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ESTIMATING THE IMPACT OF INCIDENTS ON PROCESS DELAY

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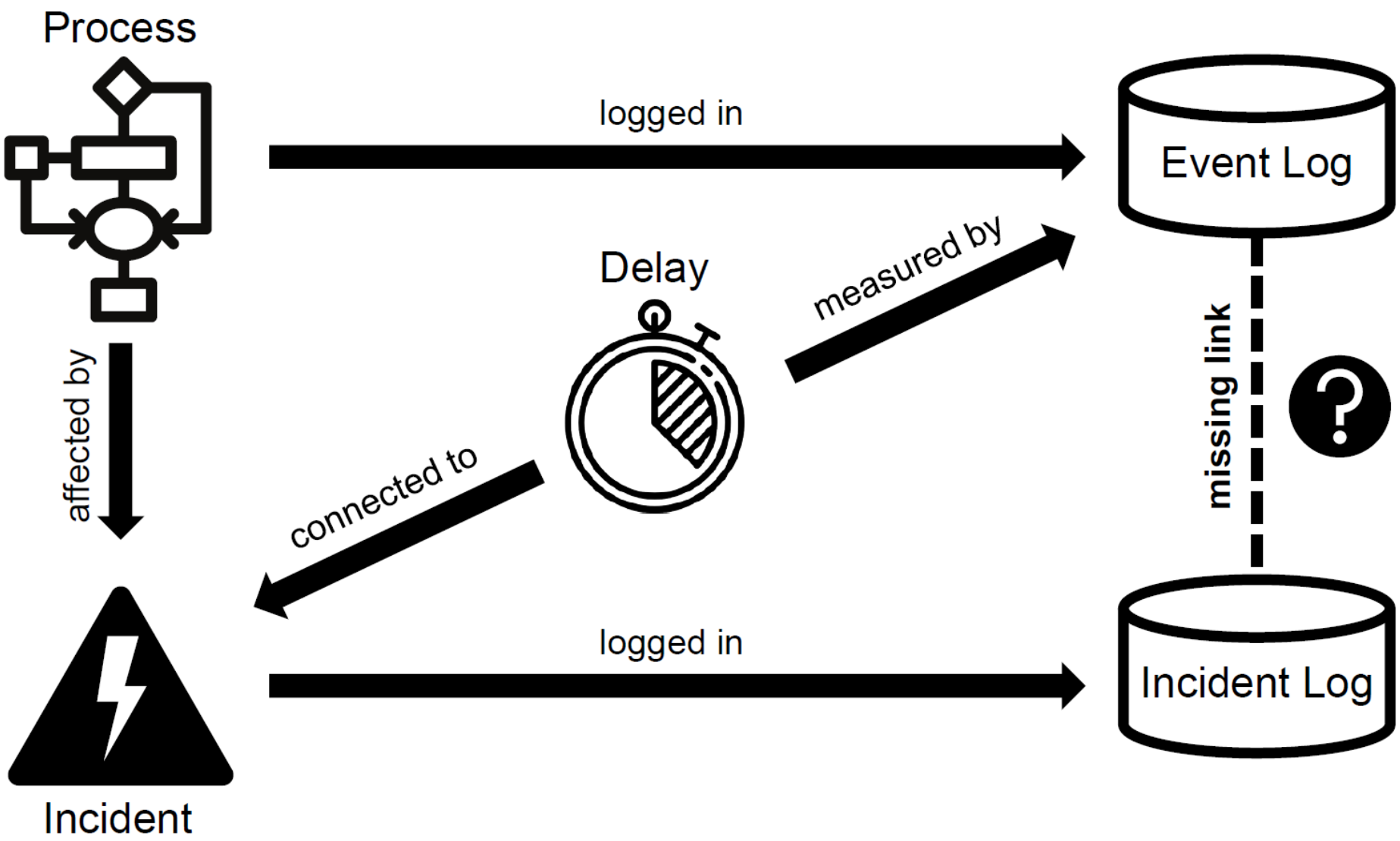
Andreas D. Landmark


Process
logged in
Event Log
Delay
measured by
affected by
missing link
connected to
logged in
Incident Log
Incident

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Railway Traffic Control Logs

Case

Activity

id	train	day	time	schedule	station	type	direction
e_1	407	2017-12-04	2017-12-04 06:30:43	2017-12-04 06:30:00	OPD	arrival	up
e_2	407	2017-12-04	2017-12-04 06:47:52	2017-12-04 06:45:00	OPD	departure	up
e_3	407	2017-12-04	2017-12-04 06:53:27	2017-12-04 06:51:30	FGH	arrival	up
e_4	407	2017-12-04	2017-12-04 06:53:49	2017-12-04 06:52:00	FGH	departure	up
e_5	407	2017-12-04	2017-12-04 07:02:49	2017-12-04 07:00:30	UBG	arrival	up
e_6	407	2017-12-04	2017-12-04 07:03:25	2017-12-04 07:01:00	UBG	departure	up
e_7	407	2017-12-04	2017-12-04 07:11:19	2017-12-04 07:08:00	BAK	arrival	up
e_8	407	2017-12-04	2017-12-04 07:13:15	2017-12-04 07:09:00	BAK	departure	up
e_9	42	2017-12-04	2017-12-04 09:30:03	2017-12-04 09:29:00	BAK	arrival	down
e_{10}	42	2017-12-04	2017-12-04 09:31:54	2017-12-04 09:30:00	BAK	departure	down
e_{11}	42	2017-12-04	2017-12-04 09:39:49	2017-12-04 09:38:30	UBG	arrival	down
e_{12}	42	2017-12-04	2017-12-04 09:40:30	2017-12-04 09:39:00	UBG	departure	down
e_{13}	42	2017-12-04	2017-12-04 09:49:19	2017-12-04 09:47:30	FGH	arrival	down
e_{14}	42	2017-12-04	2017-12-04 09:49:50	2017-12-04 09:48:00	FGH	departure	down

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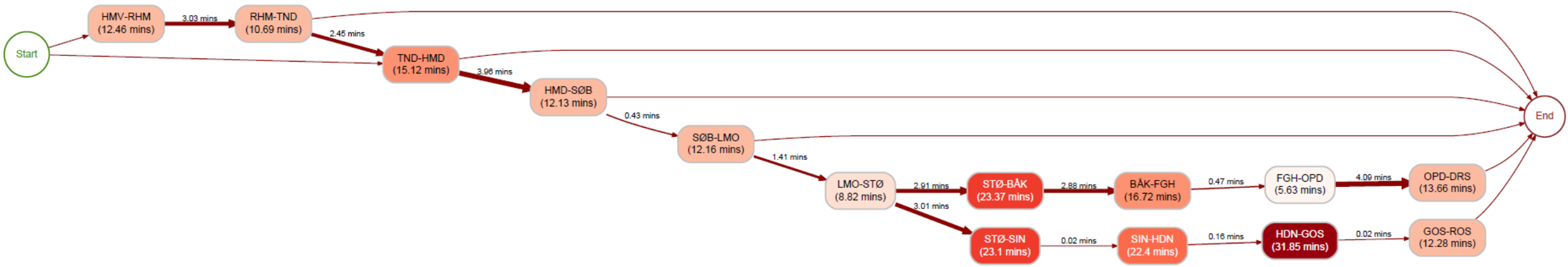
Railway Traffic Logs – Example Process Model



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What is process delay?

Definition A

Expected/Scheduled
vs.
Actual Performance

Definition B

Normal performance
vs.
Actual performance

id	train	day	time	schedule	station	type
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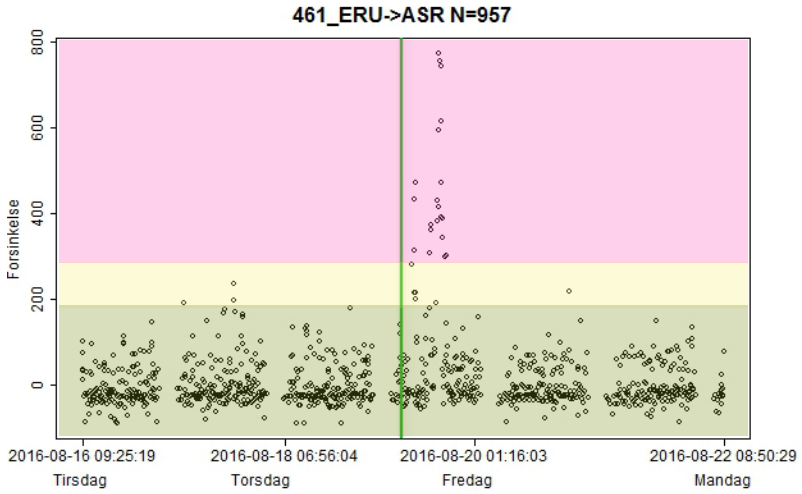

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What is known about incidents?

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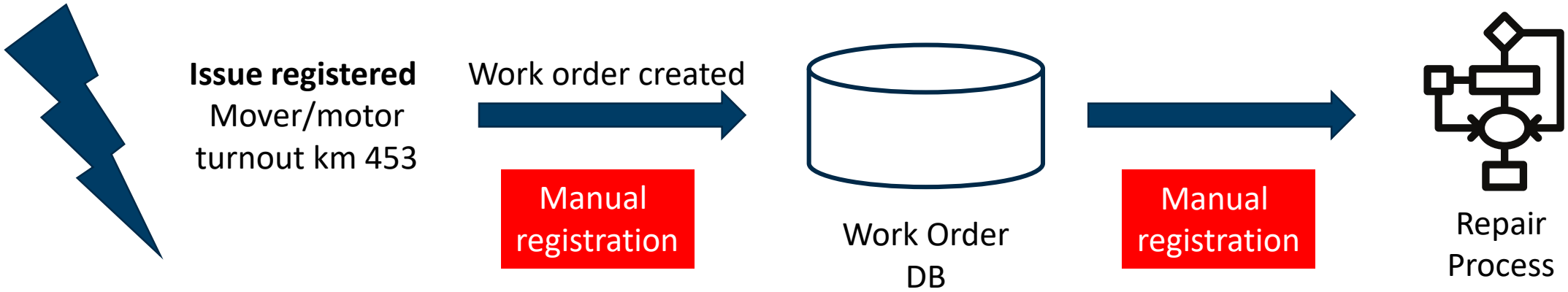
Image sources: banenor.no

What is known about incidents?



Incident Log

id	object	location	time
i_1	EH-MAS-123	km 453	2017-12-04 06:58:00
i_2	SA-DRV-123	km 442	2017-12-06 13:23:00
i_3	SA-SIK-123	km 320	2017-12-12 20:51:00
...	...	...	...

Registered?
Work started?
Contractor notified?
When was it fixed?

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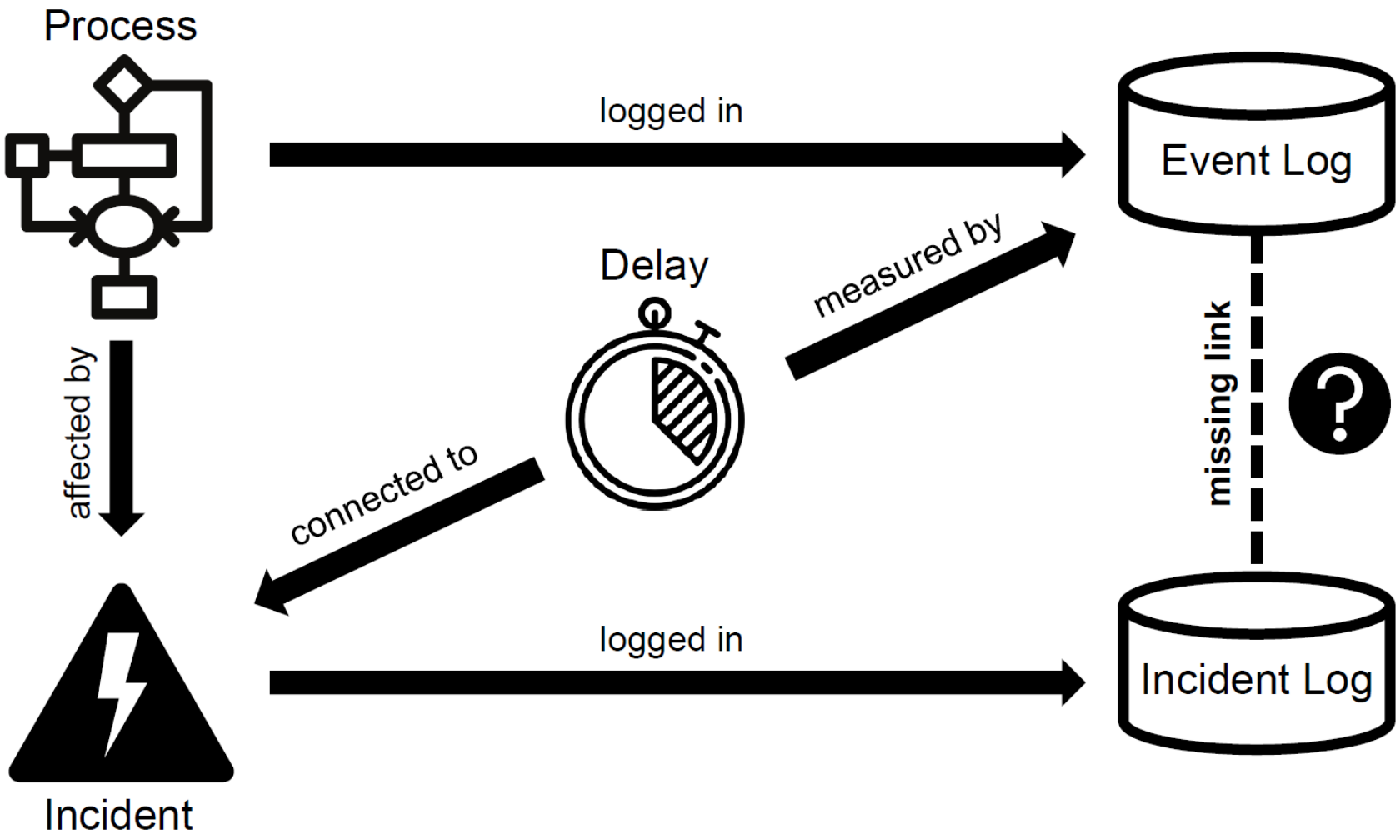
The Problem – Linking Incidents to Delay



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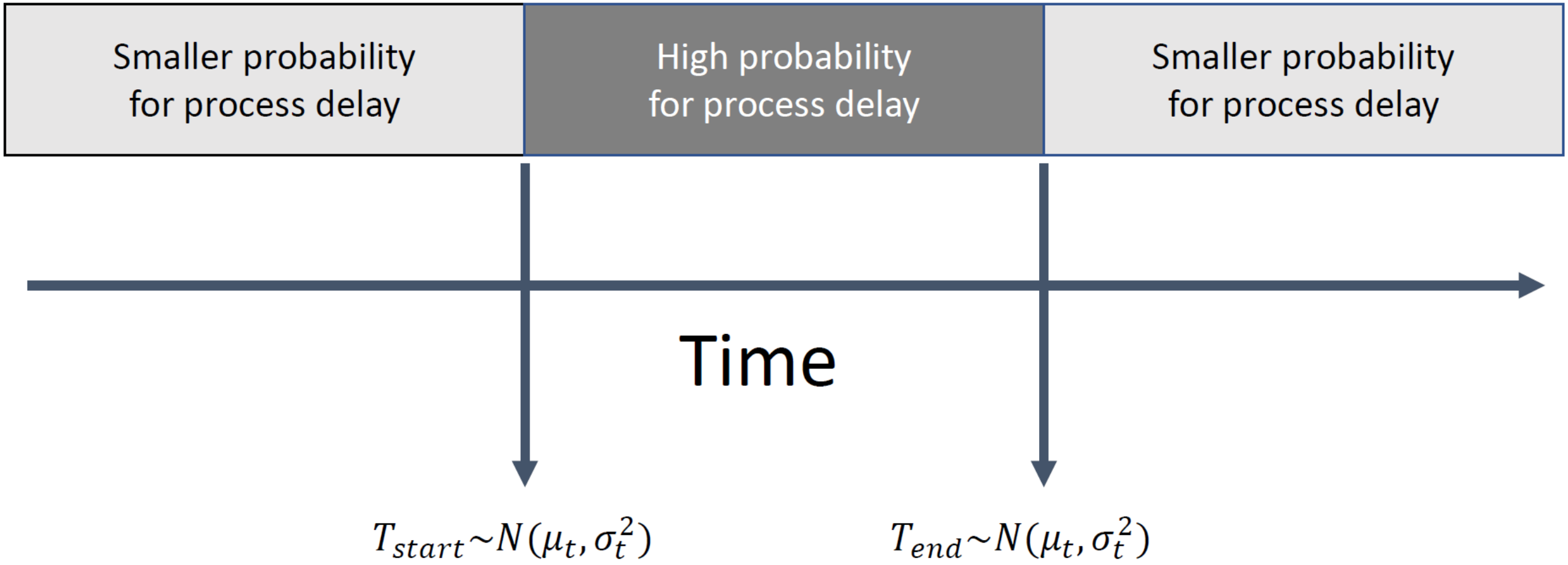
Existing work

- Internal performance factors
  - Alignments to project performance information
  - Identification of slow variants / combination of attributes
  - Identification of slow resources
- Prediction of performance
  - Remaining time to completion
  - Some work considering inter-case parameters
- Visualisation of performance
  - Dotted chart
  - Others: Process Profiler, Performance Spectrum etc.

None is addressing the linking/estimation challenge!

Proposed Approach – Assumptions #1



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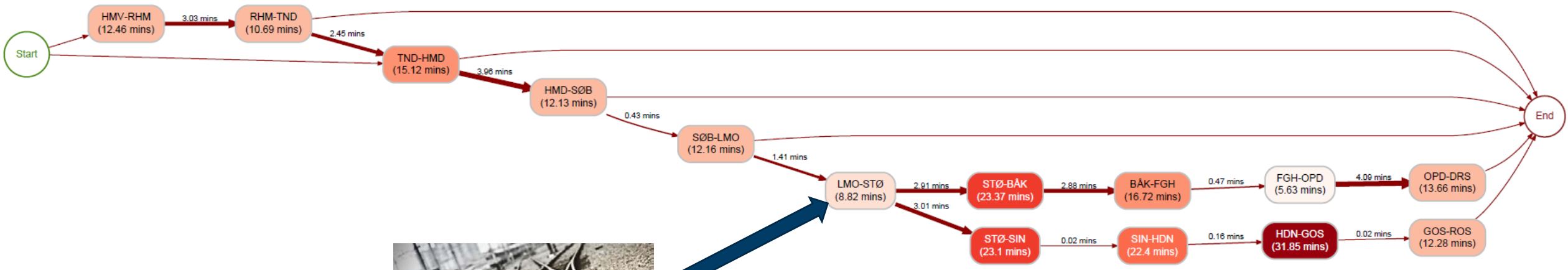
Proposed Approach – Assumptions #2



Resource required for trains to pass station Støren!

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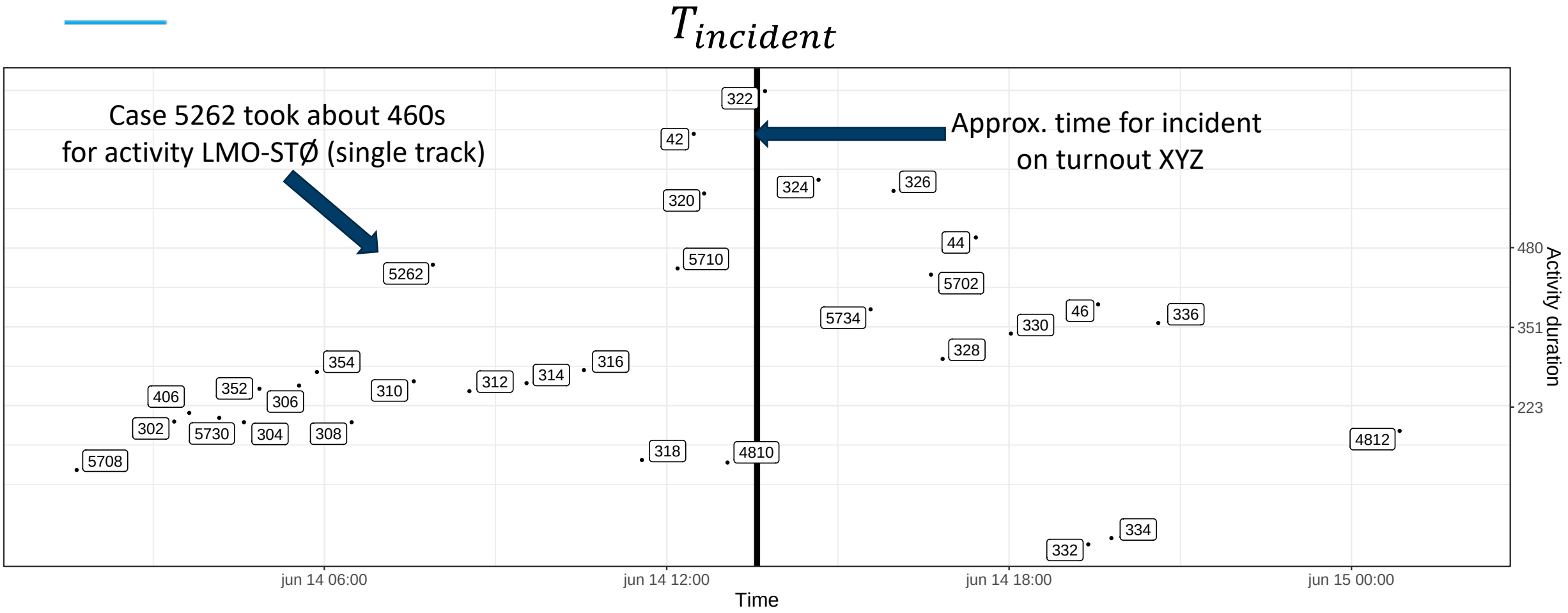
Proposed Approach – Impact Estimation #1



Approximate incident time

Step 1: Collect performance information from event log

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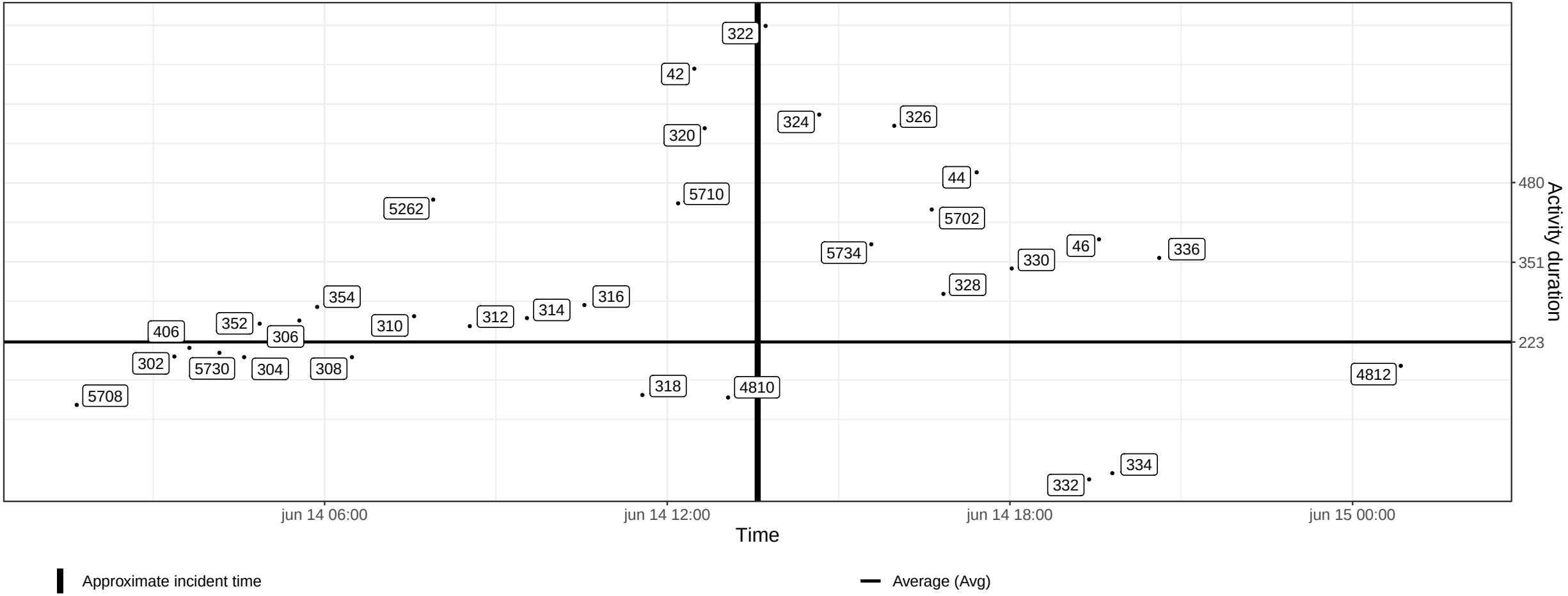
Proposed Approach – Impact Estimation #2



Step 2: Determine normal process performance

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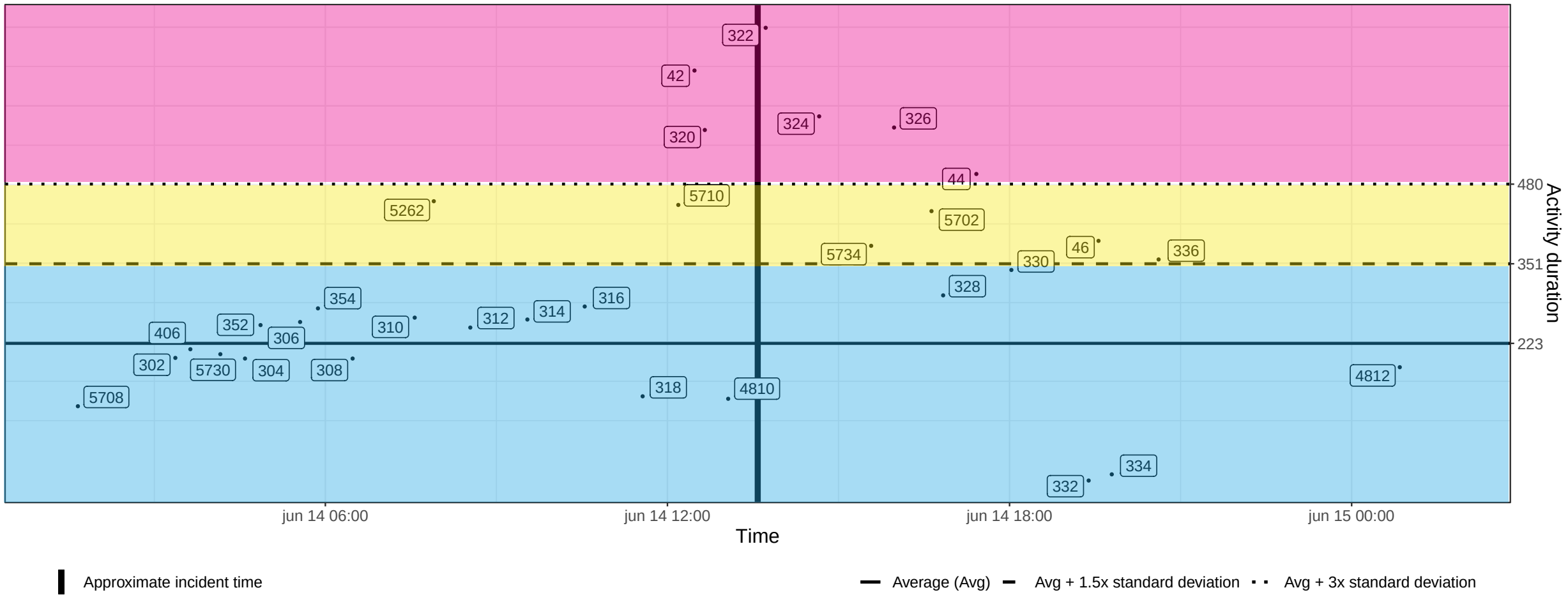
Proposed Approach – Impact Estimation #3



Step 3: Classify activity instances into three classes

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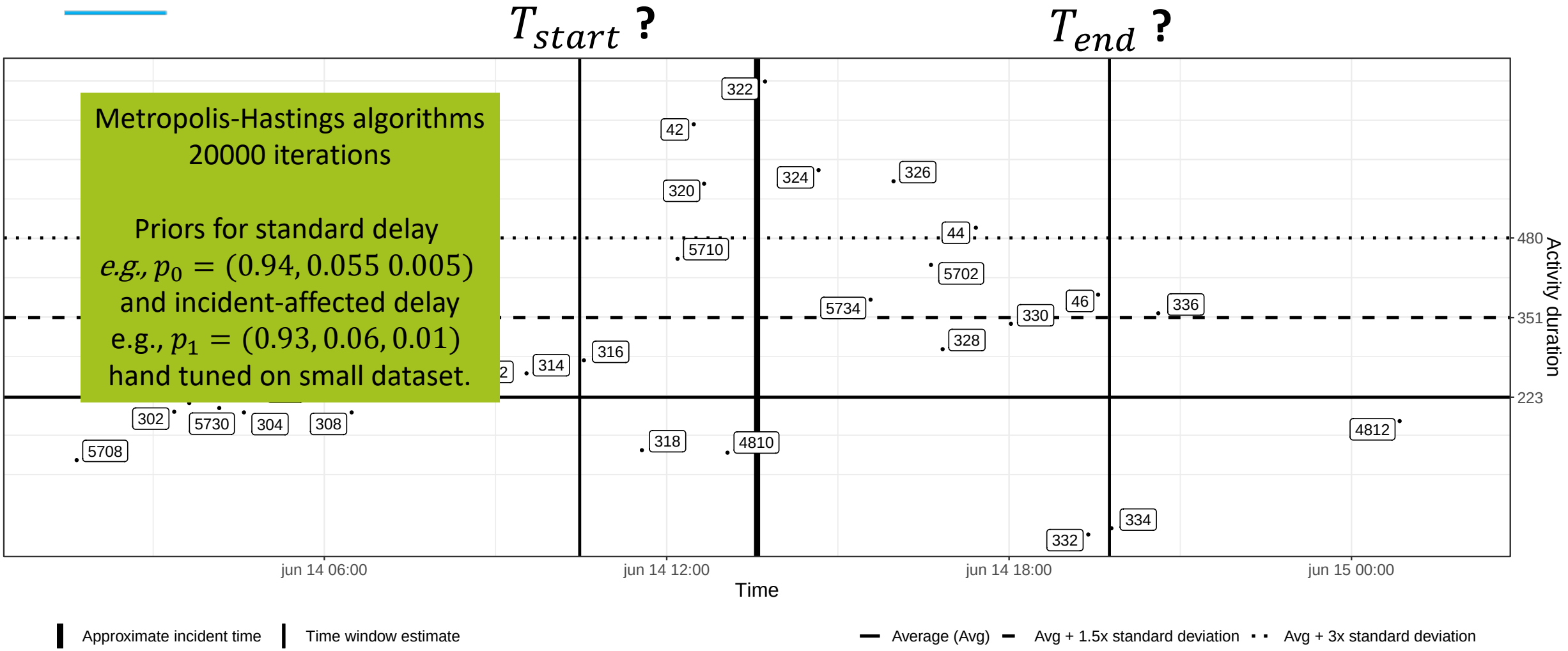
Proposed Approach – Impact Estimation #4



Step 4: Determine likely start/end of impact using MCMC

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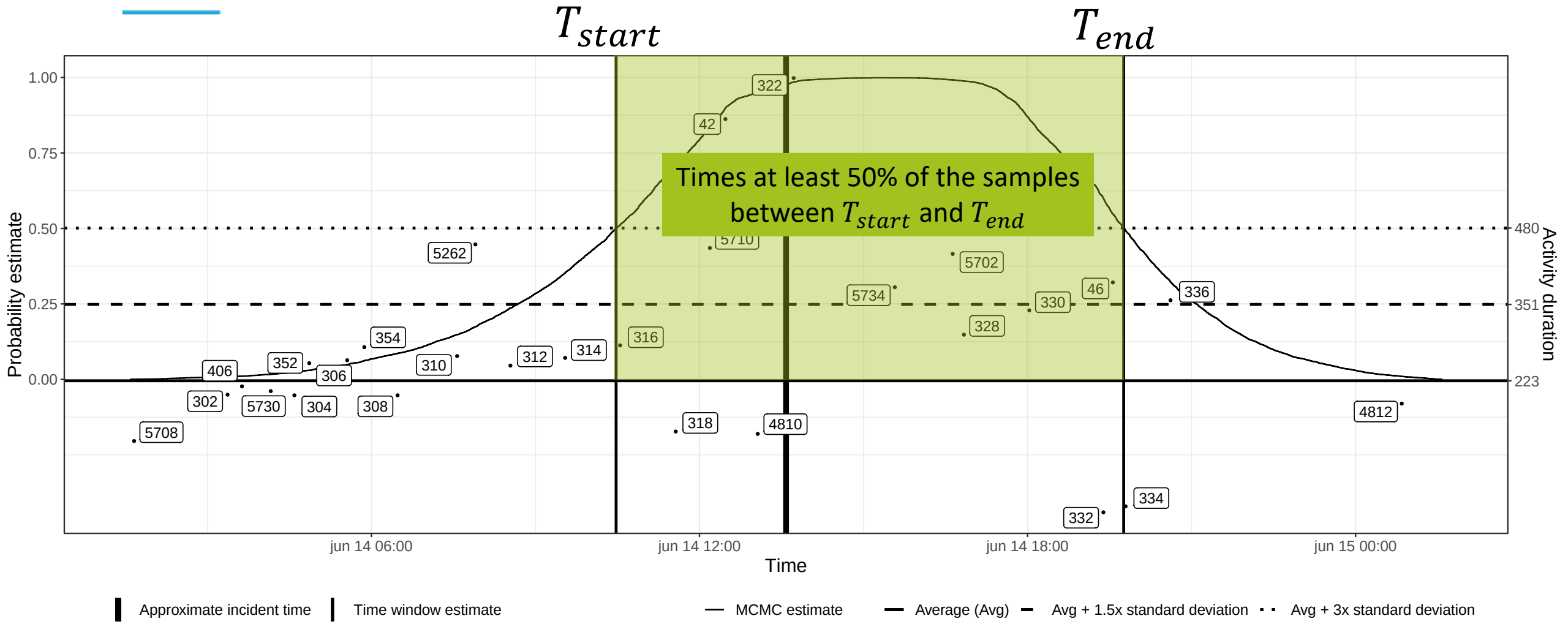
Proposed Approach – Impact Estimation #4



Step 4: Determine likely start/end of impact using MCMC

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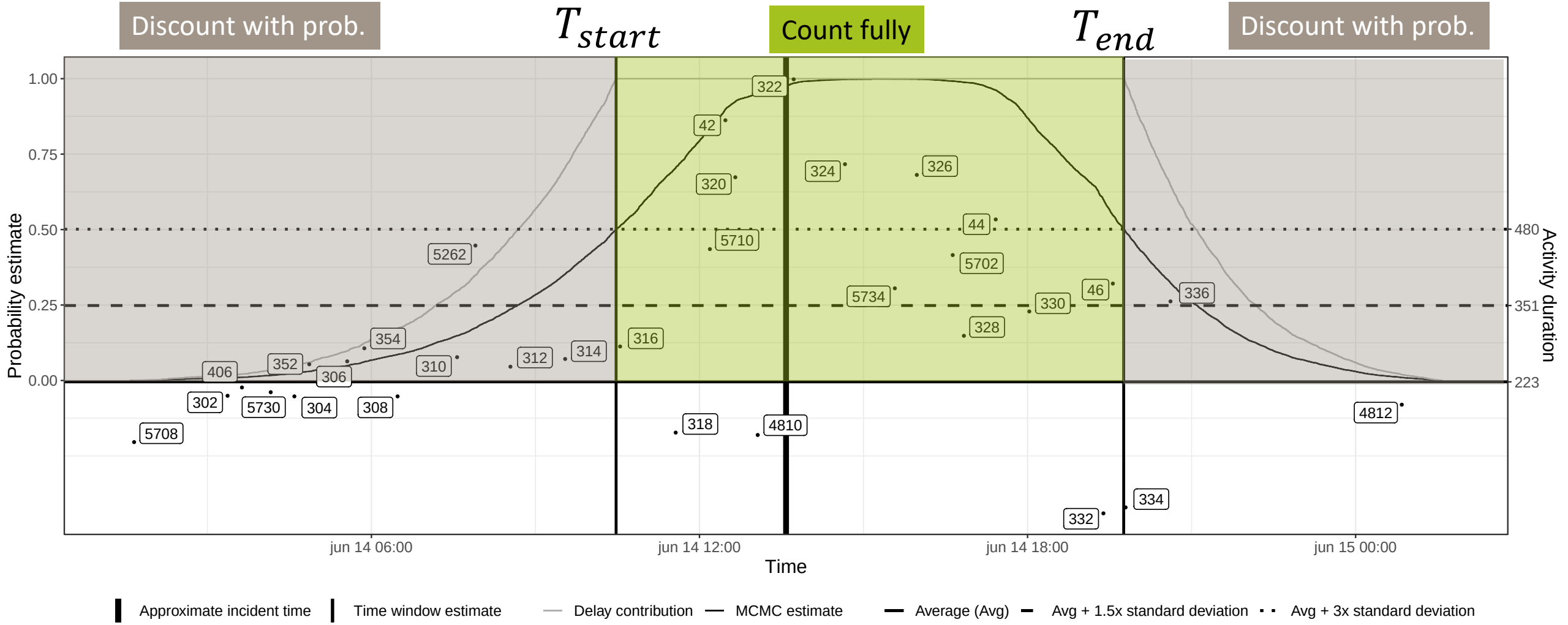
Proposed Approach – Impact Estimation #5



Step 5: Accumulate delay

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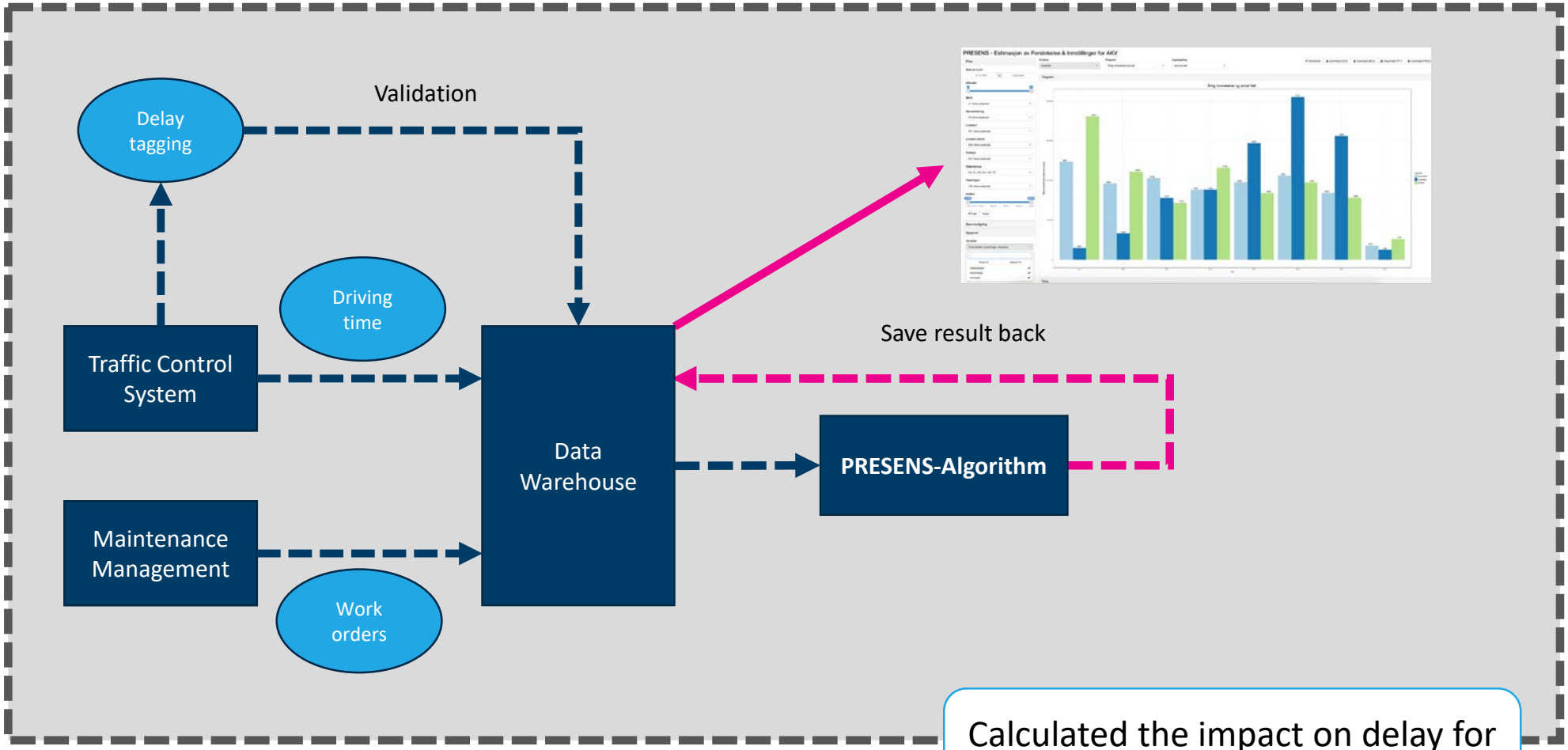
Evaluation – Case Study in Norway



Calculated the impact on delay for each major incident since 2011

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Evaluation – Delay Dashboard

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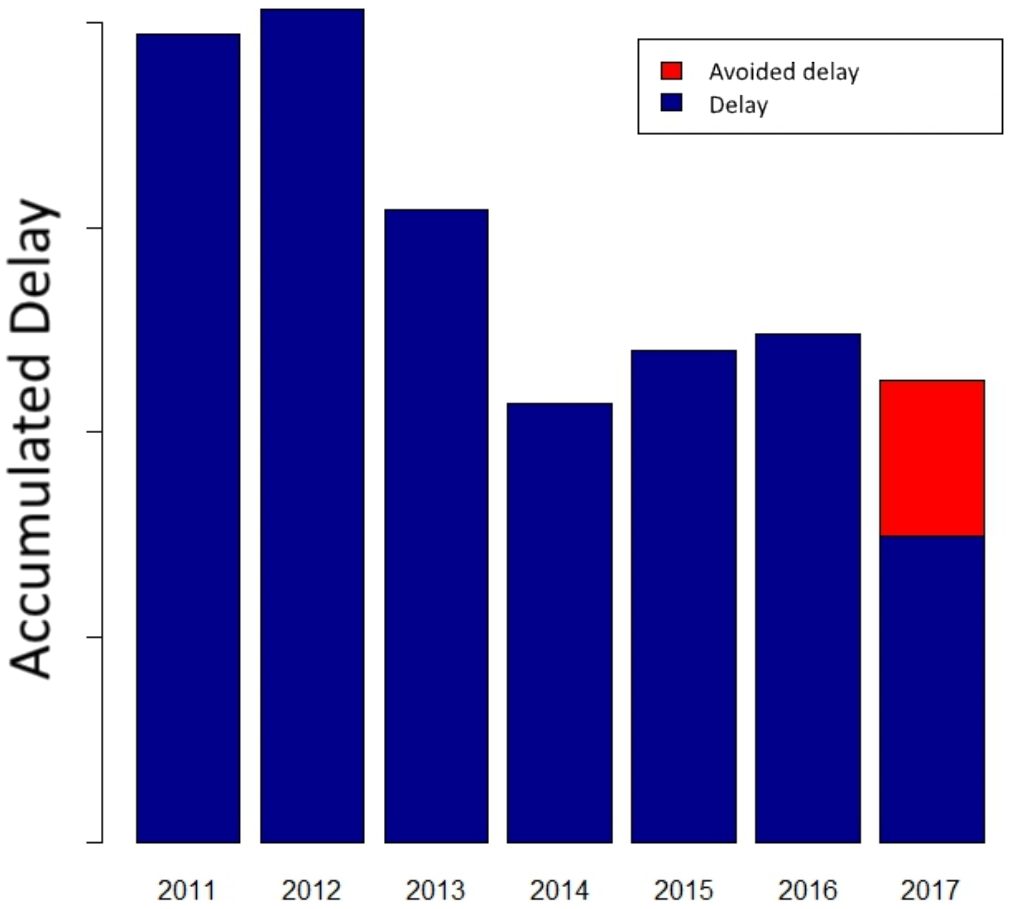
Evaluation – Predictive Maintenance

- Prediction of "avoided" delay due to smart maintenance
  - Smart monitoring of turnouts
  - Justification of investments
- Using the delay effect base on historical data as proxy
  - Not perfect, often rather small data basis for prediction
  - Better than management by `rule of thumb`



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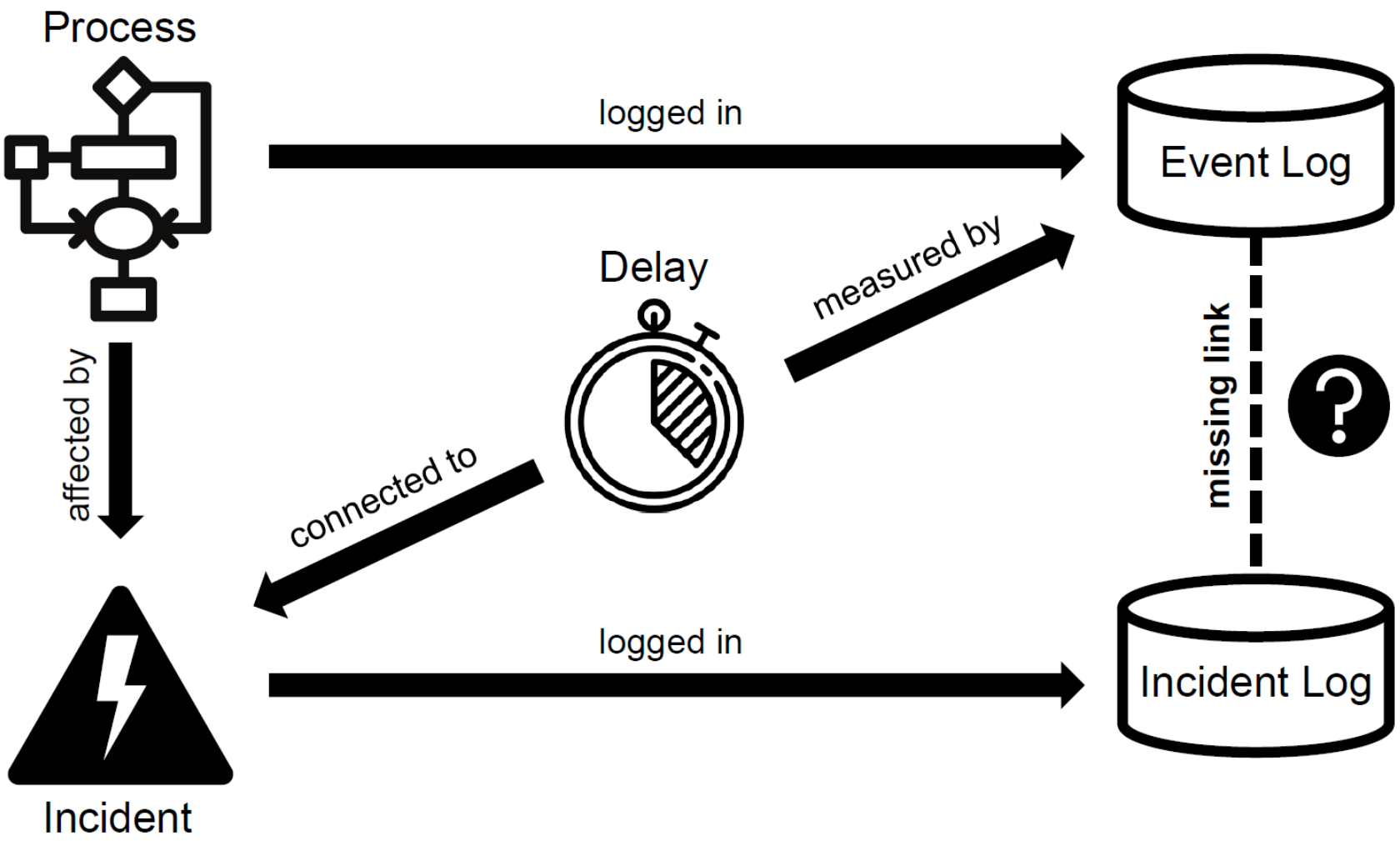
Future work

- Explore application on non-infrastructure focussed processes
  - Activity-incident relation is less obvious?
  - Estimation of `normal` process performance challenging?
- Address the issue of multiple co-occurring incidents
  - MCMC would have trouble with multi-modal distributions
- Address non-local knock-on effects on process delay
  - Initial solution addresses the problem for single-track railway networks, but difficult to generalise!
  - Investigate effects of queues etc. in non-physical processes
- Address the strong dependency on the chosen parameters in the prior distribution ➔ possible but high computational cost



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Teknologi for et bedre samfunn