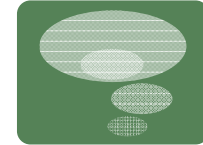# Vital Train Queues – selected applications

Peter Burns, PYB Consulting
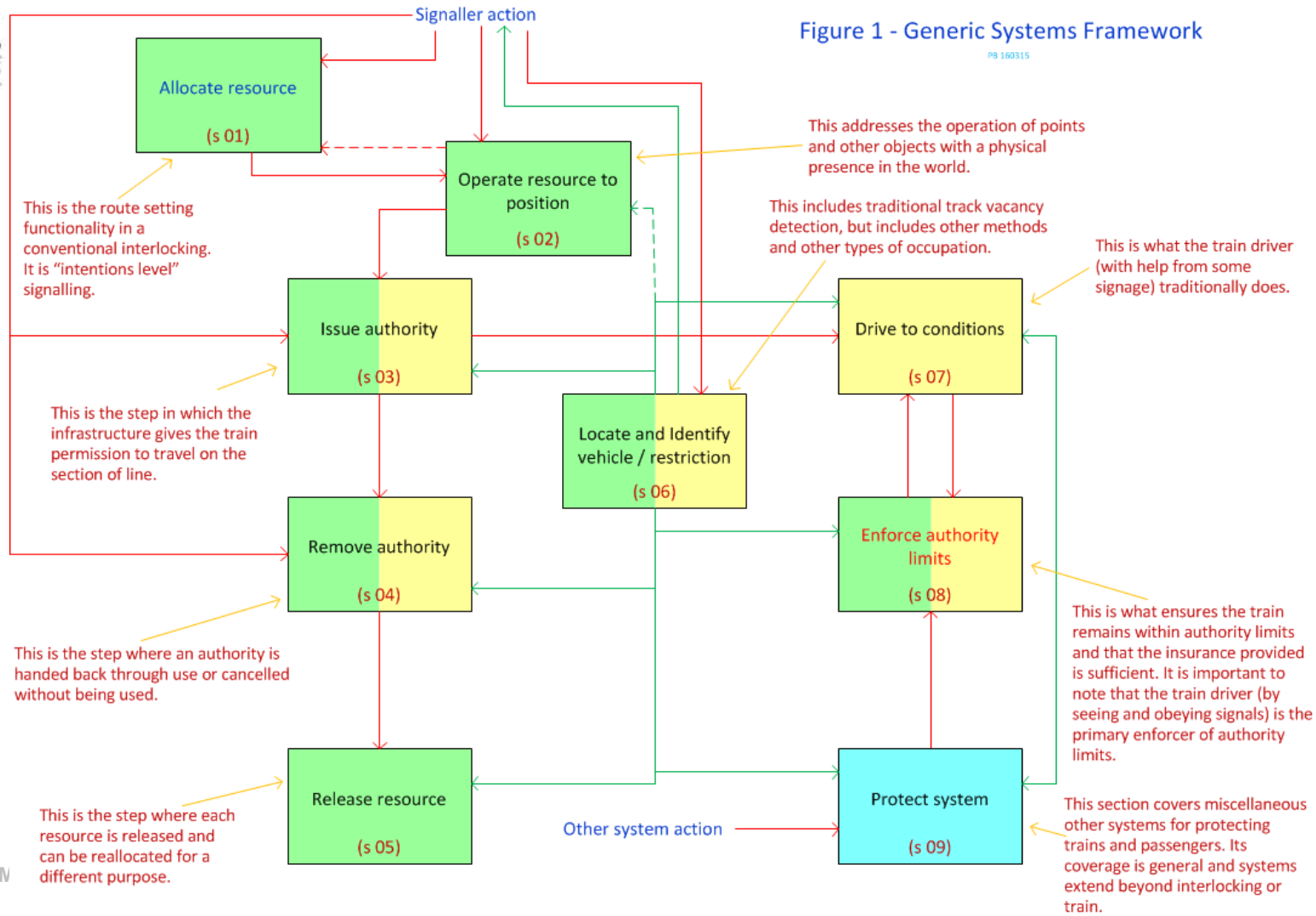
Overview

- Context
  - The "open road" view of the authority process

- Introducing train queues
  - Converging and diverging
  - A road based example

- Controlling points
  - Train queues in infrastructure

- Bi-directional applications

Figure 1 - Generic Systems Framework

PB 160315

Signaller action

Allocate resource
(s 01)

Operate resource to position
(s 02)

Issue authority
(s 03)

Remove authority
(s 04)

Release resource
(s 05)

Locate and Identify vehicle / restriction
(s 06)

Drive to conditions
(s 07)

Enforce authority limits
(s 08)

Protect system
(s 09)

Other system action

This is the route setting functionality in a conventional interlocking. It is "intentions level" signalling.

This is the step in which the infrastructure gives the train permission to travel on the section of line.

This is the step where an authority is handed back through use or cancelled without being used.

This is the step where each resource is released and can be reallocated for a different purpose.

This addresses the operation of points and other objects with a physical presence in the world.

This includes traditional track vacancy detection, but includes other methods and other types of occupation.

This is what the train driver (with help from some signage) traditionally does.

This is what ensures the train remains within authority limits and that the insurance provided is sufficient. It is important to note that the train driver (by seeing and obeying signals) is the primary enforcer of authority limits.

This section covers miscellaneous other systems for protecting trains and passengers. Its coverage is general and systems extend beyond interlocking or train.

11/11/16

What is an authority?

- An Authority is a Contract
  - Meeting of Minds
    - Common Understanding: Train v Infrastructure
  - Agreement between parties
    - Identified Train v Identified Infrastructure
    - Formal process
  - A Subject (Scope)
    - Can be about imposing a restriction
  - Terms and Conditions
    - The rules of the Rail Authority
    - Special conditions
  - Consideration
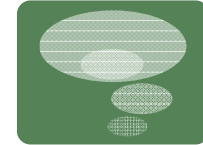
What is protection?
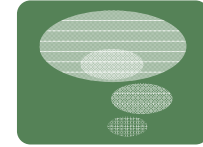
- Protection is a Unilateral Activity
  - No agreement required with another party
    - Front to rear collision avoidance
    - Earthquake protection
    - Landslide protection
    - Failsafe responses

- Protection and Authority Functions are different but complementary

Open Road Concept

- Closed Road Concept
  - Thicket of authorities

- Open road Concept
  - "Protection" function assists "Authority" function
  - Single authority for long section
  - Train protects rear of train ahead
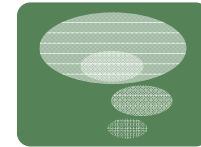
Figure 3: Closed road ETCS

Train · Stopping distance · End of authority

Closed gates · Open gates
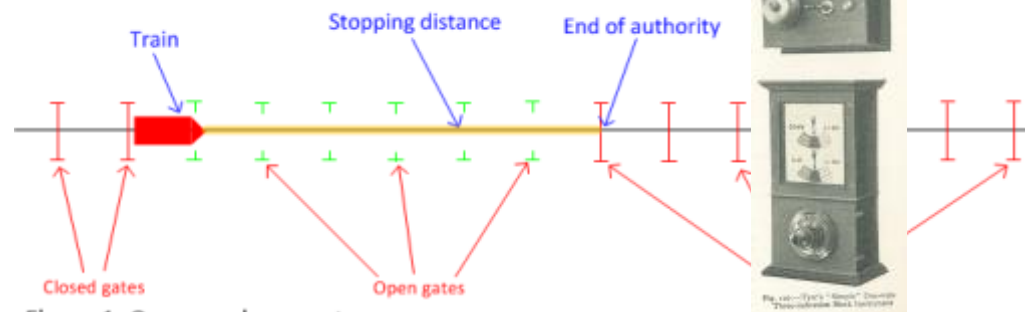
Figure 1: Open road concept

Distance to go · DTG · DTG · Closed gate

Open gate · Closed gate

Protection point · Protection point · Protection point

Authority section
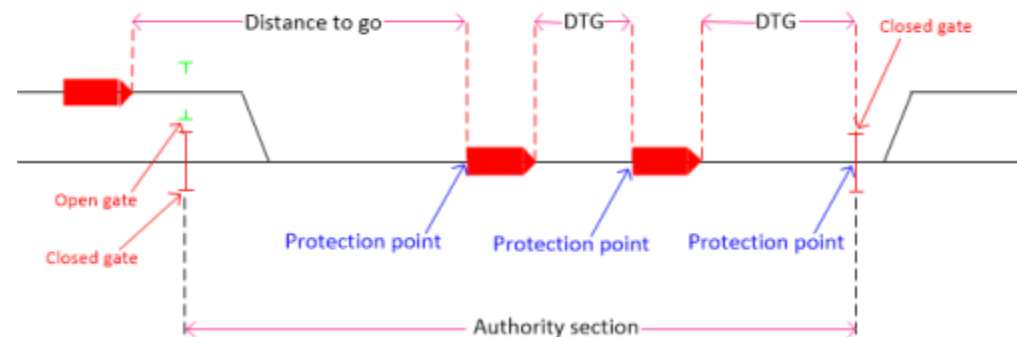
What is a train queue?

- A train queue is a list of trains scheduled to pass a fixed point in the order in which they are scheduled to pass
  - The entry for each train may include:
    - Identity of train
    - Direction train will approach
    - Time train is scheduled
    - A link to another train queue

- A timetable is an example of a queue set

- Train queues can be dynamic

Converging/ Diverging Train Queue
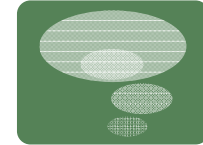
- Direction determines type of queue

- Protection point is at nearest clearance point unless train ahead path and direction are common

- Authority required to pass nearest clearance point

Train x ← Diverging queue direction
→ Converging queue direction

Clearance points

Train x
Train y
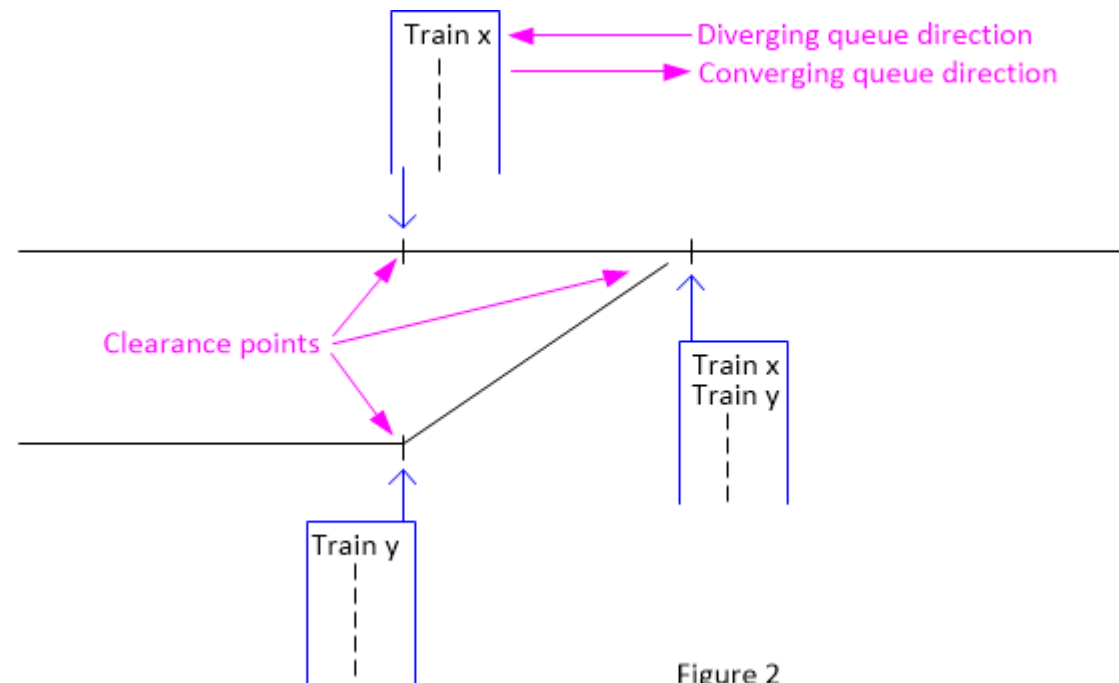
Train y

Figure 2
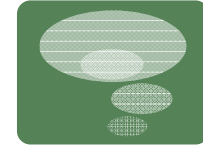
Plain Line queues

- Queue includes
  - Train ID
  - Order on queue
  - Direction

- Train may not proceed if not in queue

- Train above is train ahead

- May not proceed beyond protection point if direction is opposing

Train C
Train A

Protection points
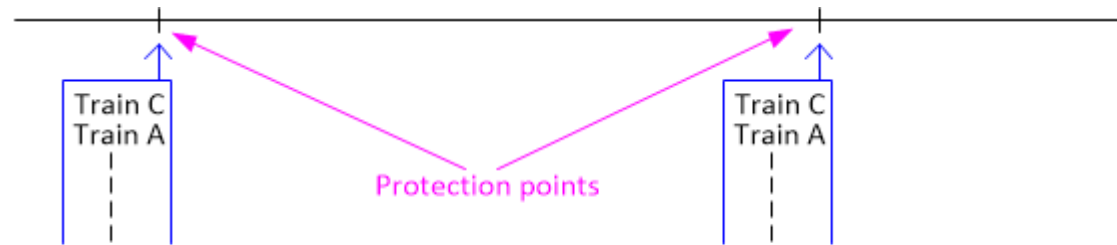
Train C
Train A

Figure 3

Plain Line queue - example
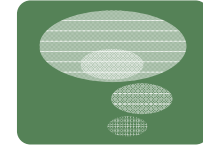
- Multiple trains have authority to travel on line

- Each train protects the rear of the train ahead
  - Order in queue does not change
  - Trains broadcast location (via infrastructure)
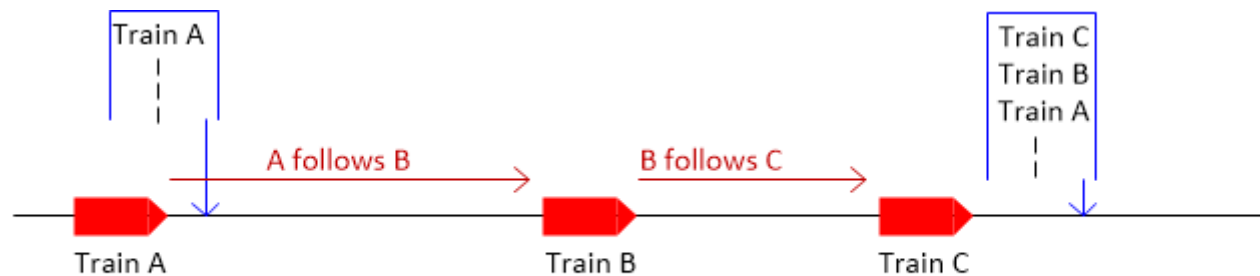
Figure 4

Plain Line queue - example
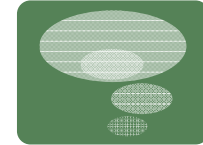
- Line with point conflicts removed
  - Travel on line managed by single queue
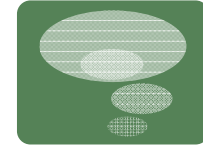 - Direct peer-to-peer reporting of location possible
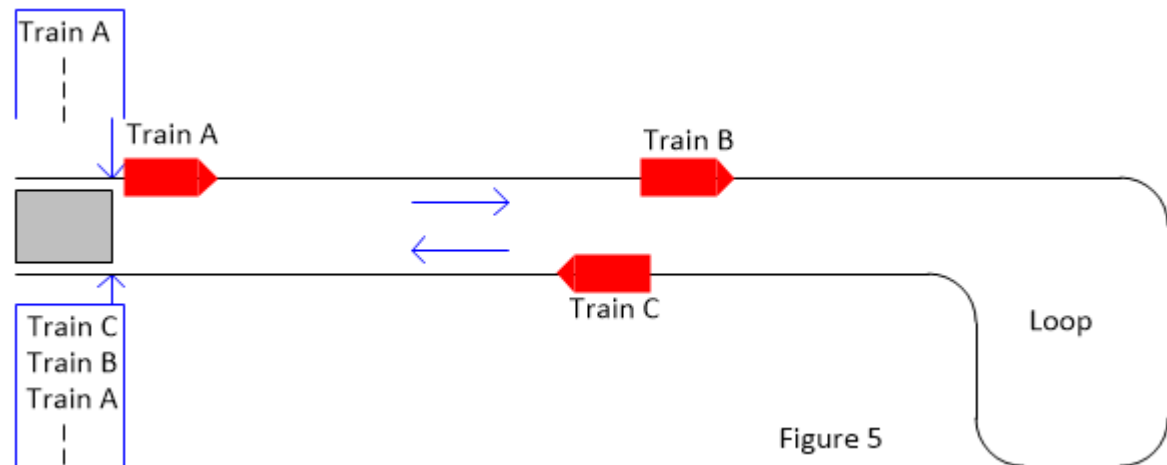
Figure 5

Converting train queue example - 1
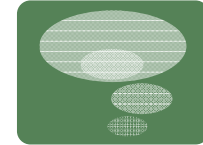
- Converging train queue
  - Trains following on same path
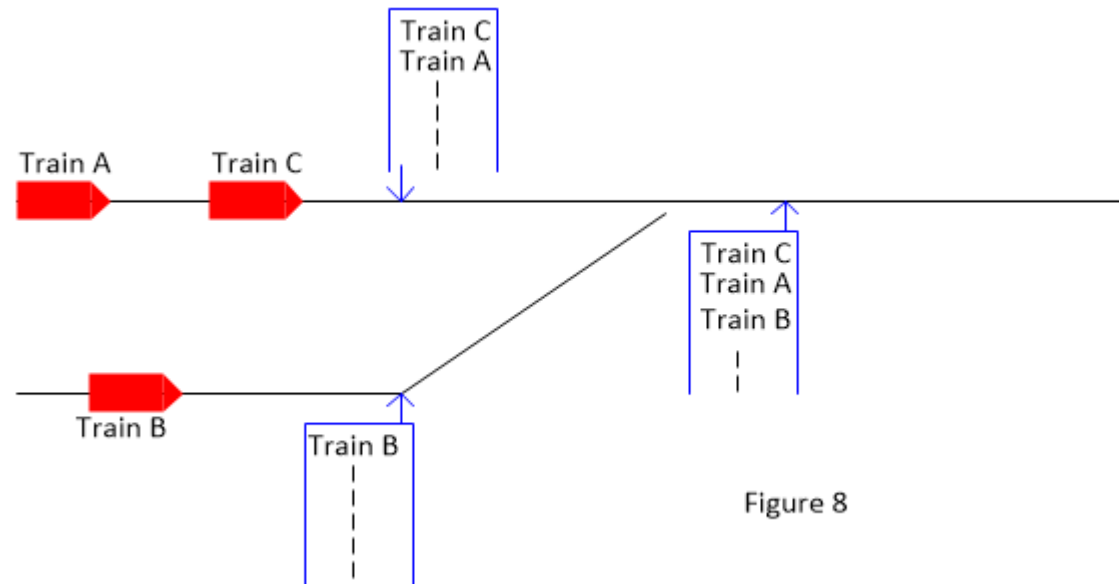 - Same as plain track subject to authority
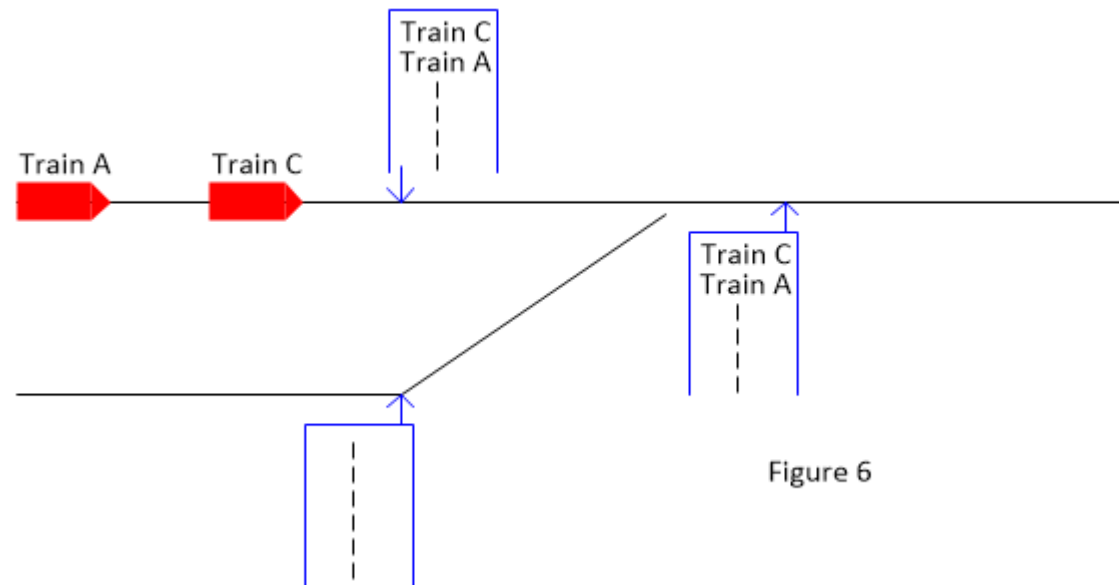
Figure 6

Converging train queue example - 2

- Converging train queue
  - Train B converging from other line
  - May join at back of queue; or
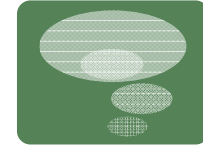 - Obtain authority to go ahead of another train

Figure 7
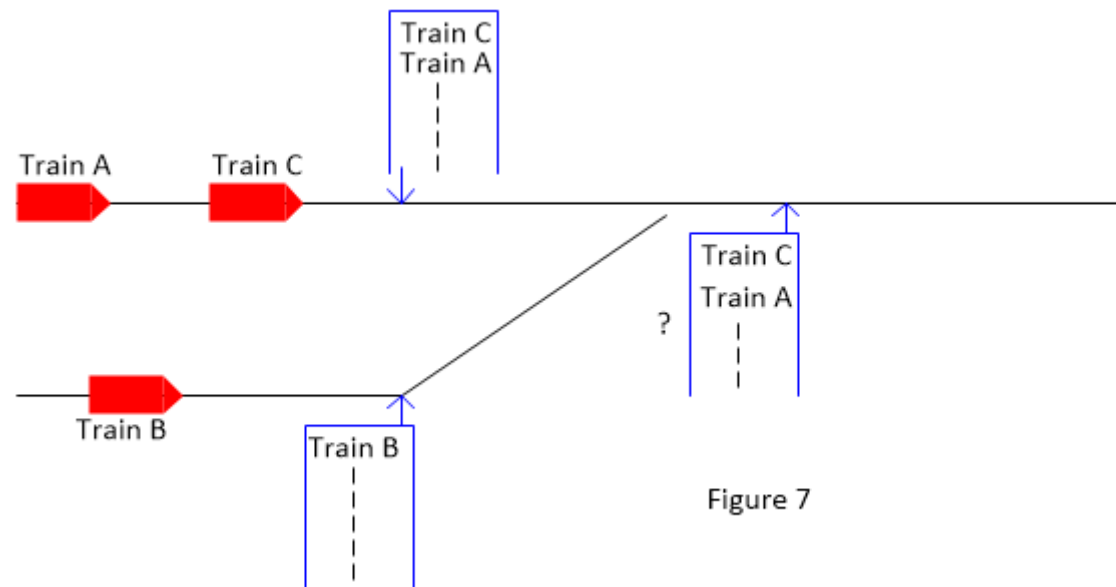
Converting train queue example - 3
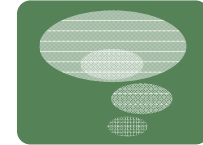
- Converging train queue
  - Example of going to rear

Figure 8

Converging train queue example - 4

- Converging train queue
  - Example of going ahead of Train A
  - Train B applies for authority from Train A (infrastructure as agent)
  - Train A accepts
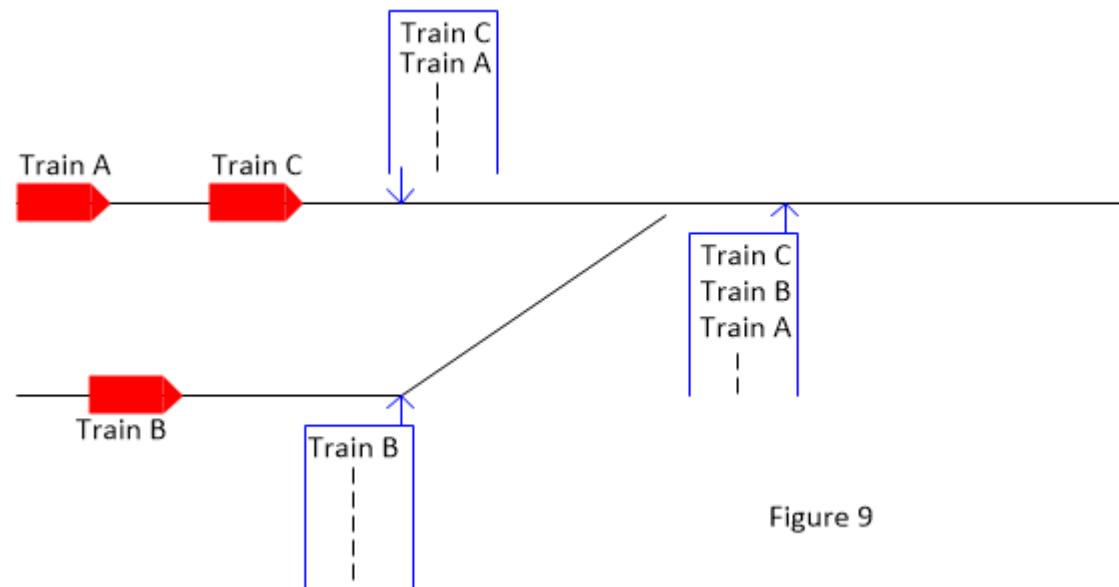 - Train A treats train B as train ahead

Figure 9

Grade Crossing queue example - 1

- Diamond crossover does not fit the templates so far discussed

Train B

Train C
Train A

?

Train A   Train C

Train C
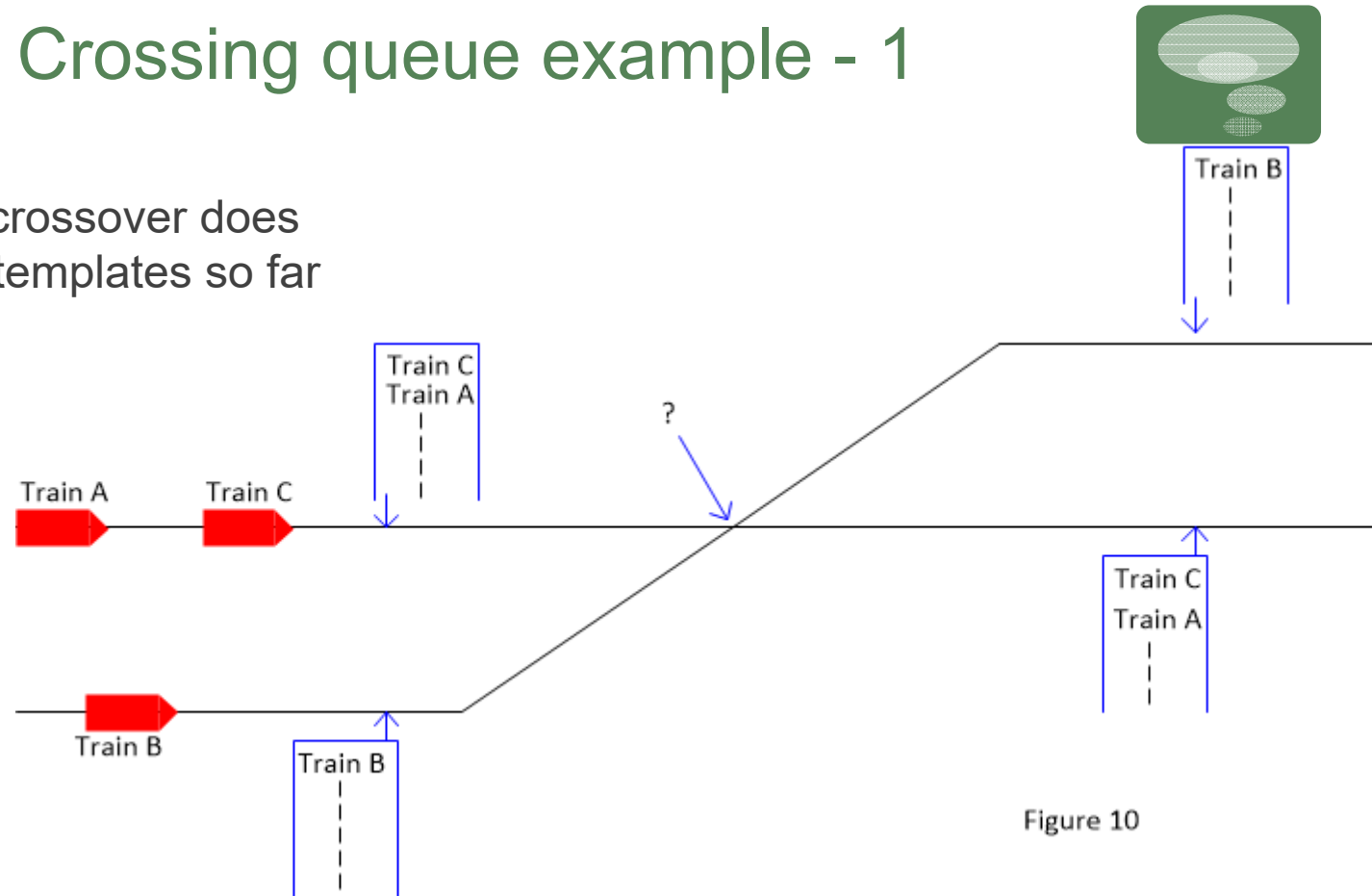Train A

Train B

Train B

Figure 10

Grade Crossing queue example - 1

- At grade crossing is modelled as turnouts with restrictions
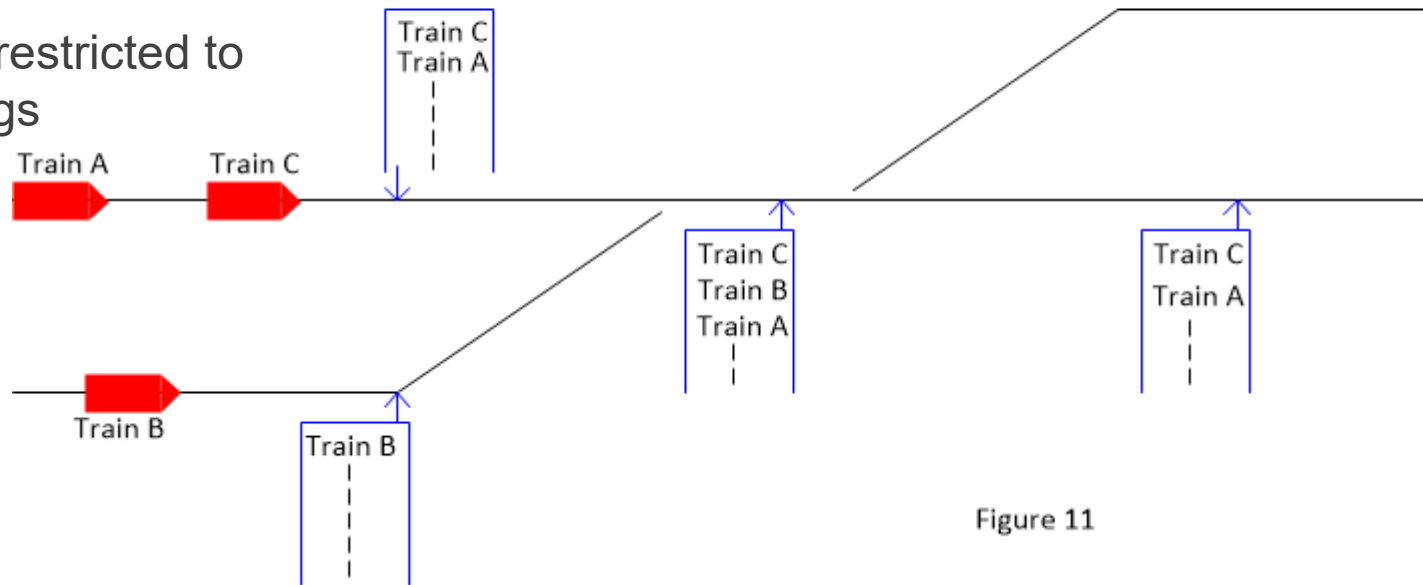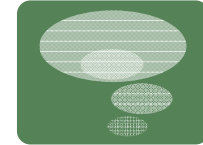 - Train B is restricted to reverse legs

Figure 11

Car changing lanes example - 1

- Queues can also be applied to road vehicles (cars):
  - Freeway – 2 lanes in single direction
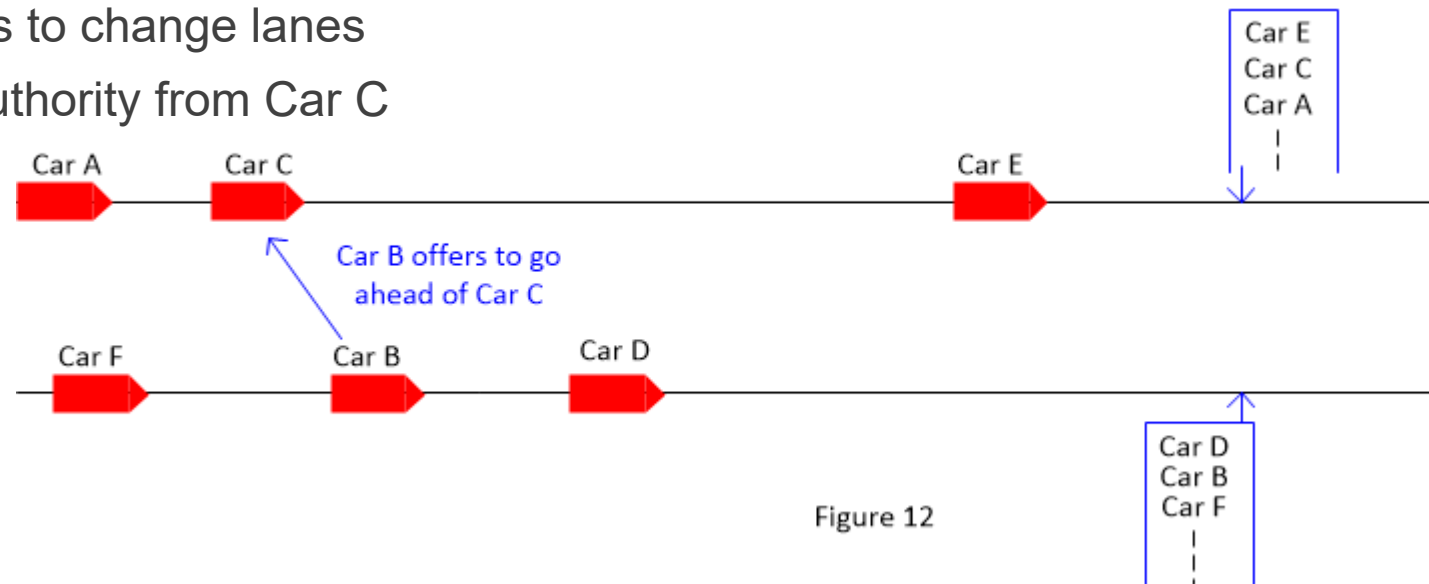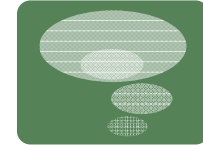 - Car B wants to change lanes
  - Requires authority from Car C

Car A   Car C   Car E

Car E
Car C
Car A

Car B offers to go ahead of Car C

Car F   Car B   Car D

Car D
Car B
Car F

Figure 12

Car changing lanes example - 2

- Virtual points may appear
  - Intention to change lanes
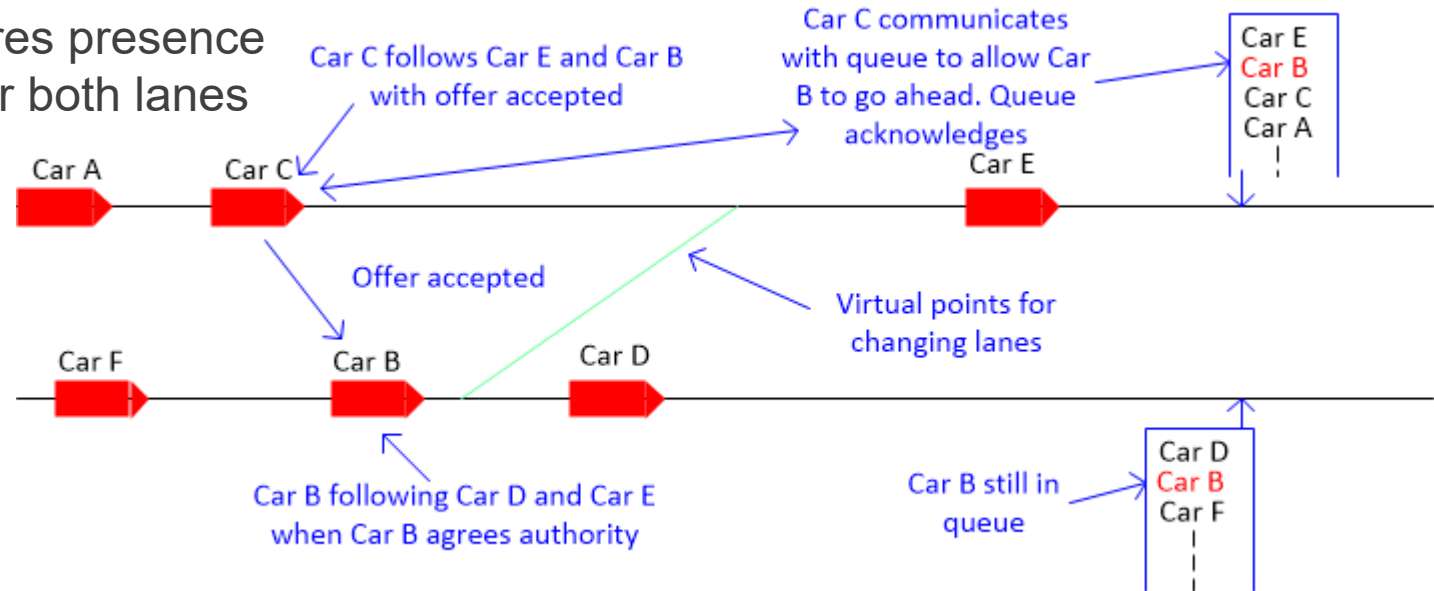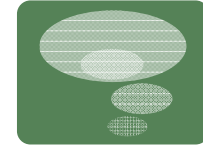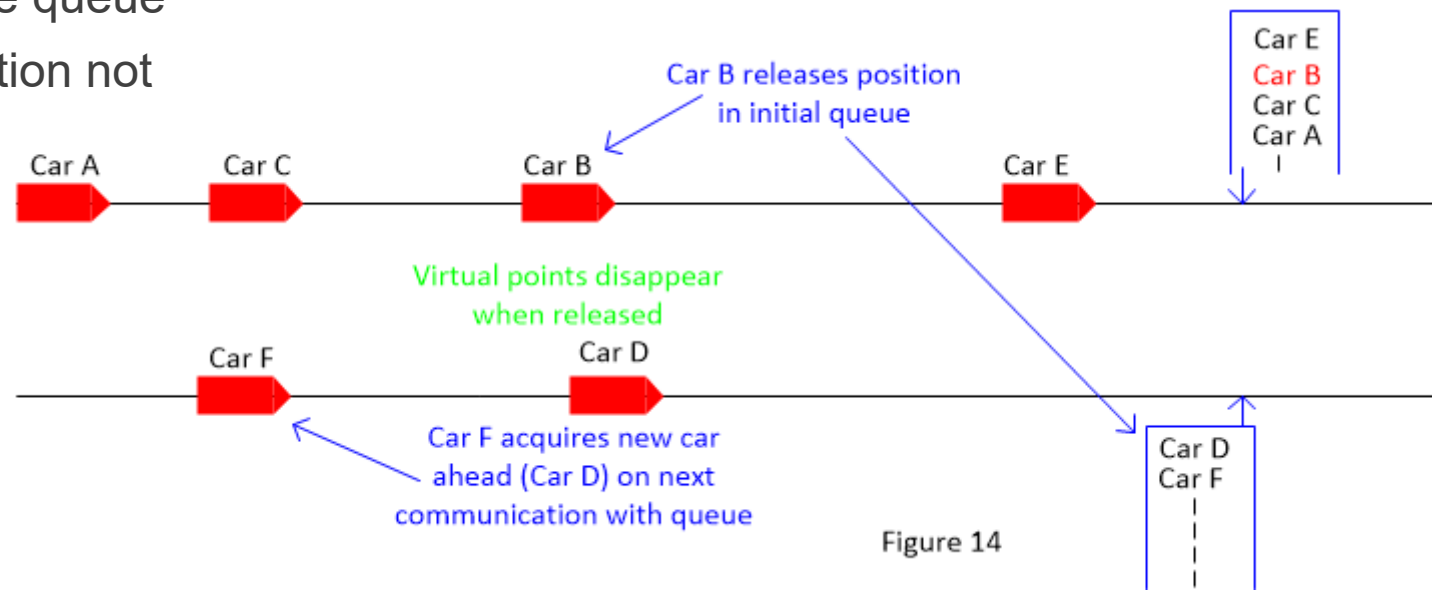 - Car B acquires presence in queues for both lanes

Car C follows Car E and Car B with offer accepted

Car C communicates with queue to allow Car B to go ahead. Queue acknowledges

Car A

Car C

Car E

| Car E |
| Car B |
| Car C |
| Car A |

Offer accepted

Virtual points for changing lanes

Car F

Car B

Car D

Car B following Car D and Car E when Car B agrees authority

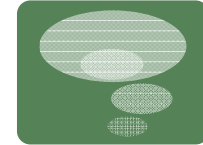Car B still in queue

| Car D |
| Car B |
| Car F |

Figure 13

Car changing lanes example - 3

- Lane change complete
  - Car B releases position in initial lane queue
  - Point detection not needed

Car B releases position
in initial queue

Car A   Car C   Car B   Car E

| Car E |
| Car B |
| Car C |
| Car A |

Virtual points disappear
when released

Car F   Car D

Car F acquires new car
ahead (Car D) on next
communication with queue

| Car D |
| Car F |

Figure 14

Allocating points example - 1

- Points are allocated to train movement at top of queue
  - Train B authority initially only to protection point
  - Train B requires points normal
  - Queue initiates points move to normal position
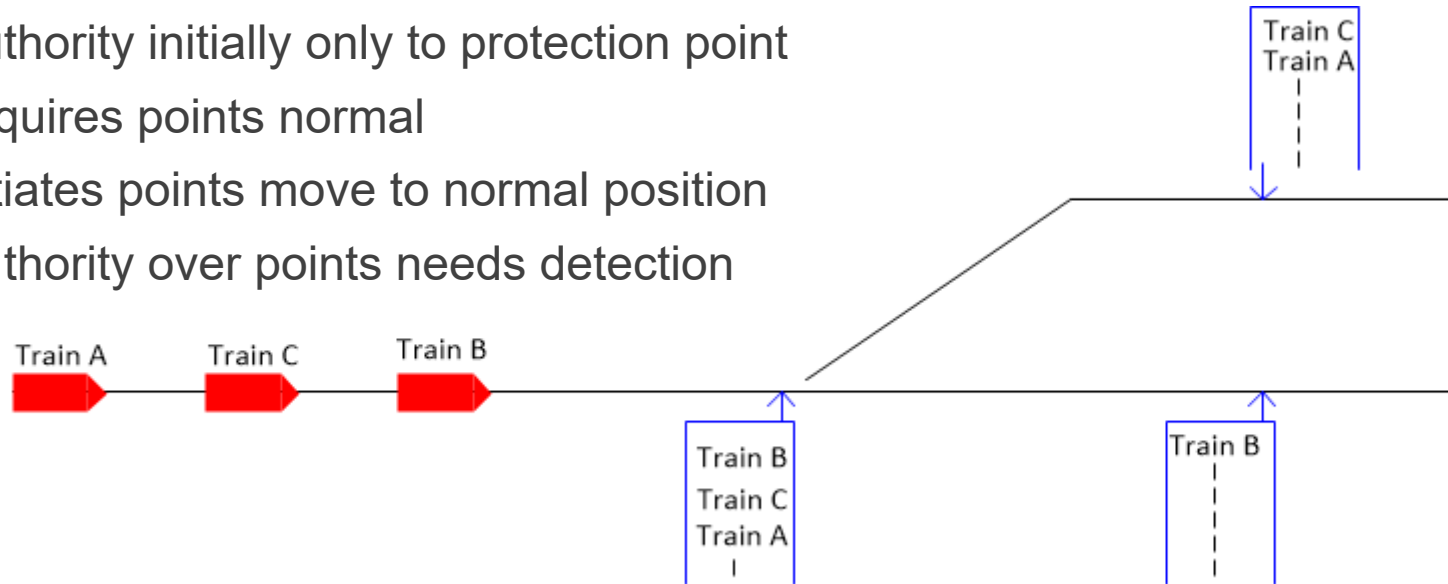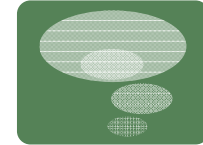 - Train B authority over points needs detection

Figure 15

Allocating points example - 2

- With Train B past points, Train C becomes top of queue
  - Train Queue alone can manage moving of points
  - Issue of authority past protection point and over the points then requires additional conditions to be met
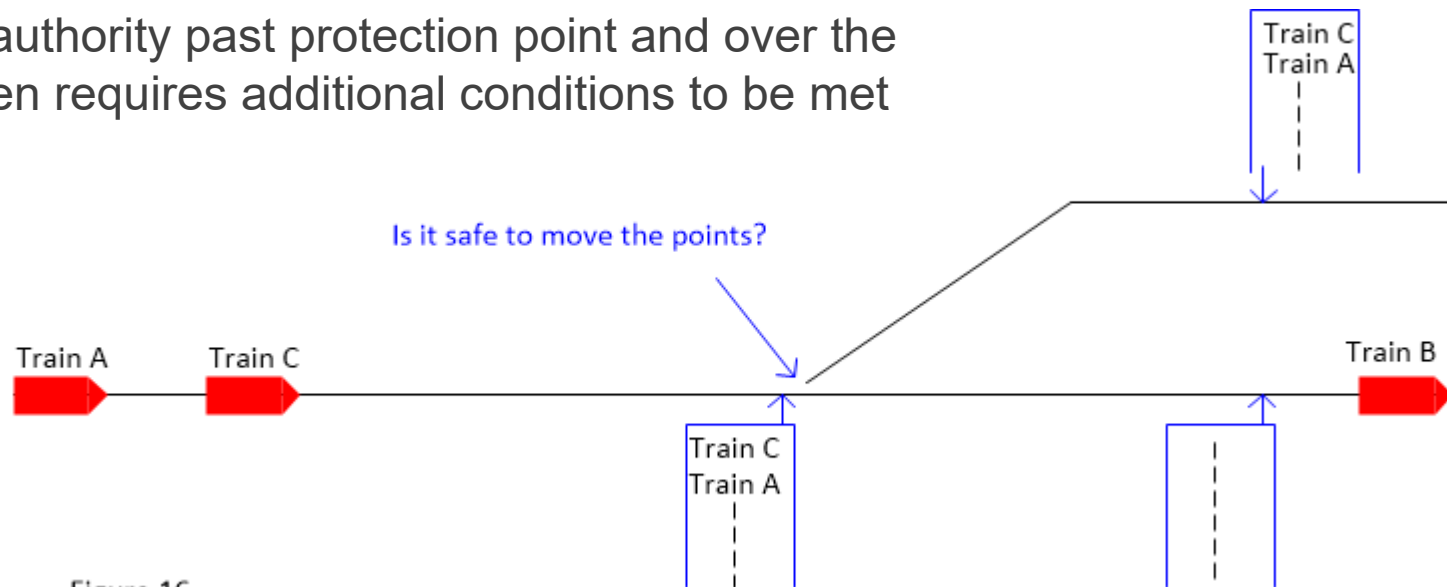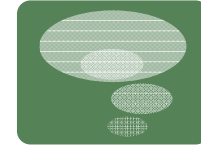
Is it safe to move the points?

Train A   Train C   Train B

Train C
Train A

Train C
Train A

Figure 16

Allocating points example - 3

- With Train B past points, Train C becomes top of queue
  - Train C authority initially only to protection point
  - Train C requires points reverse
  - Queue initiates points move to reverse position
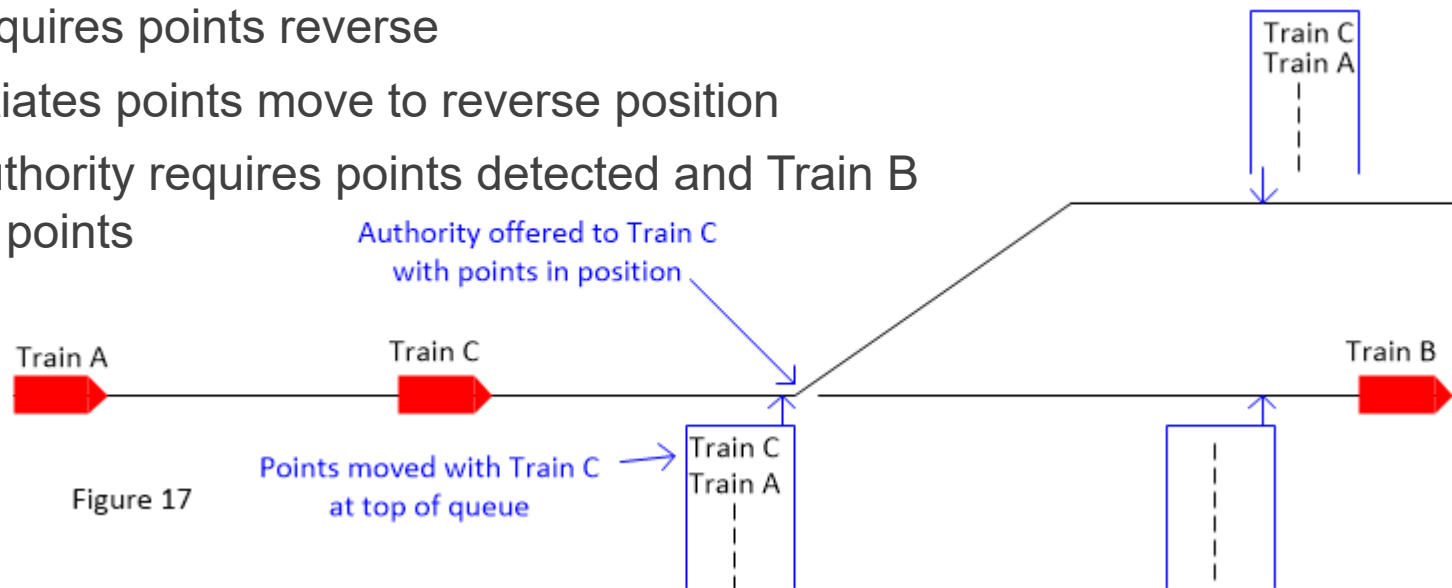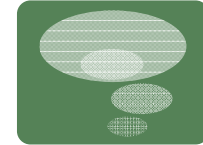 - Train C authority requires points detected and Train B not foul of points

Authority offered to Train C with points in position

Points moved with Train C at top of queue

Train A   Train C   Train B
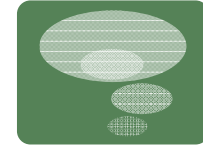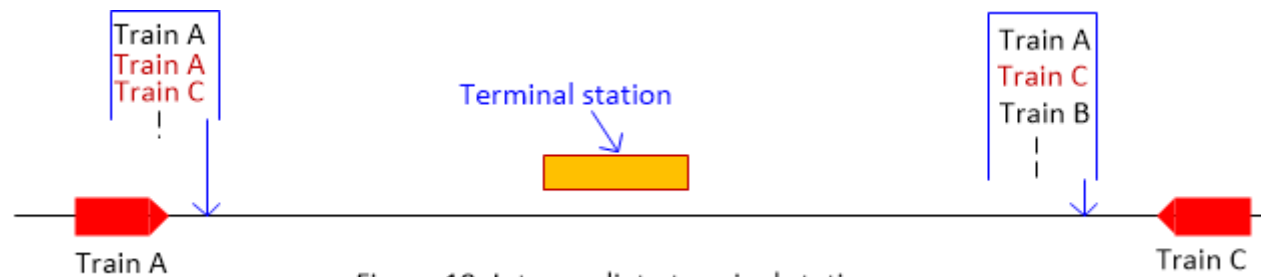
Train C / Train A

Figure 17

Bidirectional - Single Line Section

- Opposing direction trains are shown in red in sample queue

- Queue manages train order though bi-directional section
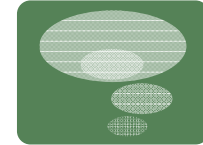

Figure 18: Single line section
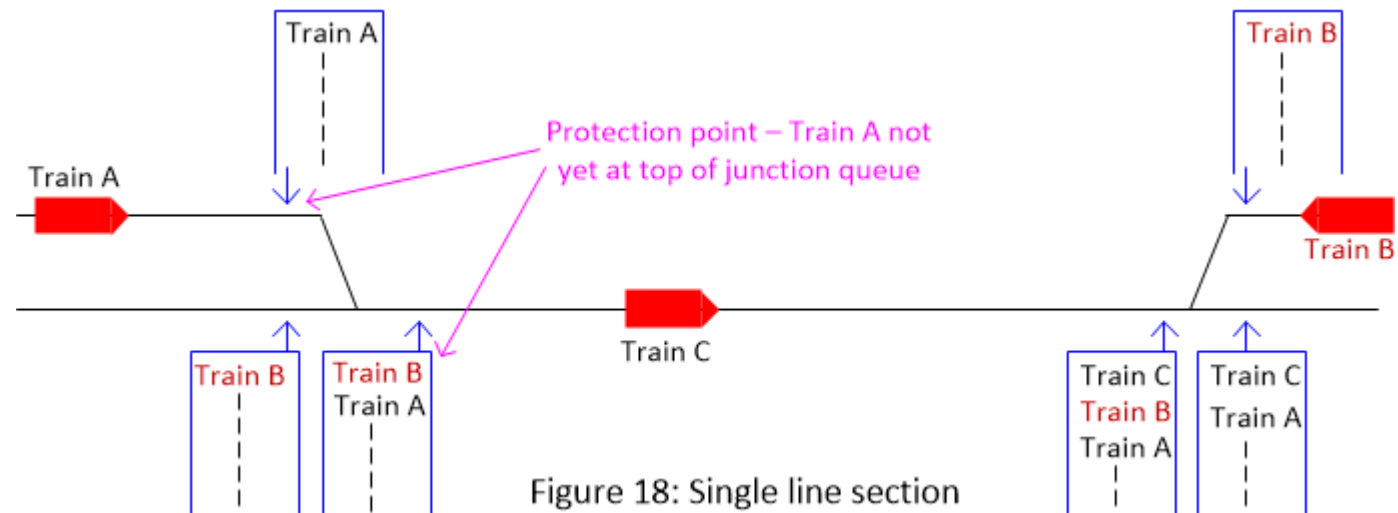
Bidirectional – Terminating train - 1

- Queues can also manage terminating trains on bi-directional line

  - Train A appears in queue at protection point for Train C

  - Train A is scheduled to change direction at terminal station

Figure 19: Intermediate terminal station

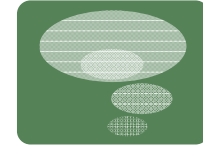# Bidirectional – Terminating train - 2

- With Train A direction change complete
  - Train A is removed from queue at protection point
  - Train A remains in queues for new movement direction
  - Train C can now proceed as following train to Train A

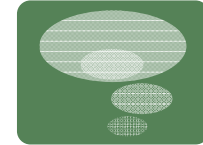Figure 20: Intermediate terminal station

Conclusion

- Vital train queues benefits
  - Reduced infrastructure
  - Reduced comms load
  - Junctions included

- Queues in the infrastructure
  - Replaces route setting
  - Reduced infrastructure

- Signalling functions move on board train

Questions?

http://pybconsulting.com.au