Delay of Incidents

Consequences of Stochastic Incident Duration

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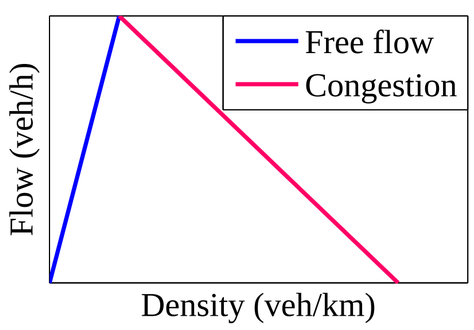
Abstract

The delay caused by an incident depends on many variables. This paper introduces an *analytical expression* for the delay, describing the location and length of the queue by shockwave theory. As long as the congestion remains on the same link, delay is proportional to the square of the duration, even in case the outflow is reduced by a junction downstream. This gives an elegant expression for the expected delay. Once the queue grows to other links (spillback or blocking back), the influence of duration becomes even larger. Therefore, it is useful to avoid spillback by network design or reduce incident times as much as possible.

Traffic flow description

- Variables:
  - Incident duration (ΔT) and location
  - Capacities
- Analytical description
- Shock wave theory
- Triangular fundamental diagram

$\Rightarrow$ *Closed delay expression*



=> Analytical modeling is possible

Stochastic duration

Analysis shows that without spillback the total delay equals $c\Delta T^2$. Then, its expectation value, $\langle \text{Delay} \rangle$, is computed by:

$$\langle \text{Delay} \rangle = \langle c\Delta T^2 \rangle = c\langle \Delta T^2 \rangle = c\left(\langle \Delta T \rangle^2 + \text{Var}(\Delta T)\right)$$

The delay is formulated as closed expression. Note it has 2 parts: *the delay of an incident with a mean duration,* $\langle \Delta T \rangle$*, and a part with the variation of the incident duration.* If a deterministic mean duration is used instead, the error is:

$$\text{error} = c\langle \Delta T \rangle^2 - \langle c\Delta T^2 \rangle = c\,\text{Var}(\Delta T)$$

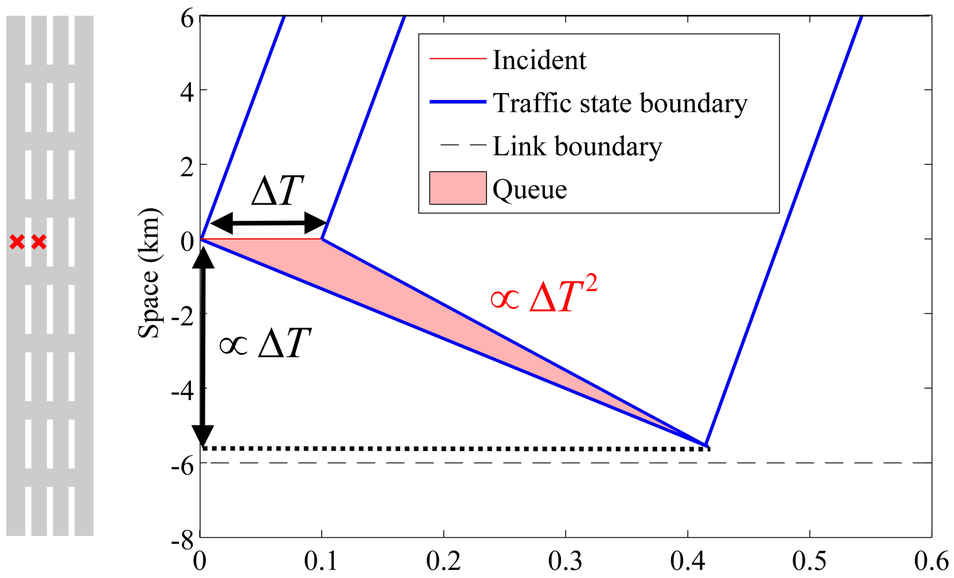
In the Netherlands, this error is 24% of the expected delay.

Influence of duration & spillback

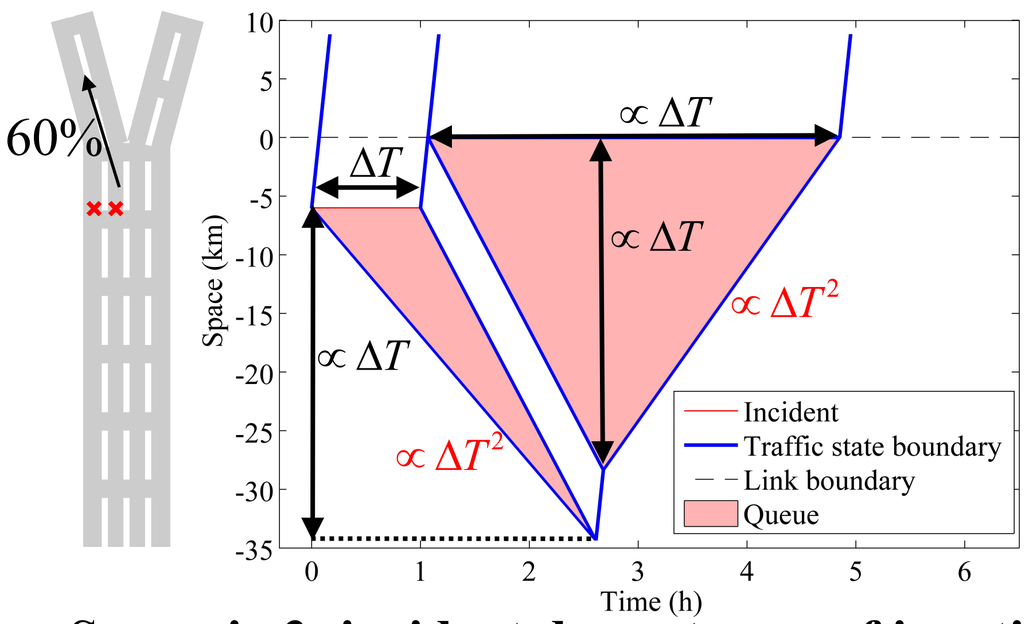
If the upstream link is not blocked, the *delay is proportional to the square of the incident duration*. It is therefore useful to reduce the incident time.

An upstream junction would be congested a time duration τ shorter than the incident duration ΔT. τ depends on the speed of the waves and the distance to the junction. If $(\Delta T\text{-}\tau)$ is positive, spillback occurs and *delay increases more than proportional to the duration squared.* Reducing the incident time is therefore even more effective if there is a risk of spillback.

Scenario 1: no junction



Scenario 2: incident upstream of junction



Scenario 3: incident downstream of junction