# Space based positioning and timing for railway operations

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## INTRODUCTION

Railway operations still rely on expensive track-based detection and signalling systems which are hindering the maximum capacity achievable by the railway network. European Rail Traffic Management System (ERTMS) are looking to implement a moving block system to address these problems. This will require the trains to be able to autonomously determine their position. This study will examine the use of a Global Navigation Satellite System (GNSS), GPS to perform this task.

## FIXED BLOCK vs MOVING BLOCK

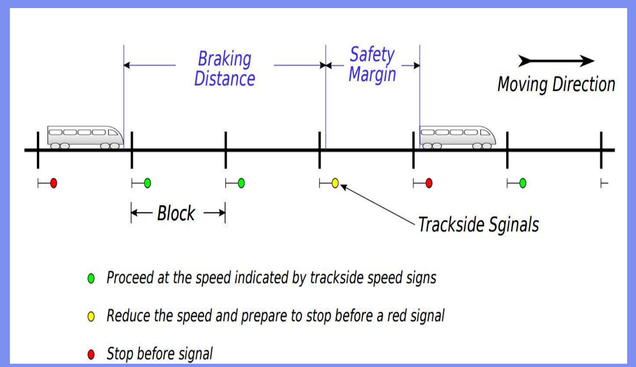


**Figure 1:** Schematic drawing of a fixed block system (Jiang, 2011)

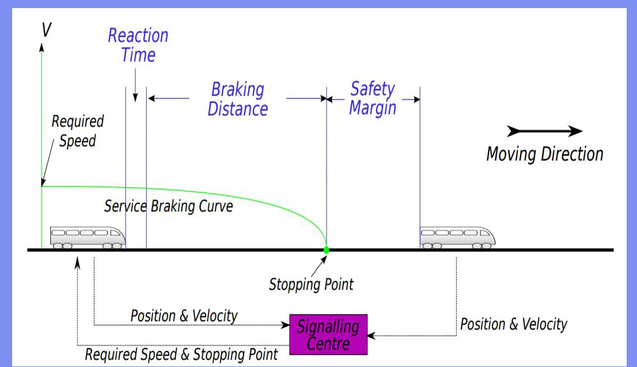


**Figure 2**: Schematic drawing of a moving block system (Jiang, 2011)

- Trains are not allowed to enter a block until the previous one has left
- Long headways governed by the length of the blocks
- Costly trackside signals are used
- Presence of a train in a block is monitored by a high maintenance detector

- Virtual block that moves with the train
- On-board computer displays ideal braking curve until the current position of the next train
- Communication to the signalling centre is done via a reserved radio frequency
- Requires a real time positioning system

## POSITIONING SYSTEM REQUIEREMENTS

- Accuracy of 2 m, integrity TTA of 2s, continuity of 99% and availability of 99% (RSSB, 2012)
- Fail safe-feature
- Train completeness monitoring

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## REFERENCES

1. Jiang, Z. (2011) *Digital route model aided integrated satellite navigation and low-cost inertial sensors for high-performance positioning on the railways*.

2. RSSB (2012) *Engineering Data analysis for a cost-effective GPS-based locator with simple augmentations Requirements analysis for locator technology in GB Railways*.

## MODELLING

- A train with a mounted GPS receiver running on a section of the proposed HS2 is simulated
- Fictional obstruction planes are added to mimic different cases of satellite visibility
- Expected GPS errors are added to the signal and subsequently removed by the receiver in order to assess their effect on positioning accuracy


**Figure 3:** Map illustrating the track and obstructions


**Figure 4**: Number of satellites in view

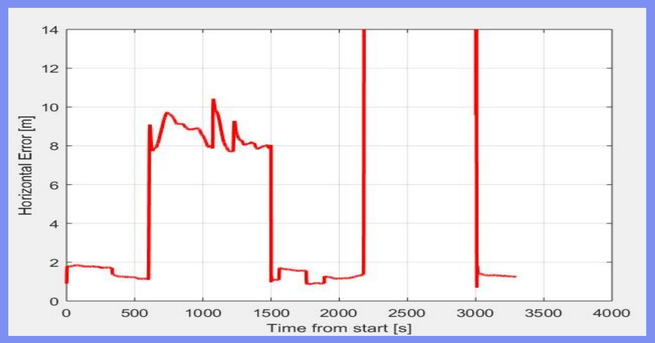


**Figure 5**: Horizontal positioning accuracy

## GPS PERFORMANCE

- Provided there are enough satellites in view with a good geometry, GPS with EGNOS provides the accuracy, integrity, availability and continuity required
- Fail safe-feature provided by EGNOS
- Train completeness can be monitored by placing multiple receivers along the train

## PROPOSED SOLUTION

- Integrate an augmented GNSS with a dead reckoning system in order to get a high update rate of information
- Use multiple constellations to obtain a better satellite geometry
- For sections of the track with limited or no satellite visibility, unless some of the positional requirements are relaxed during signal shortage, resorting to conventional detectors was the only solution found from the study