**USE CASES DRAFT 1**

**A cross-section of a road

Description automatically generated**

ITMS is stated for a phased expansion, progressively evolving from a simplified model into a decentralized, adaptable, secure, and intelligent network, proficiently tasked with the management of traffic in urban areas.

Initially, a simplified version of the system is constructed, serving as a Proof of Concept. In this version one intersection has four lanes each equipped with a traffic light (i.e., N, W, S and E) that are identical meaning if a statement is valid for one of them, it applies to the others as well. Additionally, vehicles in each lane can go straight only (i.e., cannot turn left or right). As a result, it is possible for two opposite lanes to be green simultaneously (i.e., when W is green, E can be green too and the same applies for N and S). Furthermore, all vehicles are treated as identical sedan cars (hereinafter referred to simply as “cars”) to mitigate potential bottlenecks arising from variations in vehicle lengths and widths.

To ensure safety operation of the system, three “golden rules” were defined:

1. By default, every traffic light is red.
2. The traffic lights in two perpendicular lanes cannot be green simultaneously (e.g., when N is green, both E and W must be red).
3. No car must wait more than a certain amount of time.

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| **Use Case ID:** UC-01 | **Use Case:** The only car on the crossroad wants to pass |
| **Description** | When a car in line W wants to pass the crossroad straight and there are no other cars on the crossroad, the traffic light in lane W turns green and lets the car pass. |
| **Actor:** | A car |
| **Use Case ID:** UC-02 | **Use Case:** Two cars on the opposite sides of the crossroad want to pass |
| **Description** | When two cars, one in lane W and another in lane E, came on the crossroad simultaneously and want to pass and there are no other cars present, the traffic lights in lane W and E turn green and let the cars pass simultaneously. |
| **Actor:** | Two cars |
| **Use Case ID:** UC-03 | **Use Case:** Two cars in perpendicular lines want to pass |
| **Description** | When two cars which are in perpendicular lanes (one in lane W and another in lane S) want to pass and there are no other cars on the crossroad, the car that the system determines to be first is allowed to pass first (FIFO[[1]](#footnote-2)). |
| **Actor:** | Two cars |
| **Use Case ID:** UC-04 | **Use Case:** One car in each line wants to pass |
| **Description** | When four cars (one in line N, W, S and E) want to pass and the car in line W was determined by the system to be first, it is allowed to pass first (together with it the car in line E is allowed to pass too because it is in the opposite line). Afterwards, the cars in S and N are allowed to pass (FIFO). |
| **Actor:** | Four cars |
| **Use Case ID:** UC-05 | **Use Case:** A queue of two cars passes, a single car comes in another line and a queue of six cars comes in a third line |
| **Description** | When two cars in a queue in line W came first[[2]](#footnote-3) and want to pass, they pass. While they are passing another car comes in line S. While they are still passing, a queue of six cars comes in line E but after the car in line S. The queue in line E passes before the car in line S because E has higher priority (i.e., there are more cars in E than in S). |
| **Actor:** | Nine cars |
| **Use Case ID:** UC-06 | **Use Case:** There are two perpendicular queues, each consisting of a continuous flow of cars |
| **Description** | When there are queues in line N and in line E, each consisting of a continuous flow of cars, and the queue in line N came first, cars in line N are allowed to pass. After a certain period, cars in line E are allowed to pass. This alternating pattern continues until all cars in both queues have passed. |
| **Actor:** | Two continuous flows of cars |
| **Use Case ID:** UC-07 | **Use Case:** There are three queues, each consisting of a continuous flow of cars |
| **Description** | This scenario is like UC-06, differing only in the presence of a third queue in S. As there are now twice as many cars in the N-S/S-N flow, giving them higher priority compared to UC-06, the waiting period for cars in E is extended. |
| **Actor:** | Three continuous flows of cars |
| **Use Case ID:** UC-08 | **Use Case:** There are two opposite queues, each consisting of a continuous flow of cars and a single car in a perpendicular line |
| **Description** | This scenario is like UC-07, differing only in the presence of a single car in E, not a queue. With only one car in E, giving it even less priority, the waiting period for E is significantly longer than in UC-07. Despite this, it must be allowed to pass within a reasonable amount of time. |
| **Actor:** | Two continuous flow of cars and a single car |

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| **Use Case ID:** UC-09 | **Use Case:** if detect… |
| **Description** |  |
| **Actor:** |  |
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**DRAFT 2**

**A cross-section of a road

Description automatically generated**ITMS is stated for a phased expansion, progressively evolving from a simplified model into a decentralized, adaptable, secure, and intelligent network, proficiently tasked with the management of traffic in urban areas.

Initially, a simplified version of the system is constructed, serving as a Proof of Concept. In this version one intersection has four lanes each equipped with a traffic light (i.e., N, W, S and E) that are identical meaning if a statement is valid for one of them, it applies to the others as well. Additionally, vehicles in each lane can go straight only (i.e., cannot turn left or right). As a result, it is possible for two opposite lanes to be green simultaneously (i.e., when W is green, E can be green too and the same applies for N and S). Furthermore, all vehicles are treated as identical sedan cars (hereinafter referred to simply as “cars”) to mitigate potential bottlenecks arising from variations in vehicle lengths and widths.

To ensure safety operation of the system, three “golden rules” were defined:

1. By default, every traffic light is red.
2. The traffic lights in two perpendicular lanes cannot be green simultaneously (e.g., when N is green, both E and W must be red).
3. No car must wait more than a certain amount of time.

|  |  |
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| **Use Case ID:** UC-01 | **Use Case:** The only car on the crossroad wants to pass |
| **Description** | When a car in line W wants to pass the crossroad straight and there are no other cars on the crossroad, the traffic light in lane W turns green and lets the car pass. |
| **Actor:** | A car |
| **Use Case ID:** UC-02 | **Use Case:** Two cars on the opposite sides of the crossroad want to pass |
| **Description** | When two cars, one in lane W and another in lane E, came on the crossroad simultaneously and want to pass and there are no other cars present, the traffic lights in lane W and E turn green and let the cars pass simultaneously. |
| **Actor:** | Two cars |
| **Use Case ID:** UC-03 | **Use Case:** Two cars in perpendicular lines want to pass |
| **Description** | When two cars which are in perpendicular lanes (one in lane W and another in lane S) want to pass and there are no other cars on the crossroad, the car that the system determines to be first is allowed to pass first (FIFO[[3]](#footnote-4)). |
| **Actor:** | Two cars |
| **Use Case ID:** UC-04 | **Use Case:** One car in each line wants to pass |
| **Description** | When four cars (one in line N, W, S and E) want to pass and the car in line W was determined by the system to be first, it is allowed to pass first (together with it the car in line E is allowed to pass too because it is in the opposite line). Afterwards, the cars in S and N are allowed to pass (FIFO). |
| **Actor:** | Four cars |
| **Use Case ID:** UC-05 | **Use Case:** A queue of two cars passes, a single car comes in another line and a queue of six cars comes in a third line |
| **Description** | When two cars in a queue in line W came first[[4]](#footnote-5) and want to pass, they pass. While they are passing another car comes in line S. While they are still passing, a queue of six cars comes in line E but after the car in line S. The queue in line E passes before the car in line S because E has higher priority (i.e., there are more cars in E than in S). |
| **Actor:** | Nine cars |
| **Use Case ID:** UC-06 | **Use Case:** There are two perpendicular queues, each consisting of a continuous flow of cars |
| **Description** | When there are queues in line N and in line E, each consisting of a continuous flow of cars, and the queue in line N came first, cars in line N are allowed to pass. After a certain period, cars in line E are allowed to pass. This alternating pattern continues until all cars in both queues have passed. |
| **Actor:** | Two continuous flows of cars |
| **Use Case ID:** UC-07 | **Use Case:** There are three queues, each consisting of a continuous flow of cars |
| **Description** | This scenario is like UC-06, differing only in the presence of a third queue in S. As there are now twice as many cars in the N-S/S-N flow, giving them higher priority compared to UC-06, the waiting period for cars in E is extended. |
| **Actor:** | Three continuous flows of cars |
| **Use Case ID:** UC-08 | **Use Case:** There are two opposite queues, each consisting of a continuous flow of cars and a single car in a perpendicular line |
| **Description** | This scenario is like UC-07, differing only in the presence of a single car in E, not a queue. With only one car in E, giving it even less priority, the waiting period for E is significantly longer than in UC-07. Despite this, it must be allowed to pass within a reasonable amount of time. |
| **Actor:** | Two continuous flow of cars and a single car |

1. FIFO – The first in is the furst out. Meaning: the car that came to the crossroad first passes first and each subsequent car passes relative to the time of its arrival. [↑](#footnote-ref-2)
2. “comes first” or “is first” – means “is determined by the system to be first”. [↑](#footnote-ref-3)
3. FIFO – The first in is the furst out. Meaning: the car that came to the crossroad first passes first and each subsequent car passes relative to the time of its arrival. [↑](#footnote-ref-4)
4. “comes first” or “is first” – means “is determined by the system to be first”. [↑](#footnote-ref-5)