Performance Evaluation of Train Moving-Block Control

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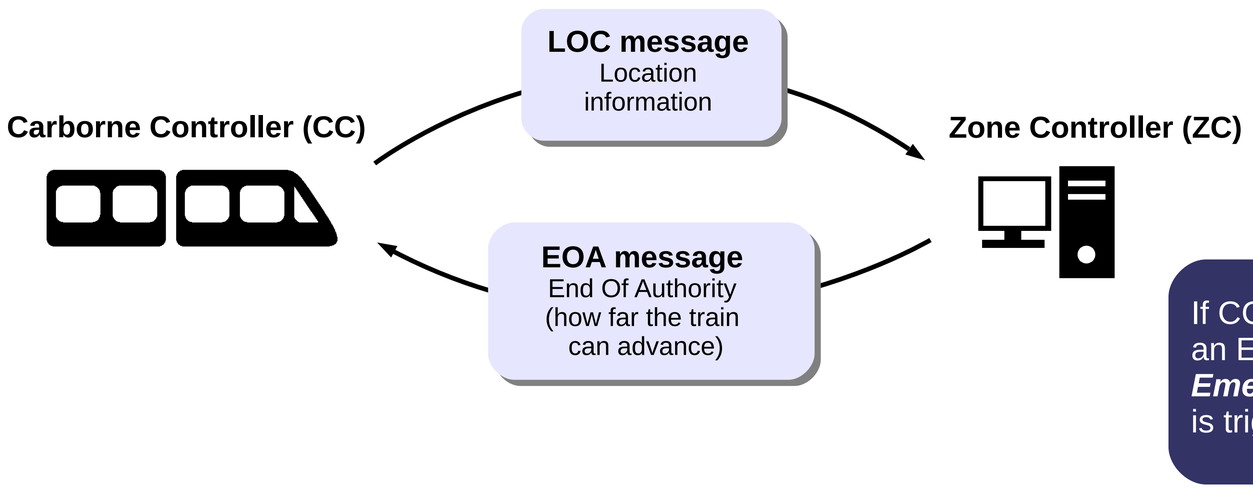


In this work we study Emergency Brake rate

Approach and General Formula

We derived general formula for the EB rate that requires to provide the loss and delay model

$$\text{EB rate} = f(\text{Loss Model}, \text{Delay Model})$$

Probability that the k-th LOC-EOA exchange is lost.

Probability that the k-th EOA arrives too late to deactivate the timer of LOC_1

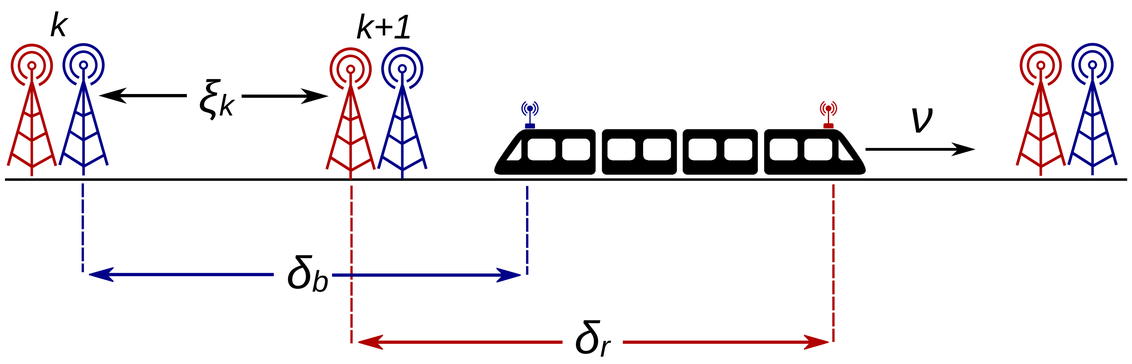
Two cases for loss model

Case 1: Independent and Homogeneous losses

✔ Exact expression for EB rate
✔ Understanding of the role of different system parameters

Case 2: Losses due to handover (HO)

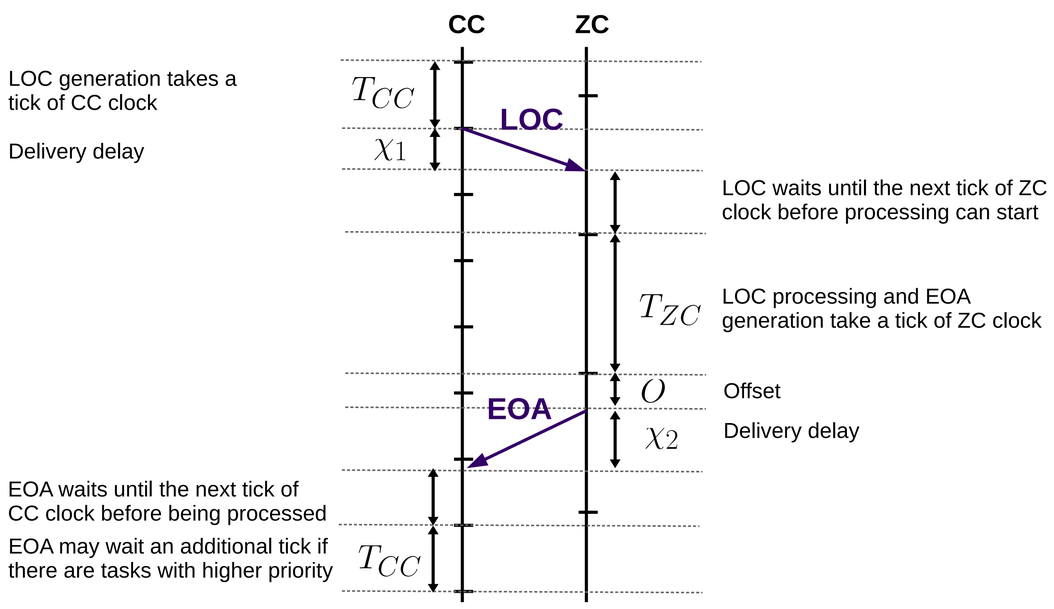
As the train moves, it regularly loses communication due to handover phases. These handover phases depend on train's mobility.



Delay model is based on real implementation for metro by ALSTOM Transport

CC and ZC servers work on the basis of ticks. CC generates LOC every third tick of its clocks.

The figure explains the procedure of one LOC-EOA exchange.

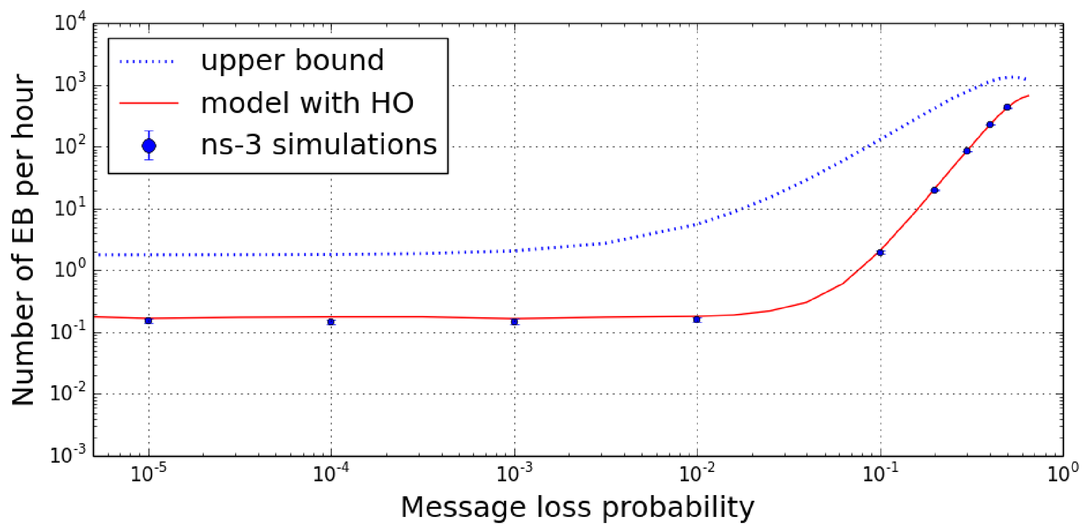


Simulation results

It is hard to derive a closed-form expression for EB rate in presence of handovers (case 2).

We evaluate the EB rate with Monte-Carlo simulations.

Computational costs do not depend on the loss probability value. Thus it is efficient even when emergency brakes are rare (as they should be).



✔ Theoretical results are validated with ns-3 simulations.

✔ Too loose bounds justify our analysis.

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