CE 572 – Spring 2015

Intersection Traffic Operations

Class 13

18 February 2015

HCM 2010 – Signalized Intersections

Overview

(pp 18.1-18.6)

- Analysis boundaries
- Analysis levels
- Study period
- Performance measures
- Travel modes
- Lane and movement groups
- Movement and phase numbering
- LOS criteria

Input Data

(pp 18.7-18.24)

- Traffic characteristics
- Geometric design
- Signal control

- Table list
- Detailed description

HCM 2010 – Signalized Intersections

Concepts

(pp 31.1-31.9)

- Types of signal control
- Traffic movements
- Signal phase sequencing
- Operational modes
- LT sequencing
- Traffic flow characteristics

Phase Duration

- Actuated control (31.10-31.30)
- Pretimed (31.37-31.42)

Other

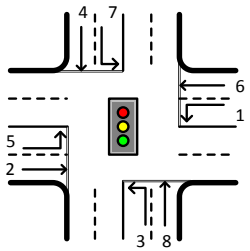
- QAP (31.48-31.68)
- QEM (31.84-31.97)

Scenarios

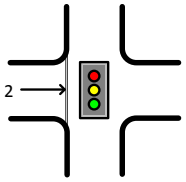
Scenario	Signal Control	Demand/Capacity	Movements	Arrival Pattern
1	Pretimed	d<c	Protected LTs	Uniform
2	Pretimed	d>c	Protected LTs	Uniform
3	Pretimed	d<c	Permitted LTs	Uniform
4	Pretimed	d<c	TH only	Non-uniform
5	Actuated	d<c	TH only	Uniform
6	Actuated	d<c	TH only	Non-uniform

Scenarios

Signalized Intersection – Scenario #1	
Pretimed ☒ Actuated ☐	
Demand < capacity	
Protected LTs	
Uniform arrivals	

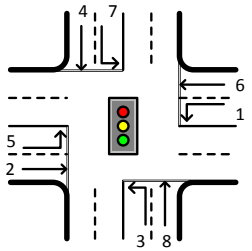


Signalized Intersection – Scenario #2	
Pretimed ☒ Actuated ☐	
Demand > capacity	
TH only	
Uniform arrivals	

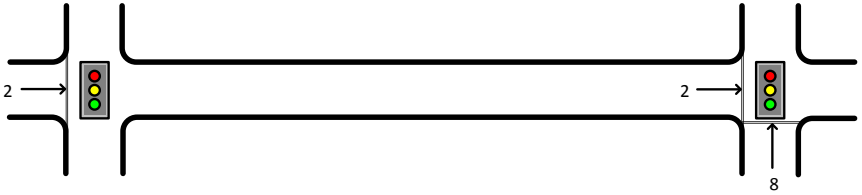


Scenarios

Signalized Intersection – Scenario #3

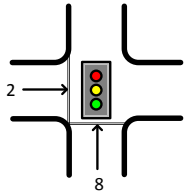
Pretimed [X]	
Actuated [ ]	
Demand < capacity	
Permitted LTs	
Uniform arrivals	

Signalized Intersection – Scenario #4

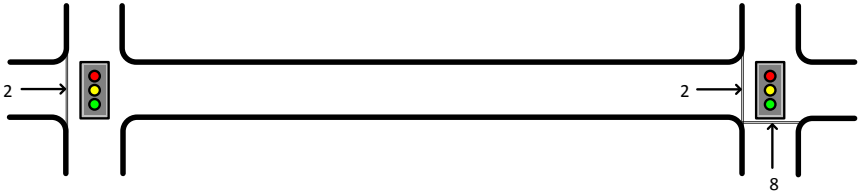
Pretimed [X]	
Actuated [ ]	
Demand < capacity	
TH only	
Non-uniform arrivals	

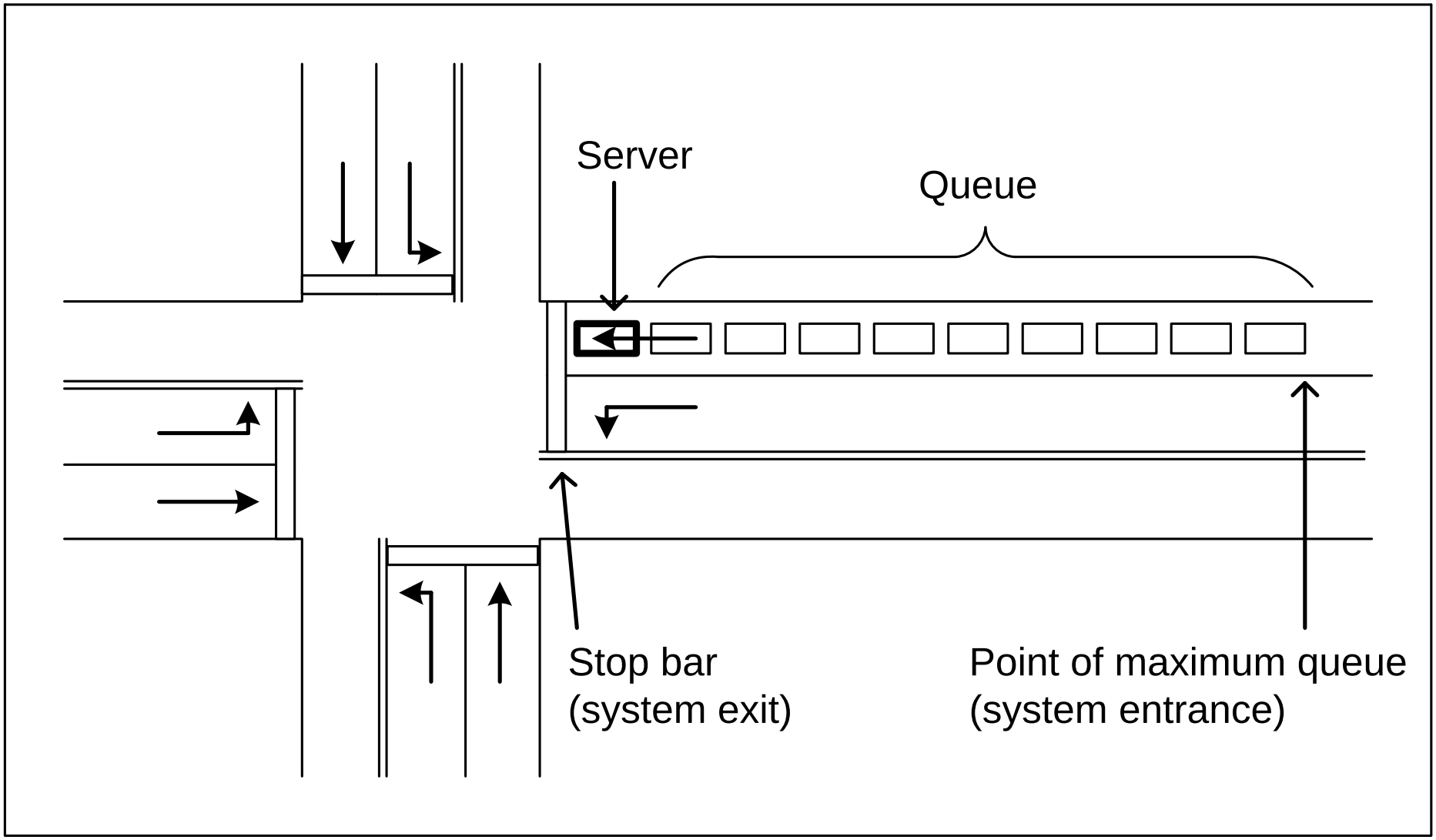
Scenarios

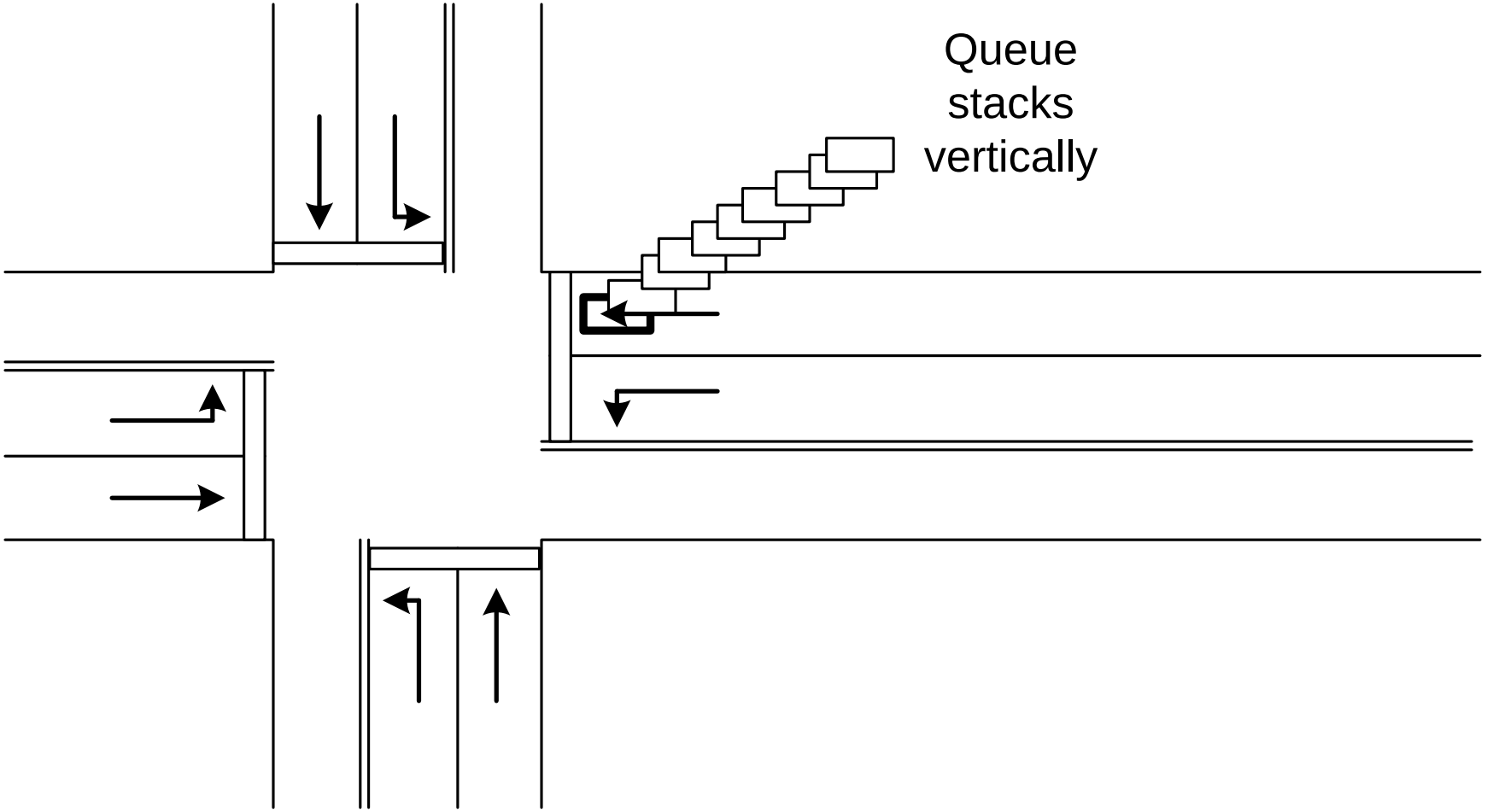
Signalized Intersection – Scenario #5

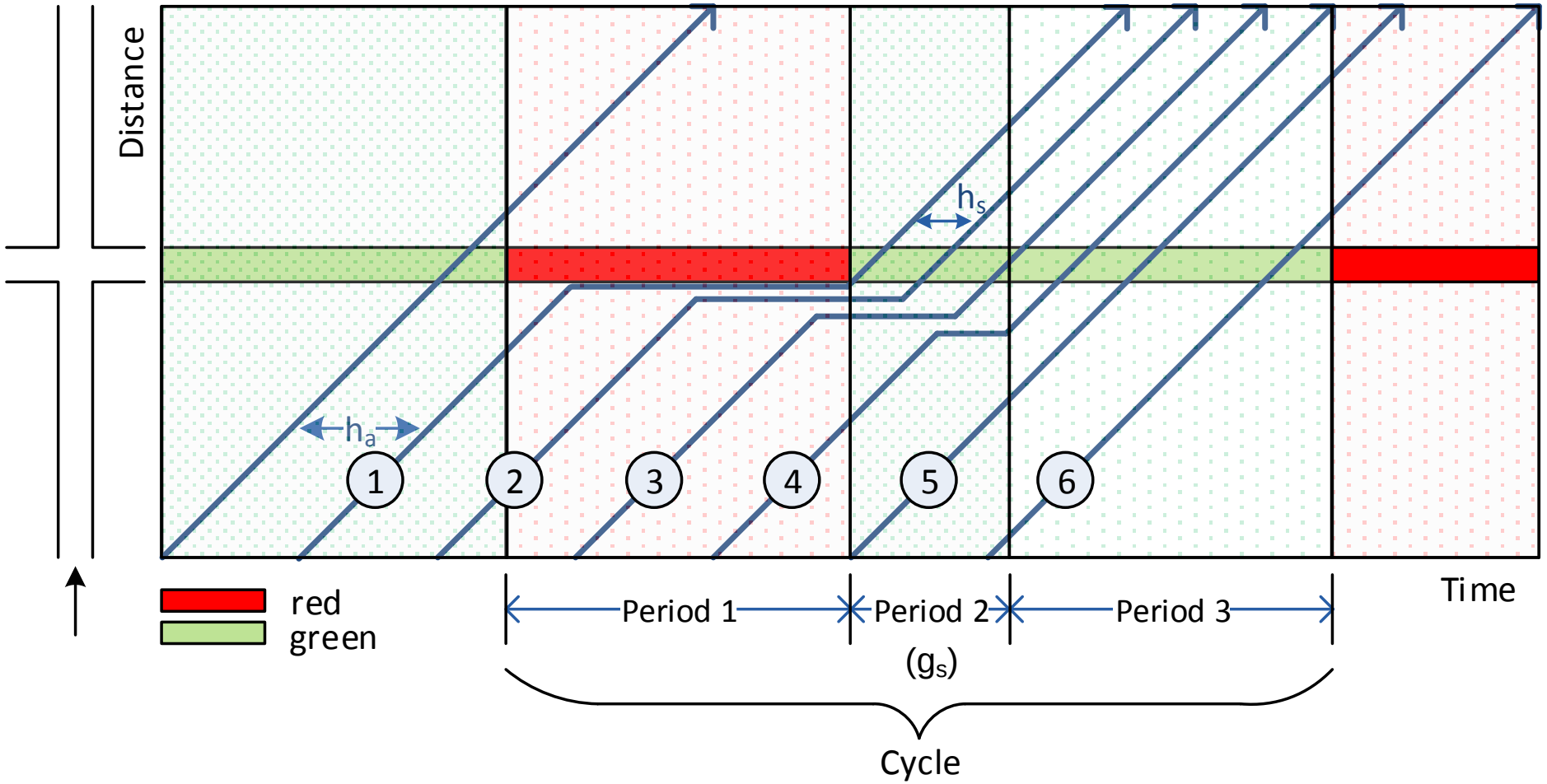
Pretimed ☐ Actuated ☒	
Demand < capacity	
TH only	
Uniform arrivals	

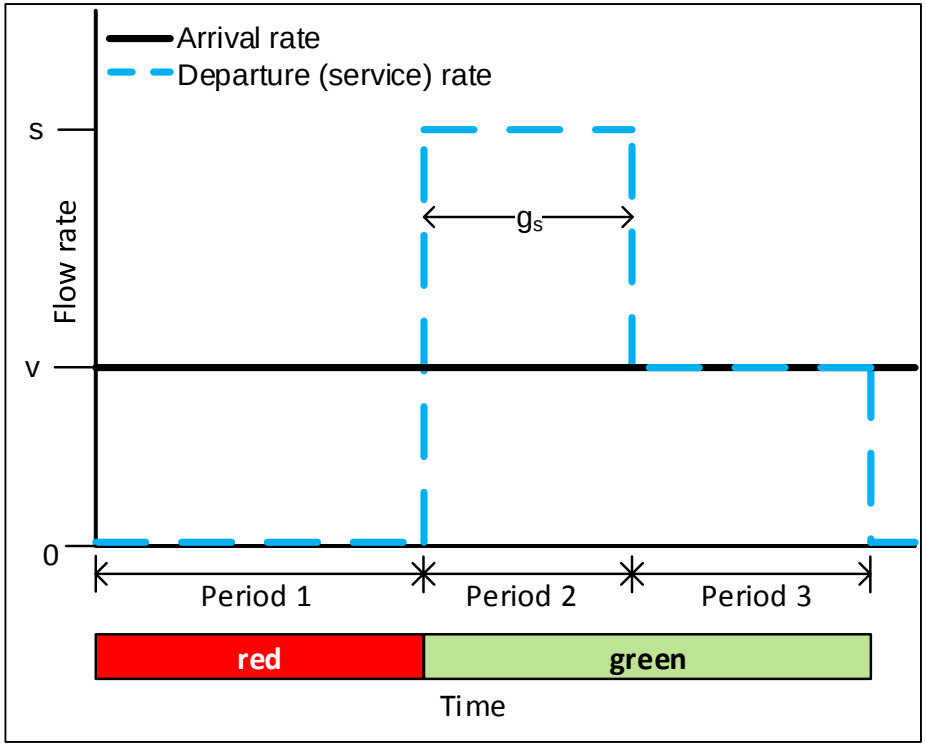
Signalized Intersection – Scenario #6

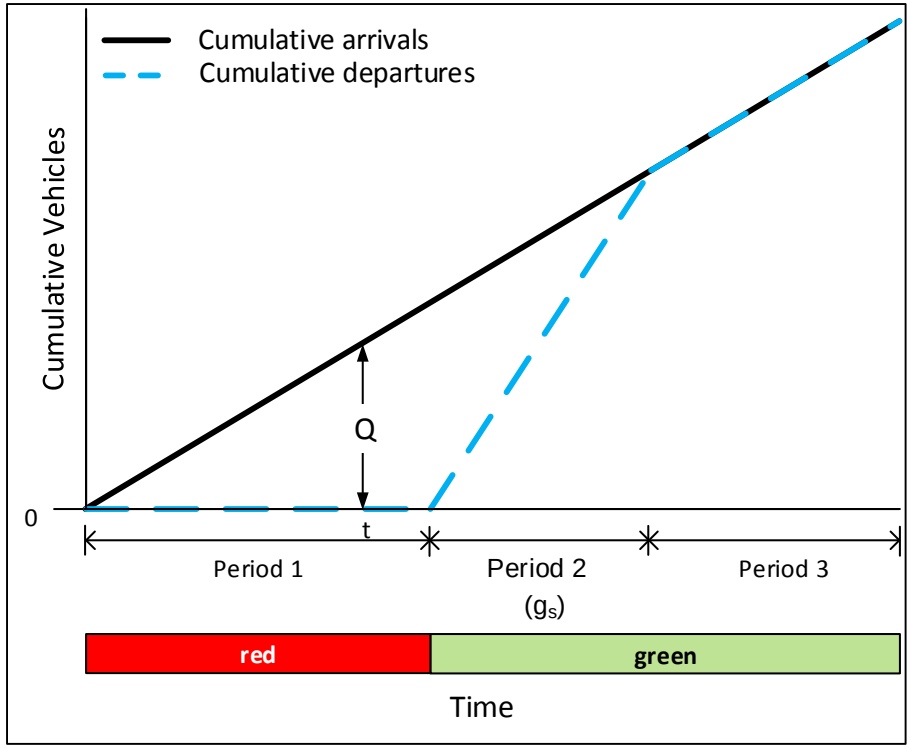
Pretimed ☐ Actuated ☒	
Demand < capacity	
TH only	
Non-uniform arrivals	

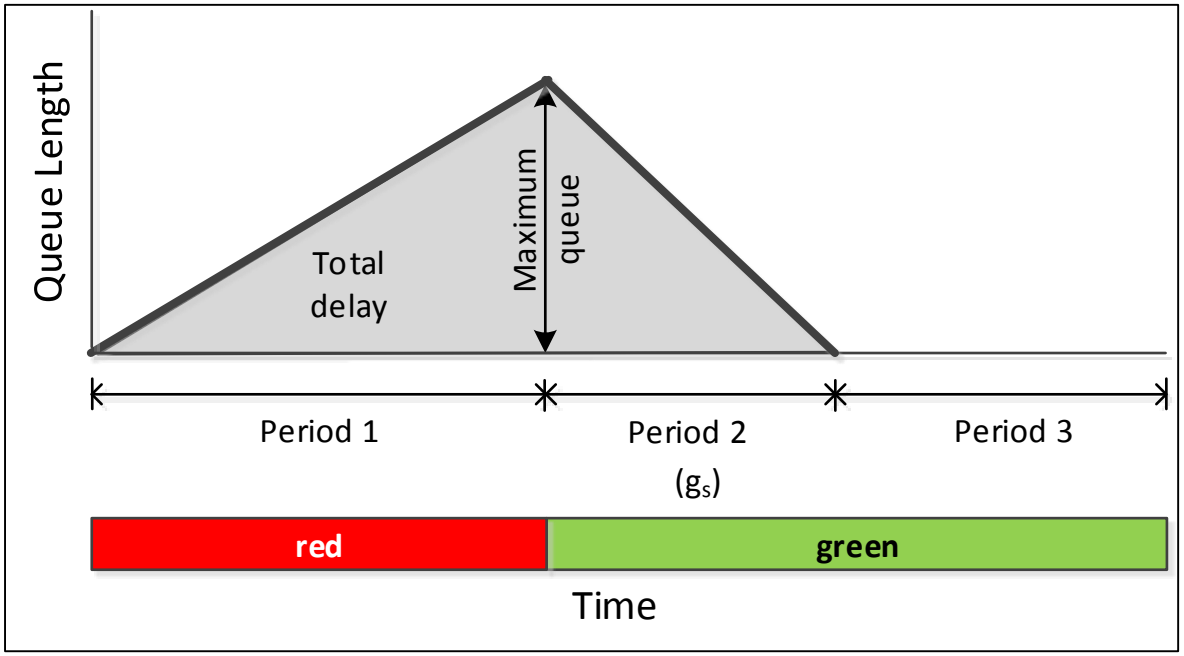

Server
Queue
Stop bar
(system exit)
Point of maximum queue
(system entrance)

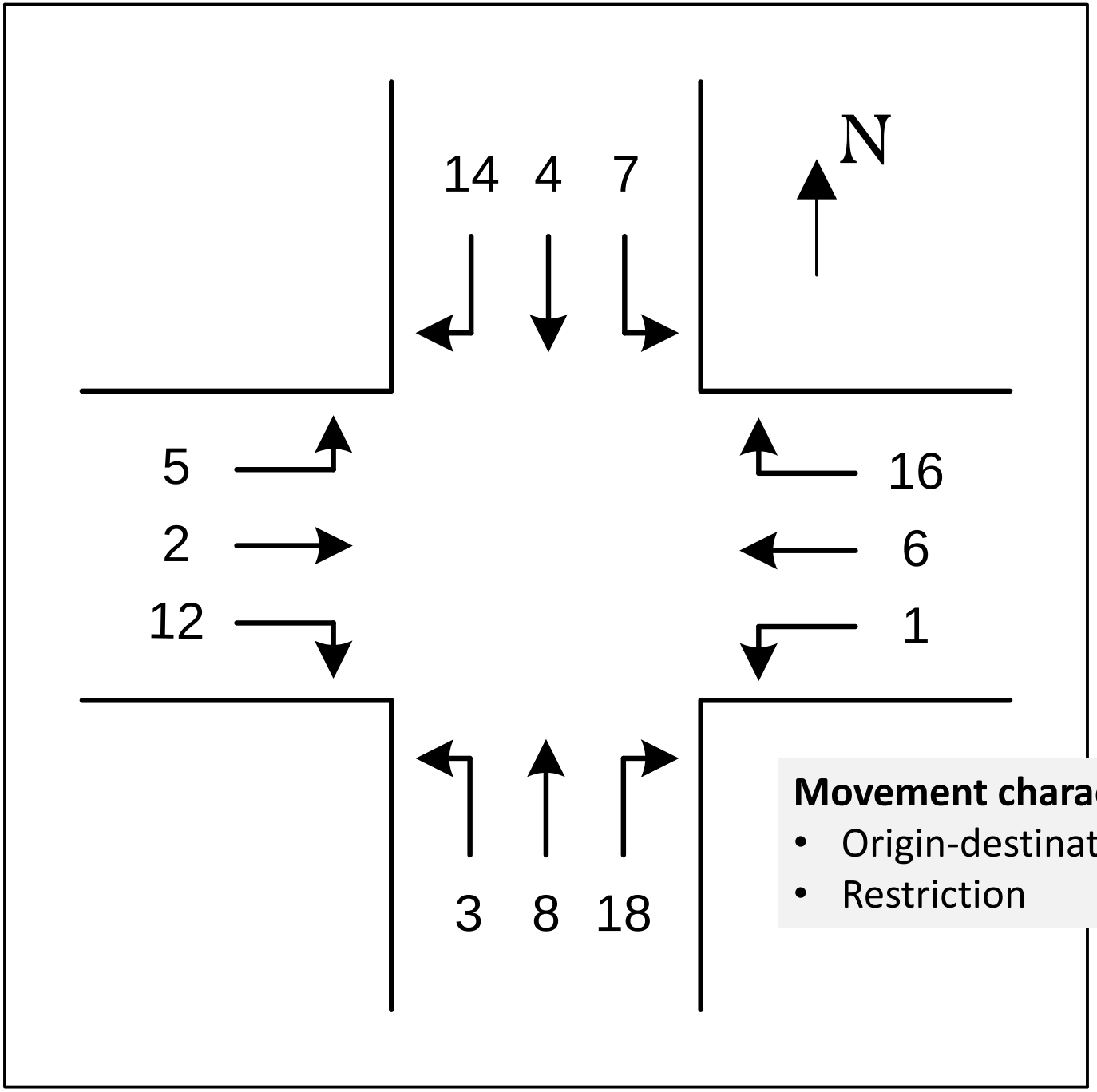

Queue
stacks
vertically


Distance
h_s
h_a
1
2
3
4
5
6
red
green
Period 1
Period 2
Period 3
Time
(g_s)
Cycle


Arrival rate
Departure (service) rate
s
Flow rate
g_s
v
0
Period 1
Period 2
Period 3
red
green
Time

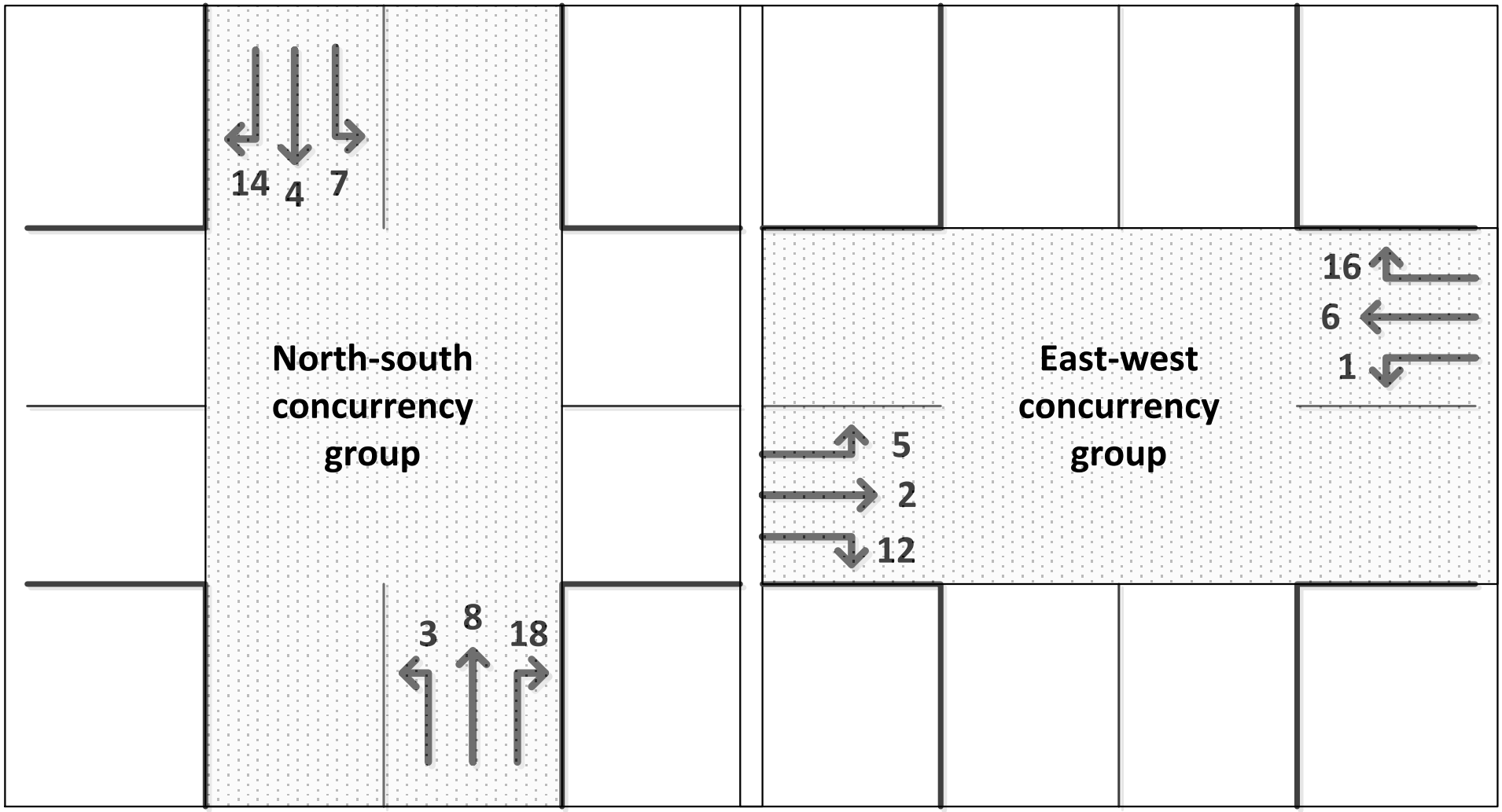

Cumulative arrivals
Cumulative departures
Cumulative Vehicles
Q
0
t
Period 1
Period 2
Period 3
(g_s)
red
green
Time


Queue Length
Total
delay
Maximum
queue
Period 1
Period 2
Period 3
(g_s)
red
green
Time

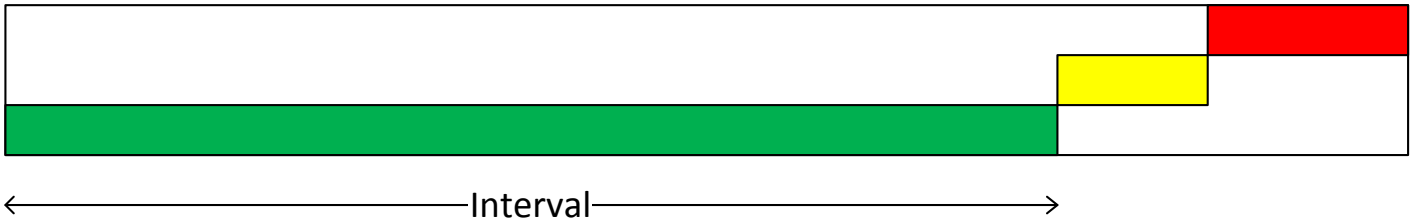


Movement characteristics

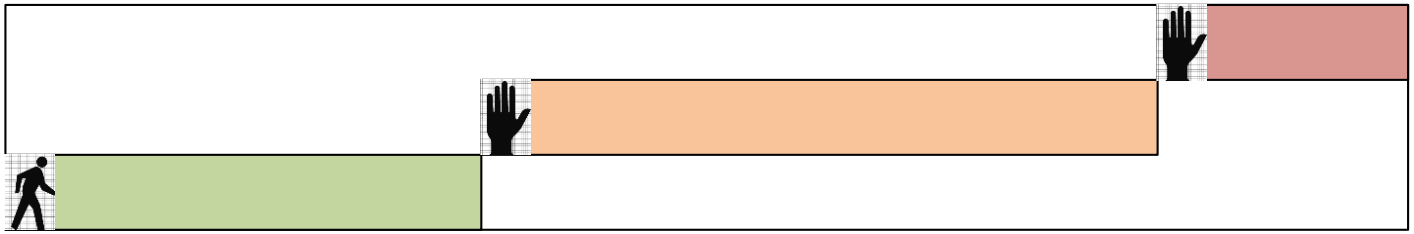
- Origin-destination
- Restriction


14
4
7
North-south concurrency group
3
8
18
5
2
12
East-west concurrency group
16
6
1

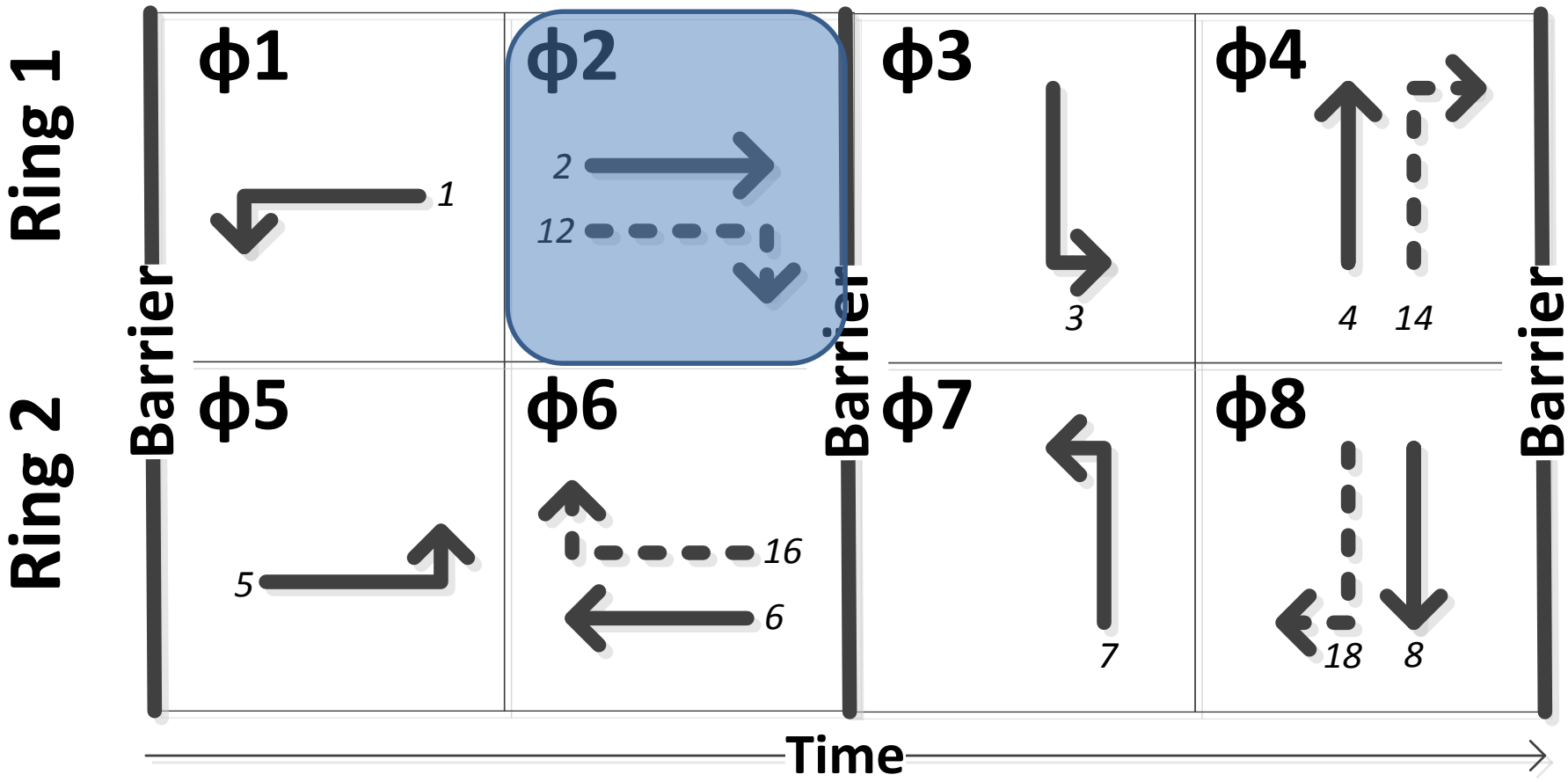
Vehicle phase: timing unit

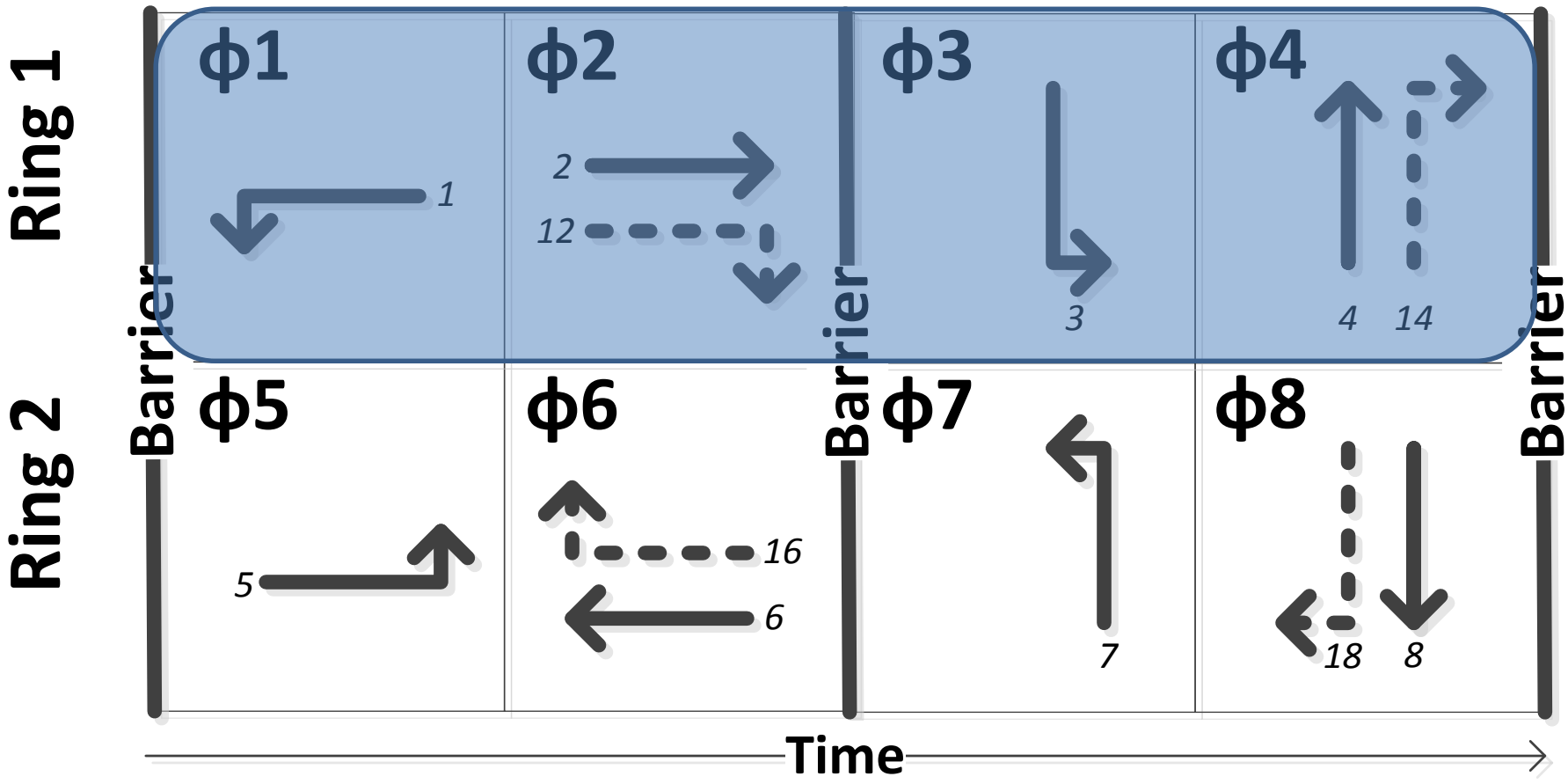


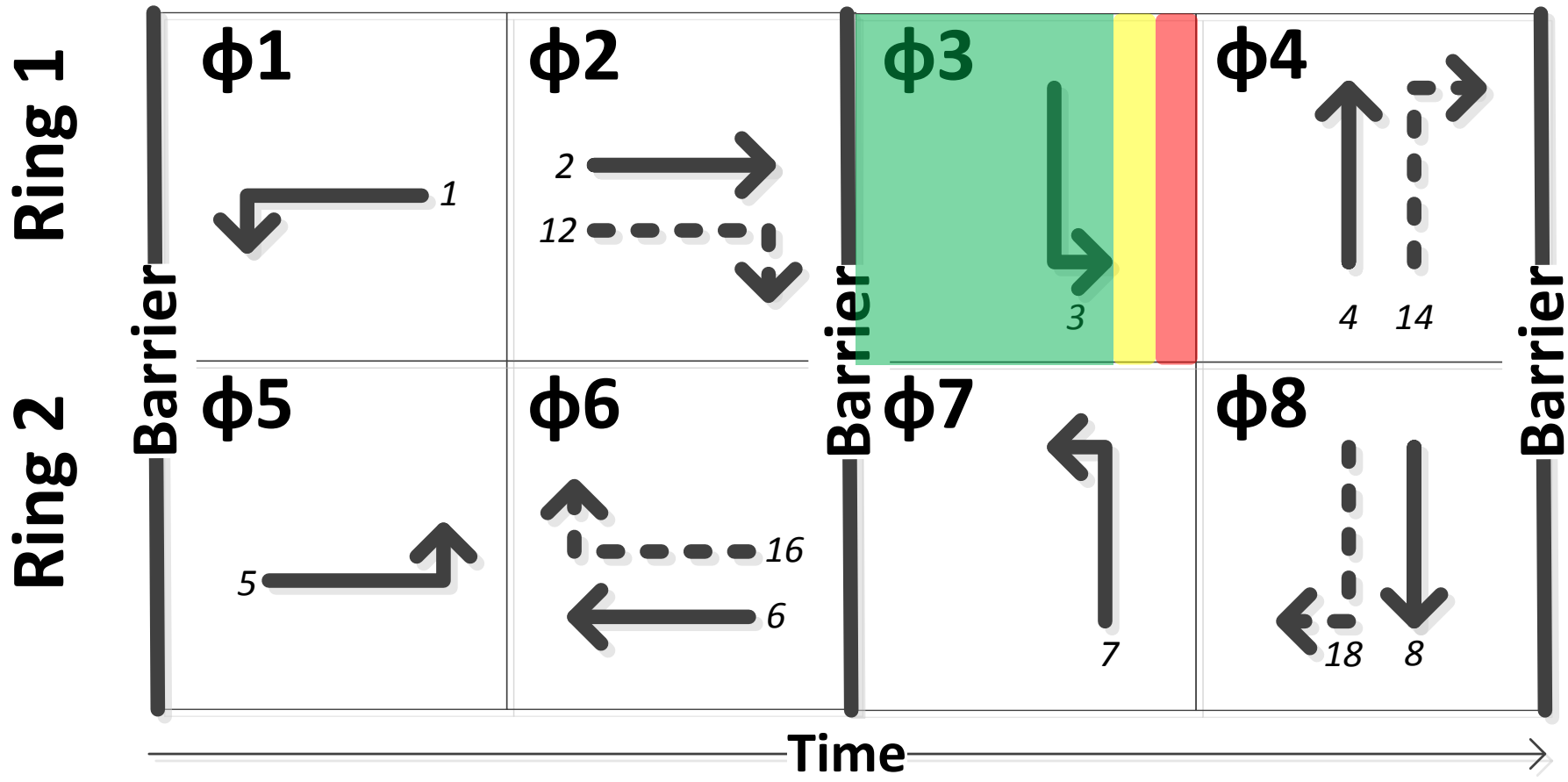
Pedestrian phase: timing unit

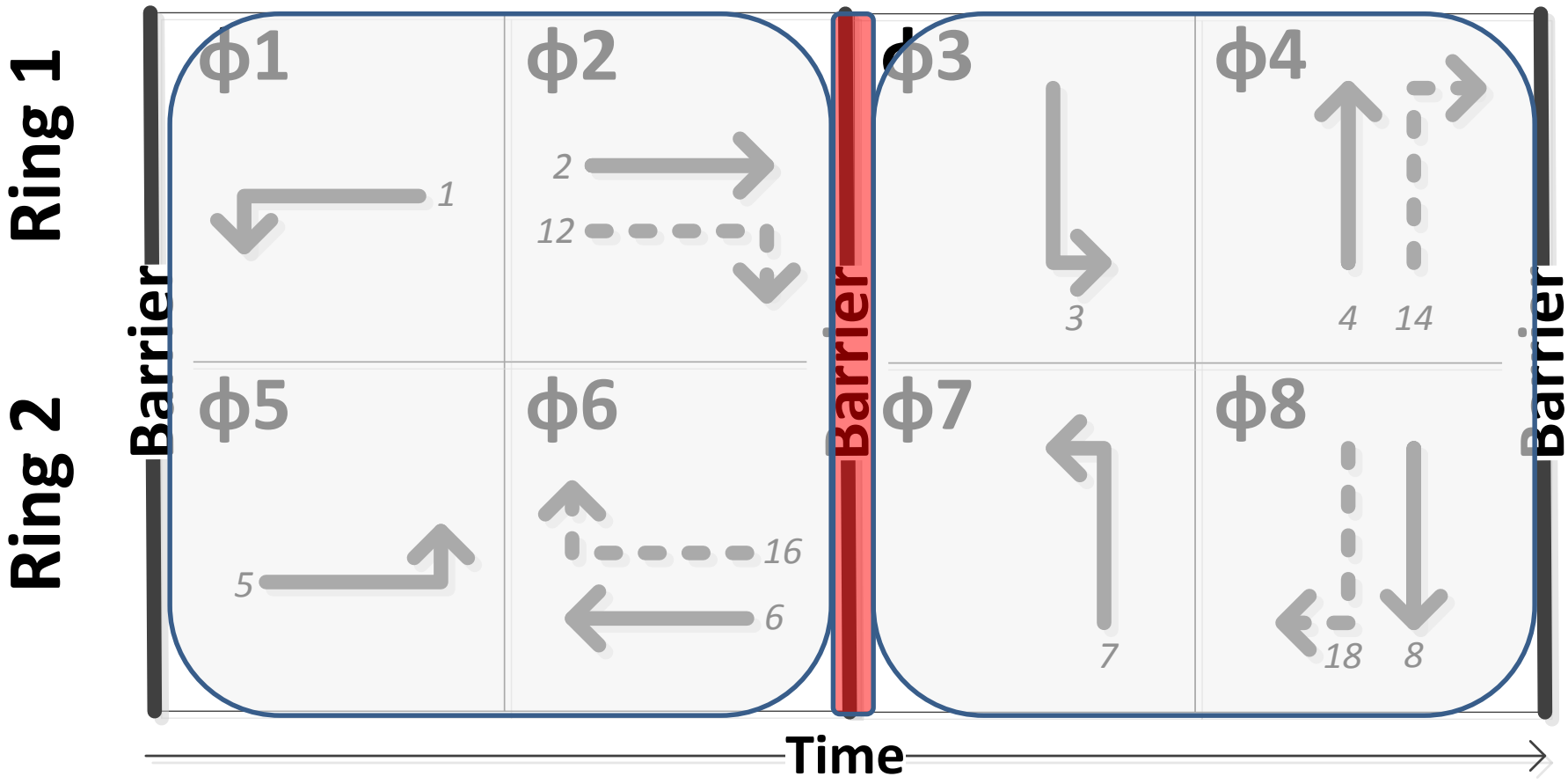


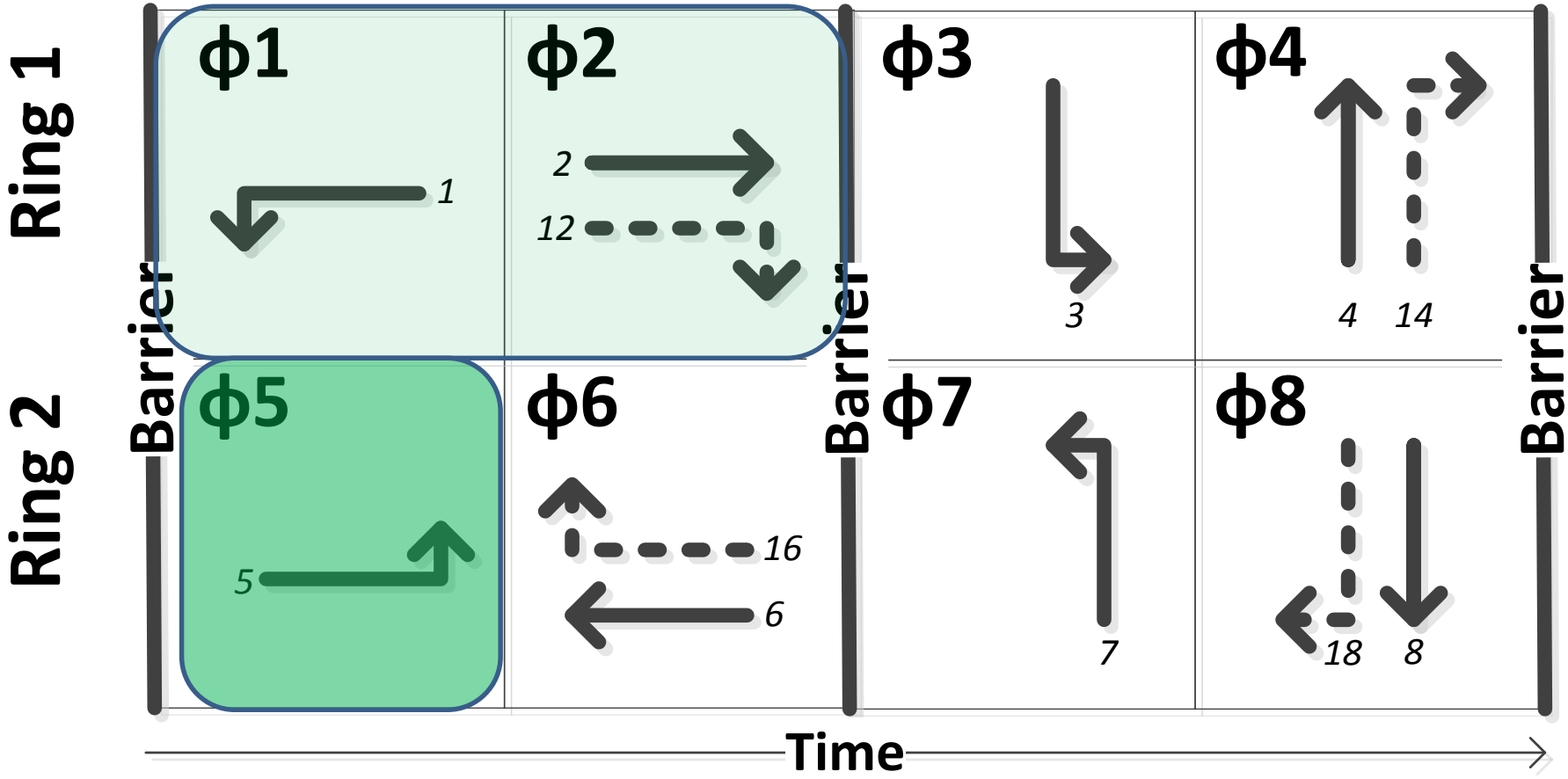
Phase: *Timing Unit* that controls one or more **movements**

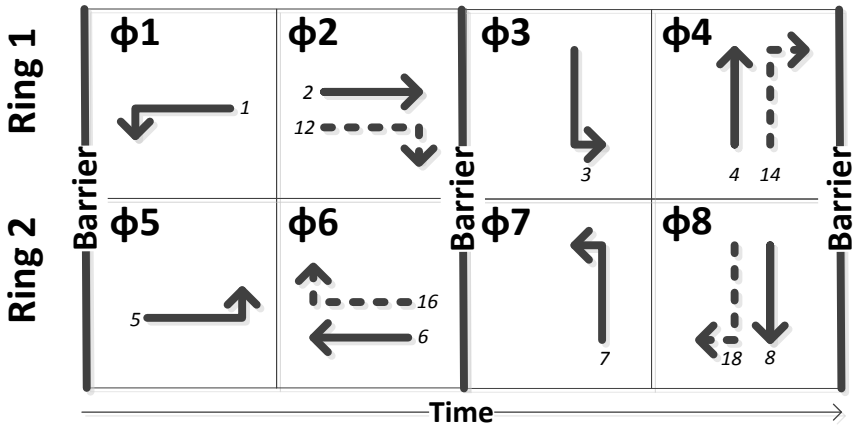

Ring 1
Ring 2
ϕ1
ϕ2
ϕ3
ϕ4
ϕ5
ϕ6
ϕ7
ϕ8
Barrier
Barrier
Barrier
1
2
12
3
4
14
5
16
6
7
18
8
Time

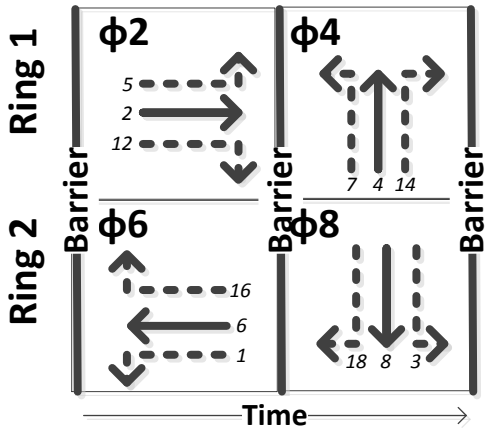

Ring 1
Ring 2
ϕ1
ϕ2
ϕ3
ϕ4
ϕ5
ϕ6
ϕ7
ϕ8
Barrier
Barrier
Barrier
1
2
12
3
4
14
5
16
6
7
18
8
Time

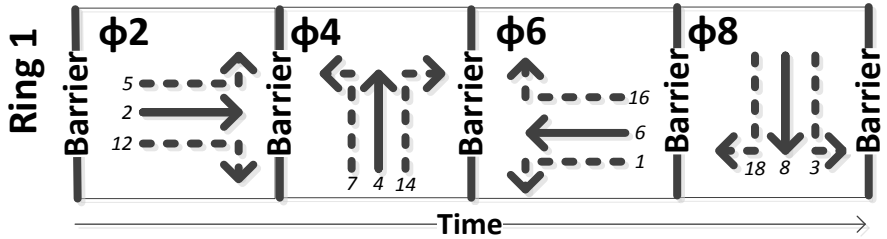

Ring 1
Ring 2
ϕ1
ϕ2
ϕ3
ϕ4
ϕ5
ϕ6
ϕ7
ϕ8
Barrier
Barrier
Barrier
1
2
12
3
4
14
5
16
6
7
18
8
Time

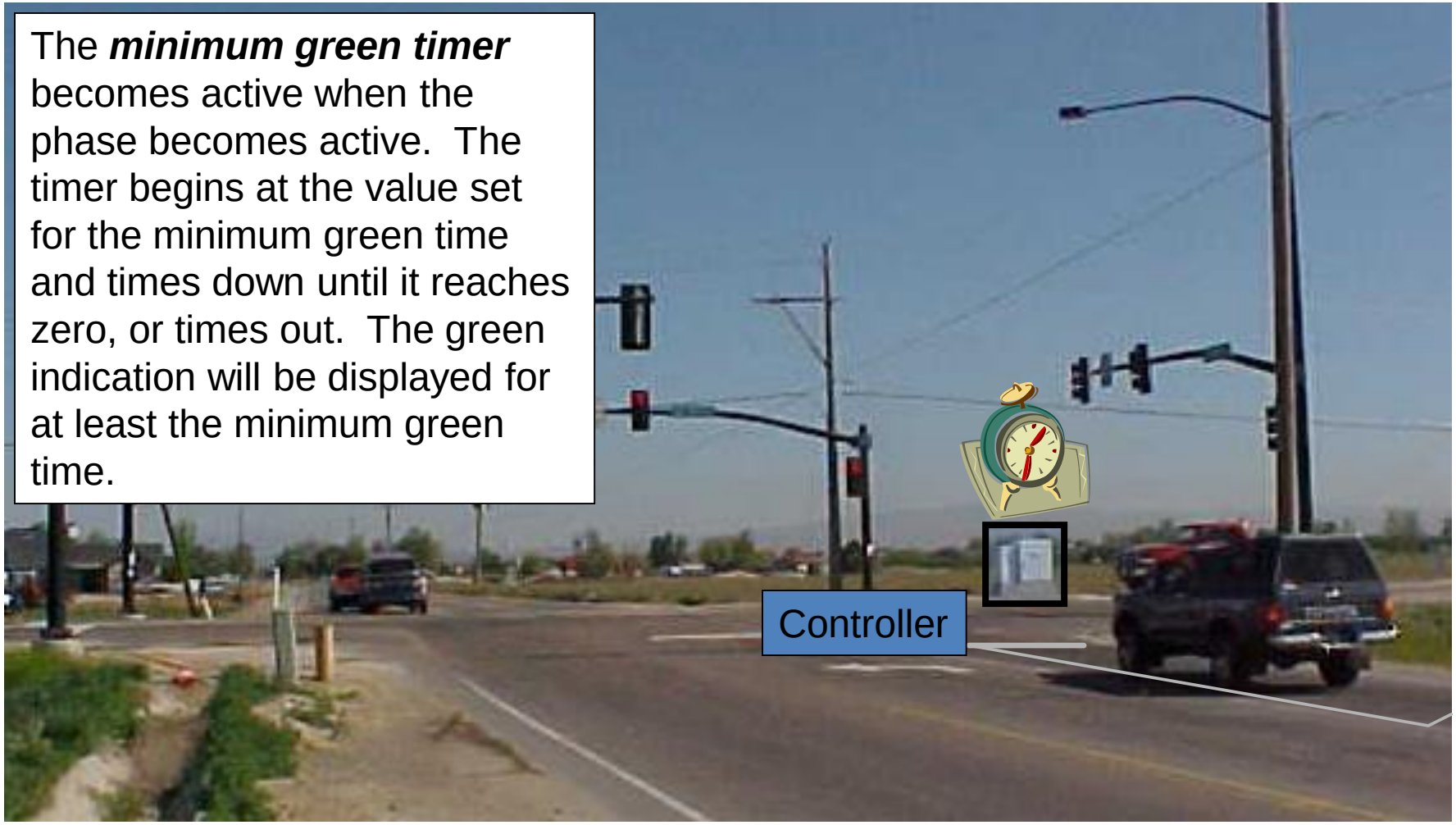

Ring 1
Ring 2
Barrier
Barrier
Barrier
ϕ1
ϕ2
ϕ3
ϕ4
ϕ5
ϕ6
ϕ7
ϕ8
1
2
12
3
4
14
5
16
6
7
18
8
Time


Ring 1
Ring 2
ϕ1
ϕ2
ϕ3
ϕ4
ϕ5
ϕ6
ϕ7
ϕ8
Barrier
Barrier
Barrier
1
2
12
3
4
14
5
16
6
7
18
8
Time

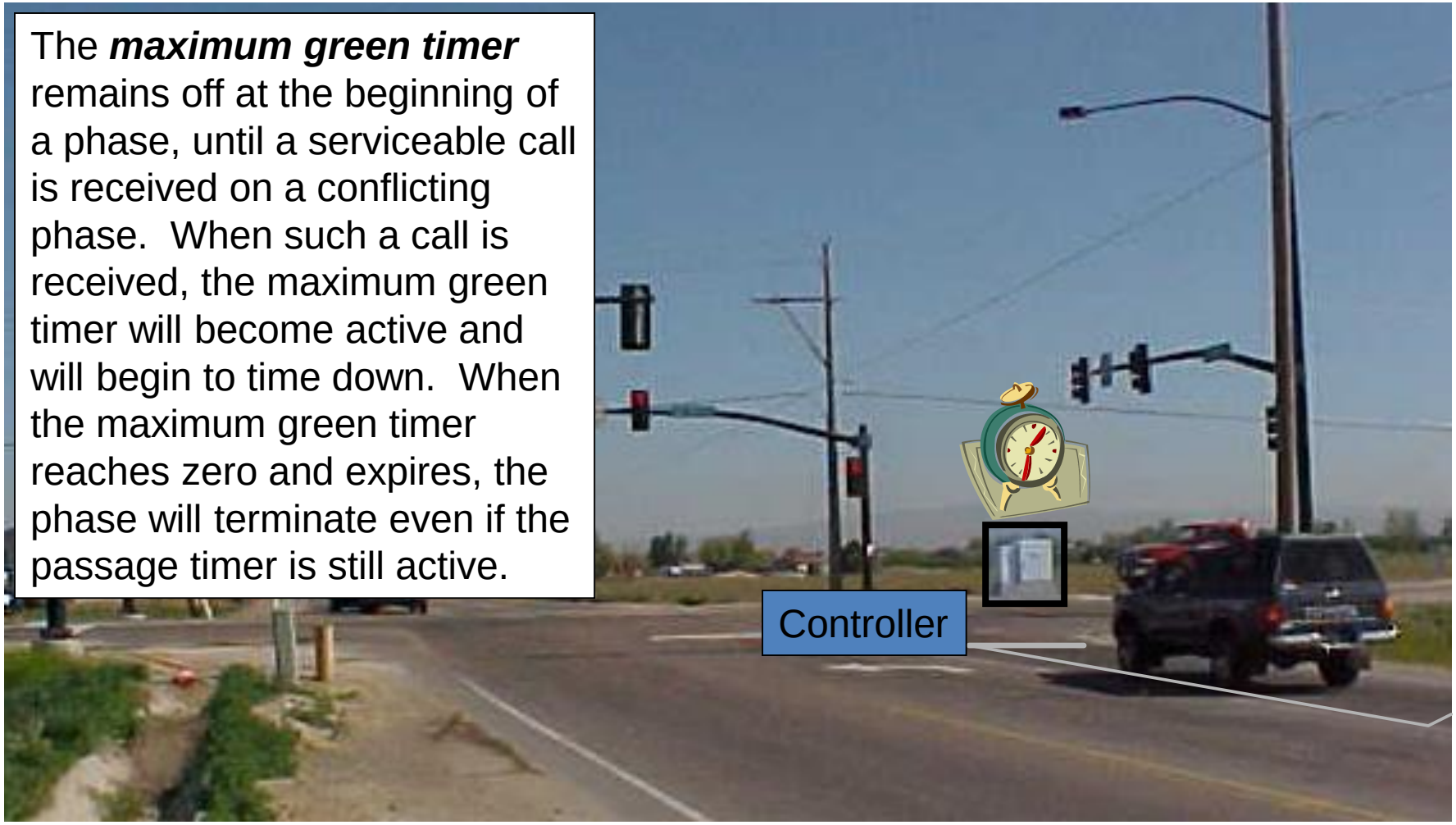

Ring 1
Ring 2
Barrier
Barrier
Barrier
ϕ1
ϕ2
ϕ3
ϕ4
ϕ5
ϕ6
ϕ7
ϕ8
1
2
12
3
4
14
5
16
6
7
18
8
Time


Ring 1
Ring 2
Barrier
Barrier
Barrier
ϕ2
ϕ4
ϕ6
ϕ8
5
2
12
7
4
14
16
6
1
18
8
3
Time


Ring 1
Barrier
Barrier
Barrier
Barrier
Barrier
ϕ2
ϕ4
ϕ6
ϕ8
5
2
12
7
4
14
16
6
1
18
8
3
Time

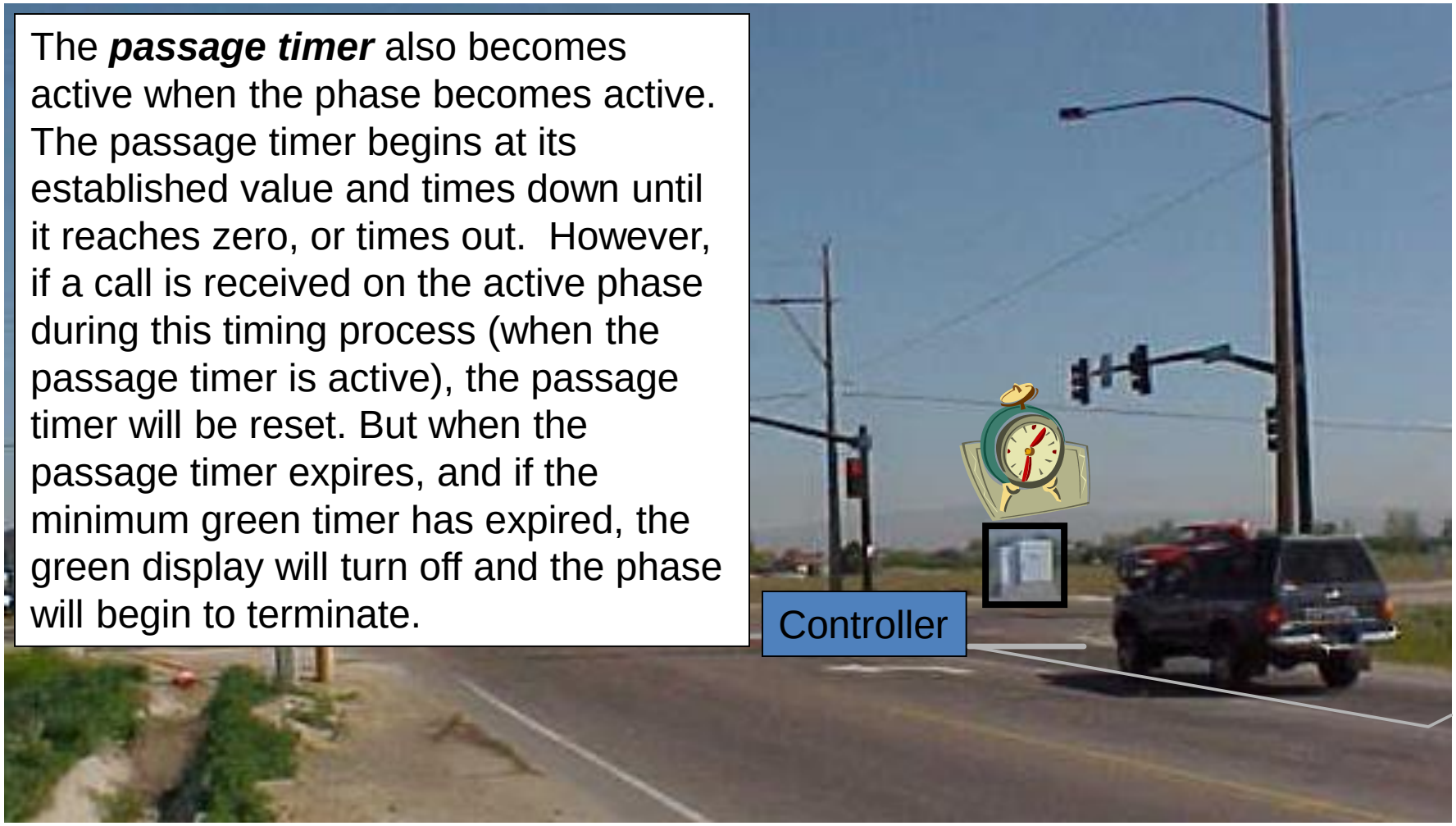


- Timers or timing processes
  - **Minimum green**
  - Maximum green
  - Vehicle extension/passage time/gap time

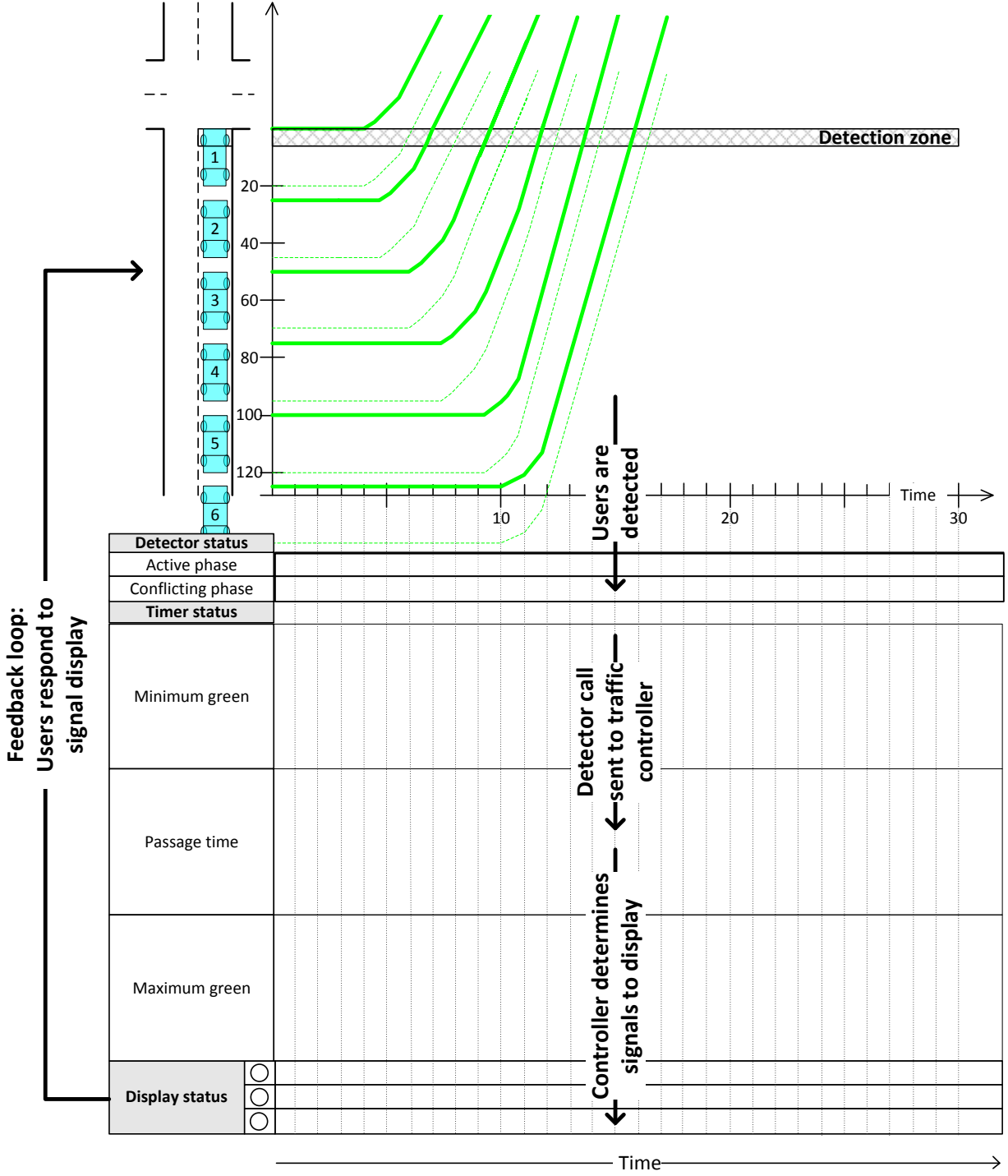


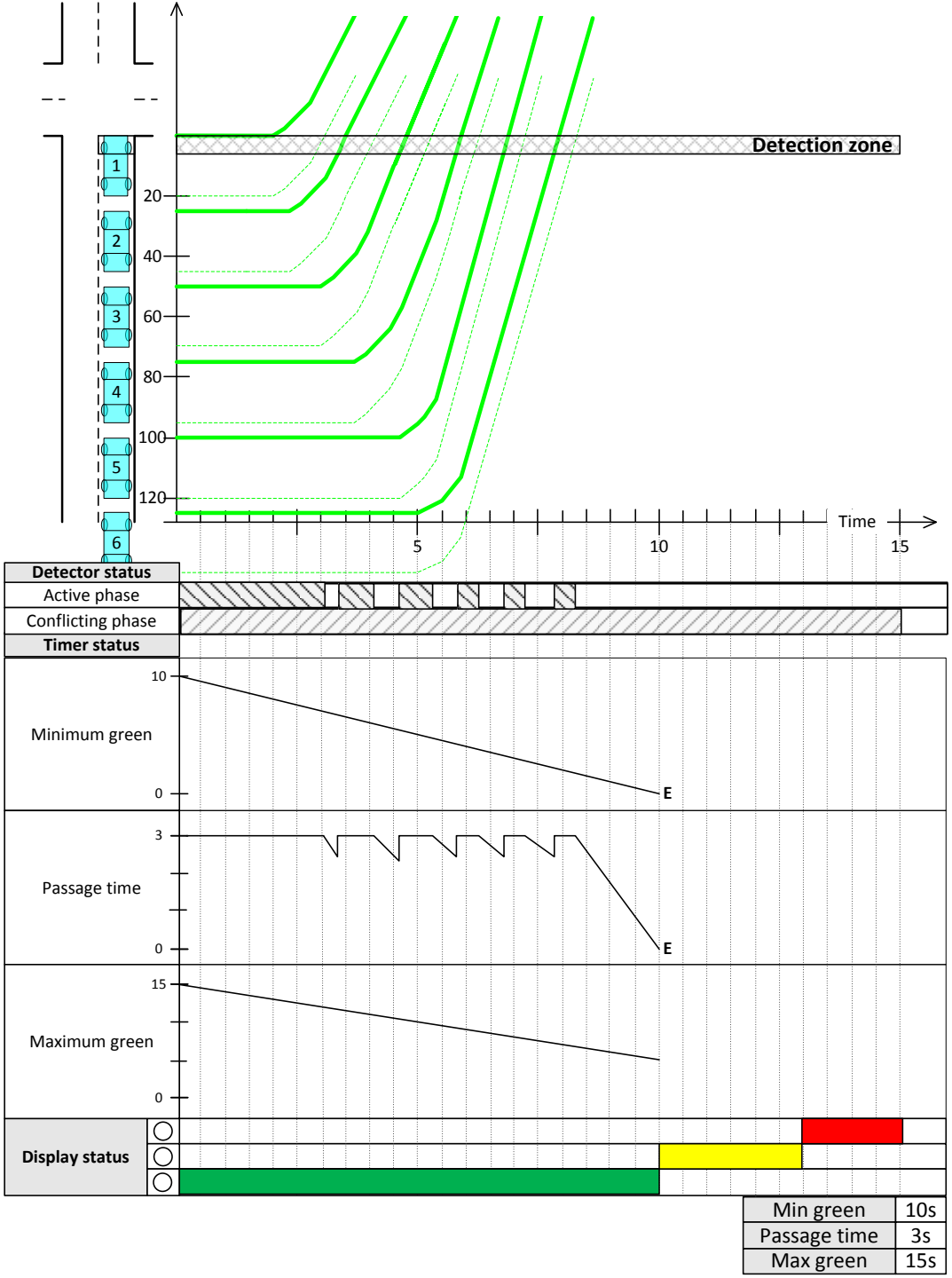
- Timers or timing processes
  - Minimum green
  - **Maximum green**
  - Vehicle extension/passage time/gap time

The ***passage timer*** also becomes active when the phase becomes active. The passage timer begins at its established value and times down until it reaches zero, or times out. However, if a call is received on the active phase during this timing process (when the passage timer is active), the passage timer will be reset. But when the passage timer expires, and if the minimum green timer has expired, the green display will turn off and the phase will begin to terminate.



- Timers or timing processes
  - Minimum green
  - Maximum green
  - **Vehicle extension/passage time/gap time**


Detection zone
1
2
3
4
5
6
20
40
60
80
100
120
Time
10
20
30
Users are detected
Detector status
Active phase
Conflicting phase
Timer status
Minimum green
Passage time
Maximum green
Display status
Detector call sent to traffic controller
Controller determines signals to display
Feedback loop: Users respond to signal display
Time



Min green	10s
Passage time	3s
Max green	15s