exchange between offices and organisations, produce both Working and Public timetable format.
Extending into rolling stock and crew diagramming, or at least interfaces with specific packages for those purposes.