Issues with Advance Train Preemption of Traffic Signals

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Location
Rail Preemption

- Designed to **transfer right-of-way** to the track movement and **clear vehicles** off the track(s) before the train arrives

- Preemption sequence in traffic signal controller:
  - Initiated by a signal from the rail equipment
  - Transfer right-of-way to track movements
  - Service and terminate track movements
  - Must be done before **train arrives**!

Current Design Methodology

- Use maximum **right-of-way transfer time**
- Assumes a heavy vehicle stopped on track
- Calculates time to get that vehicle off track
- Track clearance green time set to this value
- Request advance preemption time, if needed
- Assures vehicle is off track when train arrives
Design Case

Preempt Time To Controller

Warning Time
Minimum APT

Lights
Minimum Warning Time (20 sec)
Lights Flashing

Gates
fixed delay
Scales Descending

Signal
Maximal RWTT
Track Green

Queue
Queue Clearance Time

Train Arrives At Crossing

Question

- Is this good enough to guarantee safe operations?

No!
Operations

• **Variability** impacts preemption operations

  • Variability in **traffic signal operations**
    ▶ Due to unknown controller state at preemption initiation
    ▶ Affects right-of-way transfer time

  • Variability in **rail operations**
    ▶ Due to “train handling”
    ▶ Affects warning times

Data Collection

• Train monitoring opportunities at TTI
  ▶ Instrumented rail corridor in College Station, TX
  ▶ Good relationship with City of College Station

• Train data collection
  ▶ Logged signal changes
  ▶ Logged preemptions
  ▶ Logged lights & gates
  ▶ Logged train arrivals
Preemption Warning Time Distribution

Variation: 17 seconds

Guaranteed by Railroad:
20 sec MWT + 15 sec APT

Median Value: 48 seconds

Problem

- Exists with advance preemption
- Preemption initiation and warning device initiation are independent processes
"Uncoupling" of Events

Operations (1)

Preempt to Controller

Lights Start to Flash

Train Arrives at Crossing

Warning Time

Advance Presumptions (APT)

Minimum Warning Time

Maximum RWTT

Queue Clearance Time

Separation Time

Queue

Signal

Gates

Lights

Time

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“Preempt Trap”

- Track clearance green may end before warning lights start to flash
- Vehicles have no indication of impending train arrival and may cross tracks
- But the track clearance interval has already expired!

Solutions

Treat the symptoms
and / or
Treat the cause
Preempt To Controller

**Warning Time**
- Advance Preemption Time (APT) (variable)
- Minimum APT (fixed) (variable)
- Minimum Warning Time (20 sec)

**Lights**
- Preempt (fixed)
- Lights Flashing

**Gates**
- fixed delay
- Gates Descending
- Gates Down

**Signals**
- Track Green
- Extra Green
- Yellow
- Red / Dwell

**Queue**
- Queue Clearance Time
- Separation Time

Train Arrives At Crossing

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Add

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Treat the Symptoms

- Provide **more than the minimum** required track clearance green
- Balance probability of preempt trap with operational efficiency
- For example:
  - Set track green to APT + 15 seconds
  - Design for measured APT times

Treat the Cause (one method)

- Reduce variability in rail operations:
  - Reduce variability in advance preemption time
  - Use a “not-to-exceed” timer to **control maximum APT** as per 2000 AREMA Signal Manual
Treat the Cause (one method)

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Conclusion

- Be aware of the potential problems of advance preemption
- Take the necessary steps to avoid (or at least minimize the probability of) the preempt trap
- Consider design and operational scenarios

For More Information

- http://transops.tamu.edu/content/gradecrossing.cfm
- More extensive presentation
- Manual on good practice
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