Analysis of Lytx vehicles nearby other Lytx vehicles in collisions

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A core function of the Lytx system is to record video of vehicle collisions that may exonerate drivers based on video evidence. As the Lytx network grows there is a possiblity that other Lytx vehicles are nearby but not involved in a collision and may provide additional video evidence.

Based on current fleet size, Lytx may be able to provide additional video evidence for appx 100-150 collisions per month from nearby Lytx vehicles (within ±10sec and a 40m radius of the collision). If fleet size grows to 2B vehicles, Lytx may be able to provide additional video evidence for up to 500 collisions per month from nearby Lytx vehicles (extrapolated).

This tech memo describes a prototype system to identify Lytx vehicles in collisions nearby other Lytx vehicles that may have recorded additional video evidence of the collision or environment, and the extent to which that system may be automated. The tech memo then quantifies the coverage of Lytx vehicles in collisions where a nearby Lytx vehicle is present, and the impact of speed, road-type, and time-of-day. Impact of fleet size is also explored, where results may be extrapolated to assess coverage for a future (larger) fleet size.

Whereas a vehicle with a Lytx device may record collisions for any nearby vehicle, we restrict the study to cases where the vehicle in a collision and the nearby vehicle are both Lytx vehicles, to lower the barrier for legal approval as a production system. The case of the vehicle in a collision and the nearby vehicle from the same company is also discussed.

System to identify Lytx vehicles nearby other Lytx vehicles in collisions

This section describes the prototype system to identify Lytx vehicles nearby other Lytx vehicles in collisions and the extent to which the system may be automated. The analysis is based on all collisions for the fleet of SF-64/SF-300/SF-400 devices between 10/15/23 and 10/22/23 (query details in Appendix 1) – returning 973 collisions for 768710 devices over 7 days. The Unified Map geocode function is then used to generate additional metadata based on location for each collision, eg localtime and road-type.

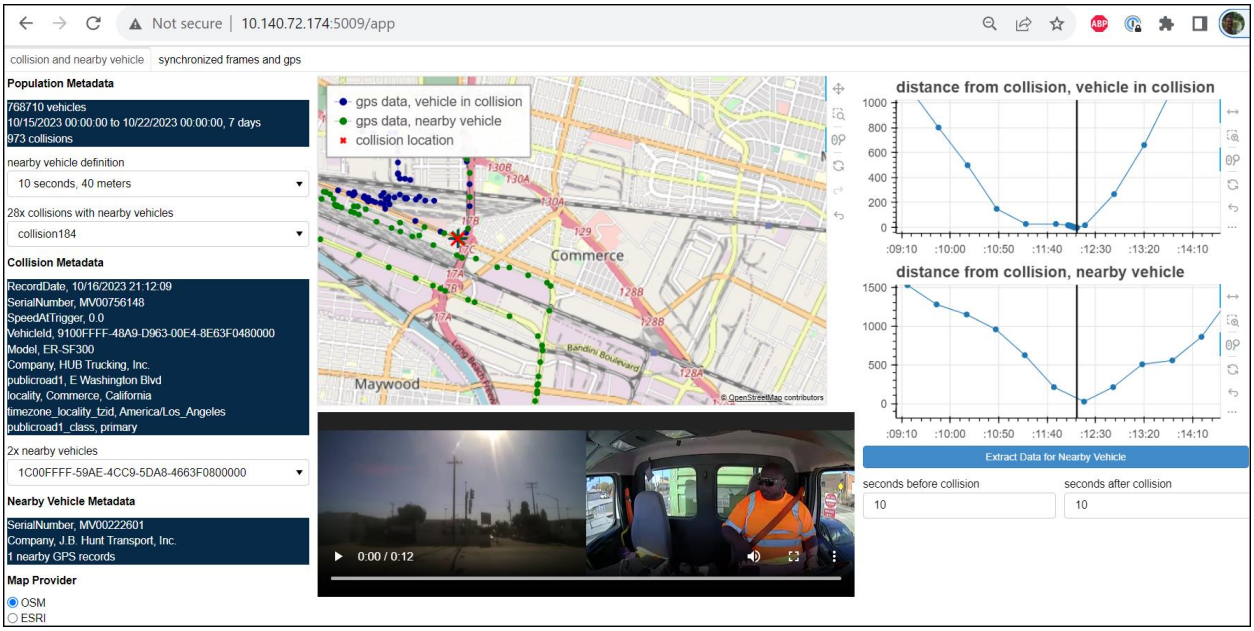
Identification of Lytx vehicles nearby a collision depends on the defintion of ‘nearby vehicle’. The definition used here is any vehicle with a GPS record within a specific time (before or after) and distance (radius) from the time/location of a collision, where the choices for time and distance are defined in the table below.

Nearby Vehicle Definition	Time from collision time	Distance from collision location
A	± 1 hour	± 40m in all cases
B	± 30 minutes	
C	± 5 minutes	
D	± 1 minute	
E	± 30 seconds	
F	± 10 seconds	

At one extreme (definition A) the coverage of collisions by nearby vehicles will be highest however the 'additional video evidence' provided by the nearby vehicle will only capture the environmental conditions before or after the collision (tbd if customers find that information useful). At the other extreme (definition F) coverage will be lowest however the nearby vehicle may record additional information to exonerate the Lytx vehicle that the customer may find useful. The table below represents coverage of the 973 collisions according to each definition (a more thorough analysis of coverage is in a subsequent section).

Nearby Vehicle Definition	A	B	C	D	E	F
Num of 973 collisions with any nearby vehicle	621	519	270	105	69	28
% of 973 collisions with any nearby vehicle	63.8%	53.3%	27.7%	10.8%	7.1%	2.9%

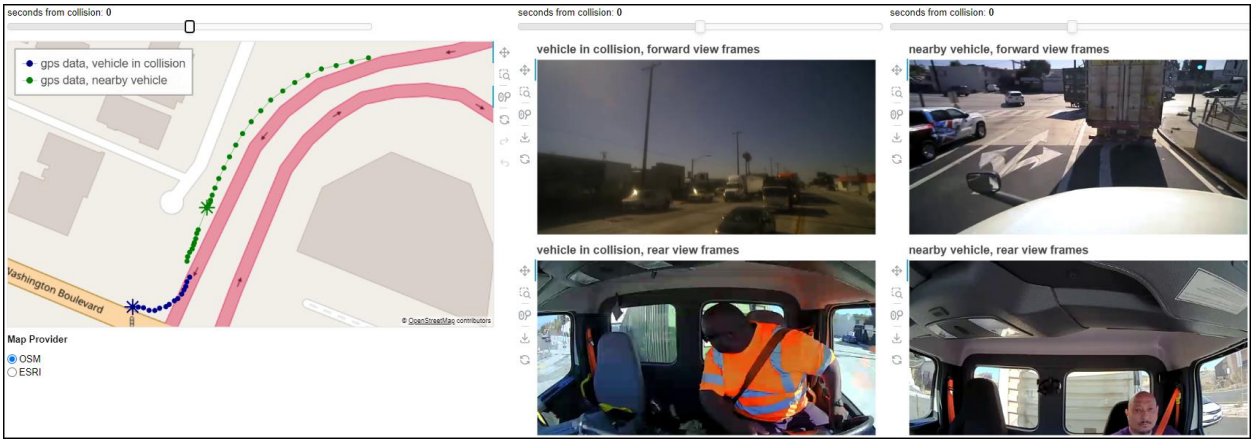
The interactive data application in the screenshot below was developed to identify and visualize Lytx vehicles nearby other Lytx vehicles in collisions. A user first selects the defintion of 'nearby vehicle' then selects an individual collision with one or more nearby vehicles. The application then updates the collision video, metadata for both vehicles (vehicle in the collision and one nearby vehicle), GPS data on the same map for both vehicles, and synchronized charts that indicate distance from the collision for both vehicles. The information is used to decide if video should be pulled manually for the nearby vehicle using Video Search, a step which could be automated later on.



After video is pulled for the nearby vehicle, another tab in the application is used to manually study details of the collision and environment from the point of view of both vehicles (vehicle in collision and nearby vehicle). The app uses a slider to step back and forth in time by 200 msec steps as gps data on the same map and video frames for both vehicles are consistently updated. The user must manually determine if any useful 'additional video evidence' is present from the nearby vehicle, which is not different from customer review of video from vehicles in collisions, ie Lytx does not currently establish collision-fault based on data from vehicles in collisions.

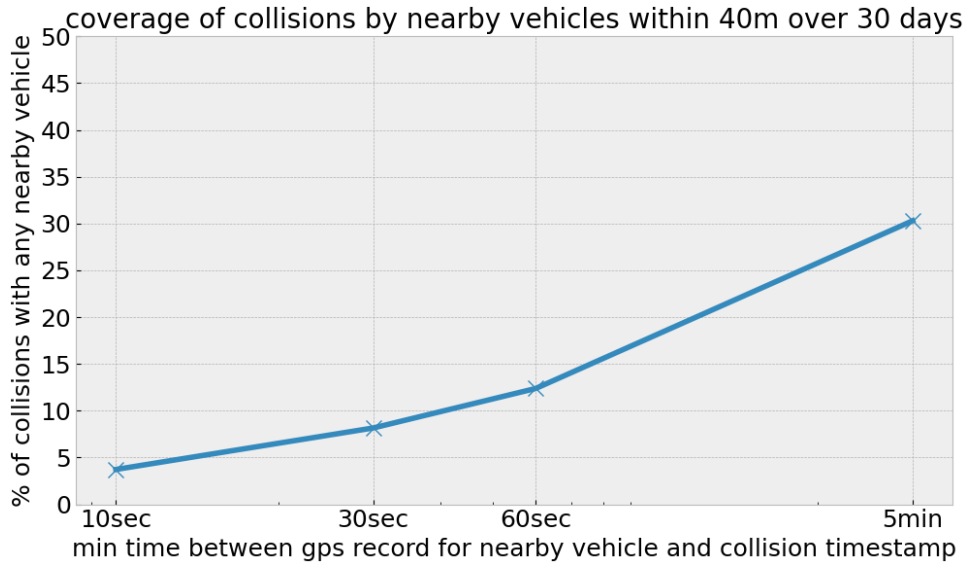
The screenshot below represents the detailed view of a vehicle in a collision and one nearby vehicle at 3 sec prior to collision. The following is my own subjective review of the video evidence from both vehicles – in practice Lytx would only provide the data in a useful interface and the customer would review independently. The driver of the vehicle in a collision is turning right at a green light as another truck approaches from behind on the inside of the turn. Based only on video from the vehicle in the collision it is not clear if the inside truck is cutting off the vehicle in the collision or if there is an available turn lane. The nearby vehicle in this case is behind the vehicle in the collision, as seen in the video frame and synchronized GPS data on the map. At 3 sec prior to the collision the nearby vehicle sees both trucks about to be involved in the collision, and it appears the inside truck is using an available turn lane.

The screenshot below is the detailed view at the time of the collision. The nearby vehicle has advanced closer to the vehicle in the collision, and now clearly sees the inside truck is using an available right turn lane. The interactive application can be used to gain a more thorough understanding by stepping through the full sequence of video frames for both vehicles. By doing so, the truck at the inside turn lane is observed to slow down before the turn and apply brakes, thereby attempting to avoid the collision. My own subjective review is then that the driver of the vehicle in the collision (Lytx vehicle) turned too tightly in the outside lane of a dual right-turn lane and caused the collision.

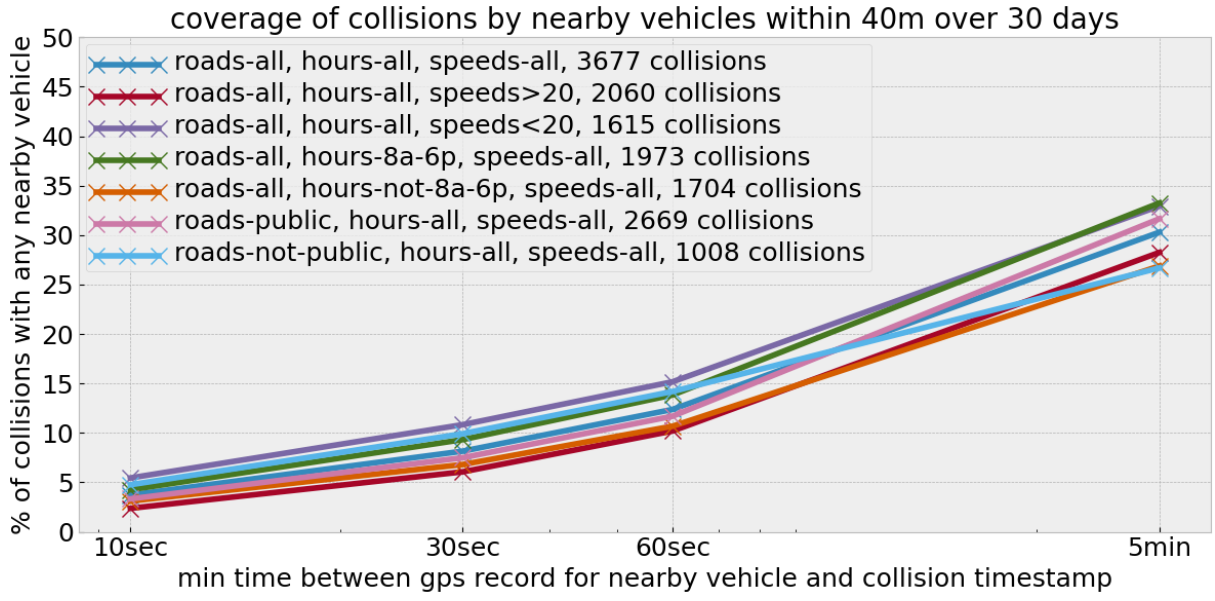


Coverage of Lytx vehicles in collisions by nearby Lytx vehicles

This section quantifies the coverage of Lytx vehicles in collisions by nearby Lytx vehicles according to a 'nearby vehicle' definition and under different collision conditions such as speed and road-type. The analysis is based on 30 days of collisions between 9/25/23 and 10/25/23 for the fleet of all SF-64/SF-300/SF-400 devices – 3677 collisions for 723204 vehicles. The chart below represents the coverage for all collisions under definitions C,D,E,F from the table in the previous section. As seen previously, coverage of collisions by nearby vehicles with GPS records within a 40m radius and ±10 sec is appx 4% and gets higher as the time window increases.

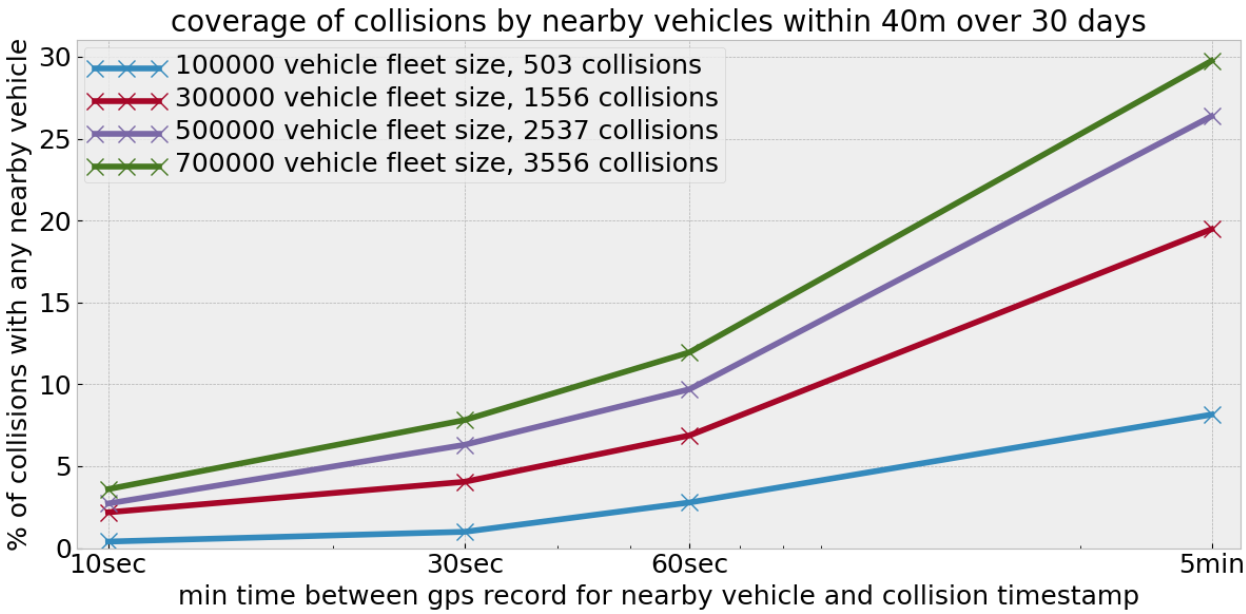


The chart below in the same format represents coverage for a variety of collision conditions (low speed vs high speed, on and off 8a-6p localtime, public vs private roads). The collision coverage at ±10 sec does not vary by more than a few percent, and at ±5 min does not vary by more than appx 10 percent based on filtering collisions by speed, road-type, or localtime.

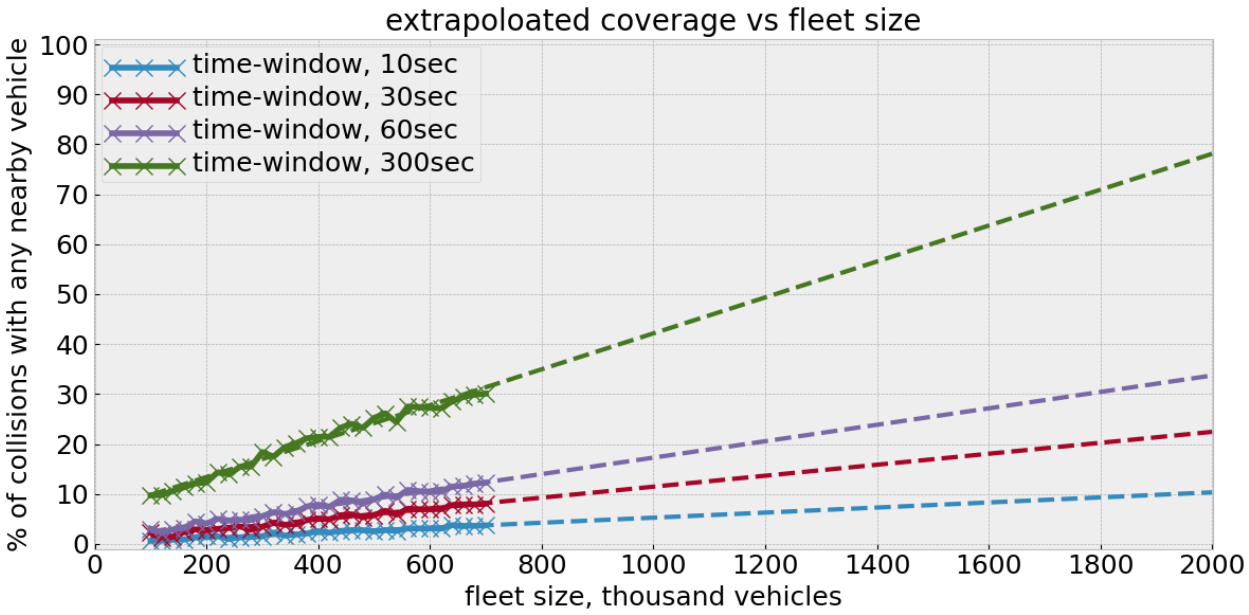


The 4% collision coverage at ±10 sec seems low, however at the current rate of collisions (appx 3500 per month) that means **Lytx can provide 'additional video evidence' from a nearby Lytx vehicle in close proximity to a collision for between 100-150 collisions per month**, and in some of those cases the additional video evidence may lead to exonerations where there otherwise would not have been sufficient video evidence from the vehicle in the collision alone.

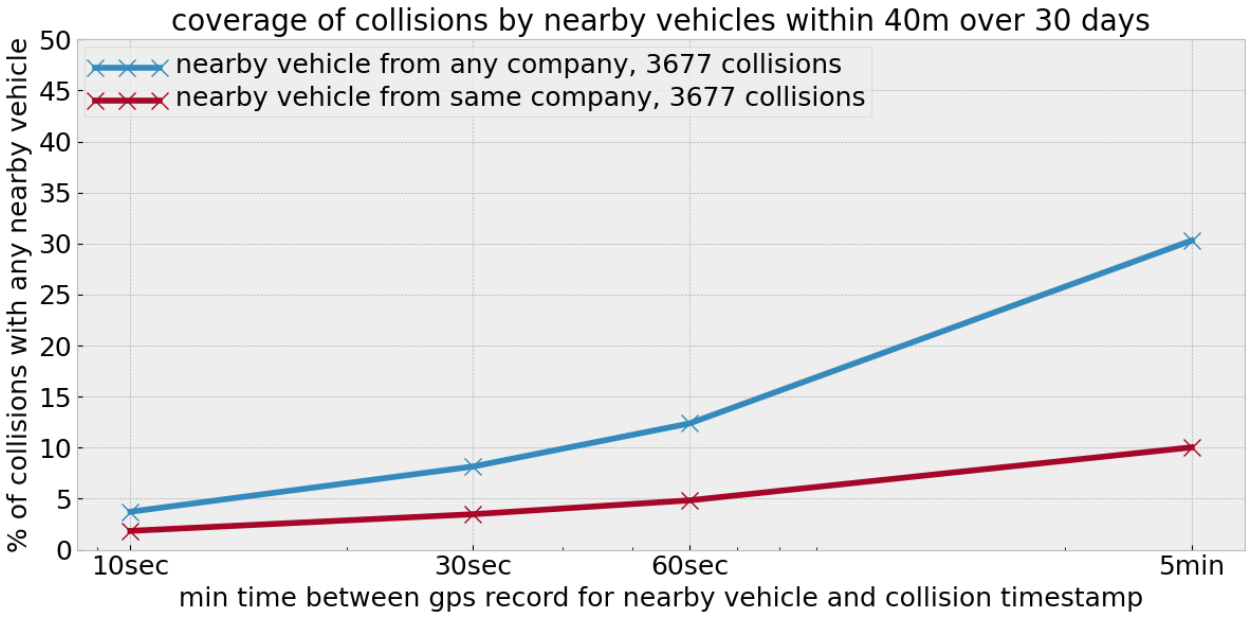
The chart below in the same format represents collision coverage by nearby vehicles as fleet size increases from 100k to 700k vehicles chosen randomly from the original 723204 vehicle population, indicating the trend to increasing coverage as fleet size increases.



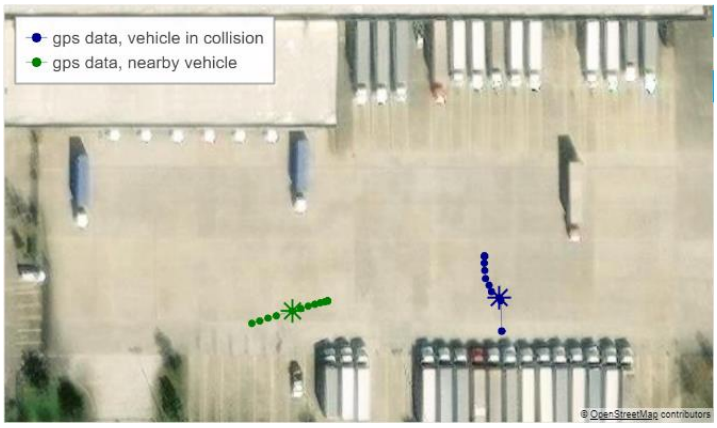
The impact of a future (larger) fleet size on coverage of collisions by nearby vehicles was investigated by extrapolating the curves in the above chart to a fleet size of 2B vehicles. The chart below contains real data points (data markers) and an extrapolated linear fit (dashed lines) for the four nearby vehicle definitions. According to the analysis, Lytx may have appx 80% coverage of collisions by a nearby vehicle within ±5min for a 2B vehicle fleet, but only appx 10% coverage within ±10sec for a 2B vehicle fleet. The extrapolated values do not capture the non-linear relationship between coverage vs fleet size and are very rough estimates only.

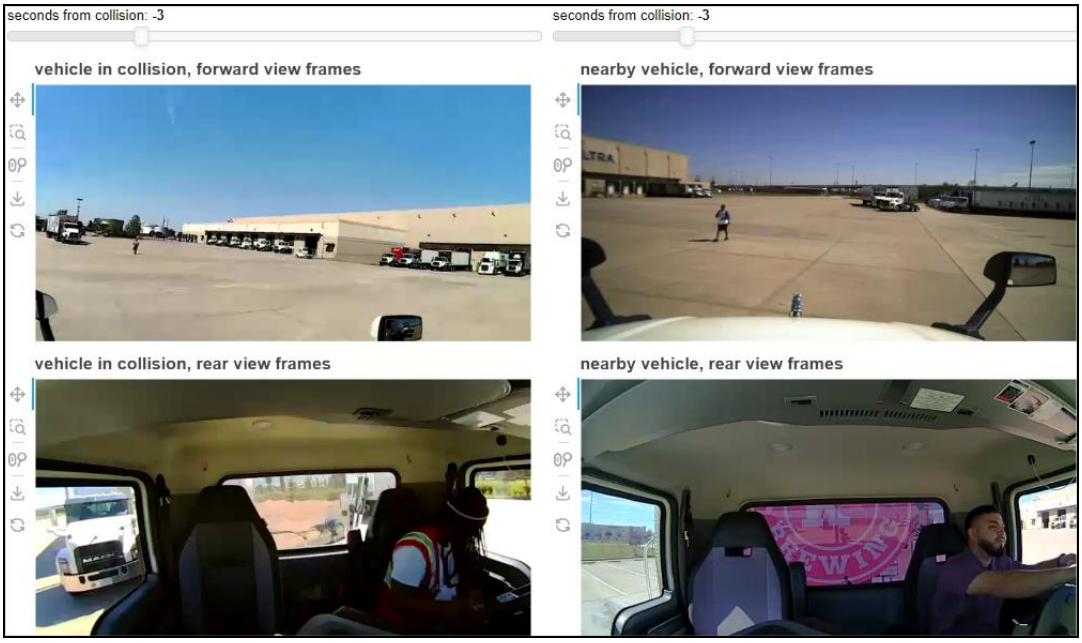


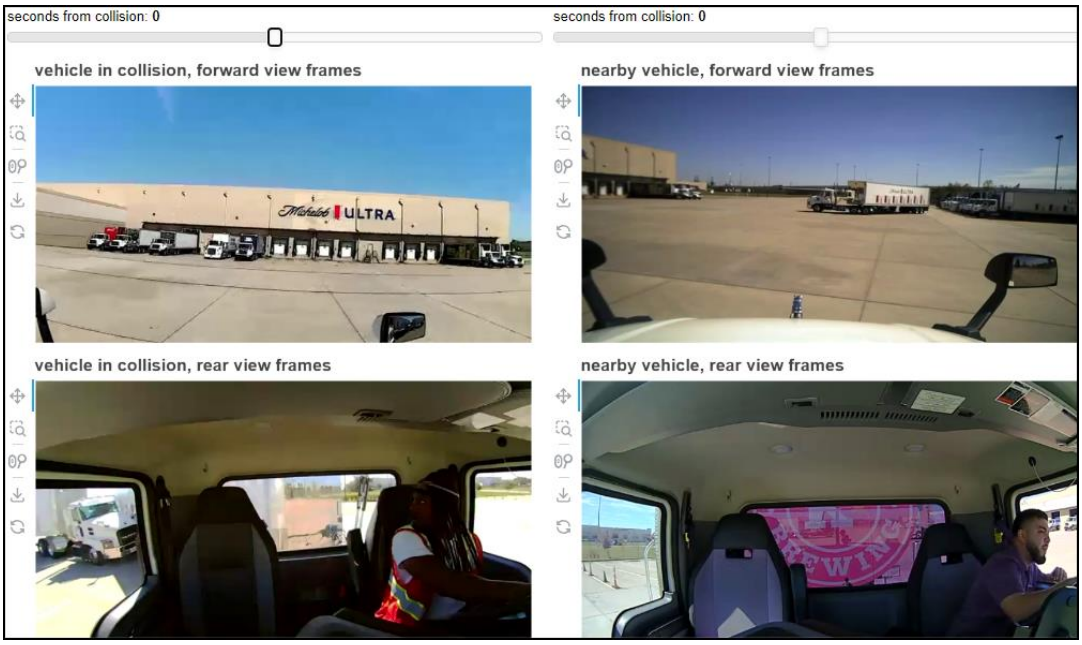
The final case of coverage investigated represents the lowest legal barrier to a production system – when the vehicle in a collision and nearby vehicle are both from the same company, as represented in the chart below. The coverage is at least cut in half under this constraint.



Screenshots from the interactive application representing the above scenario (vehicle in a collision and nearby vehicle from same company) are below. A brief review of these scenarios indicate that most seem to occur at warehouses or company facilities where many vehicles from the same company are often present. The first screenshot indicates the GPS data on the same map for both vehicles, the 2nd and 3rd screenshots are synchronized video frames at 3 sec prior to collision and at the moment of collision, respectively.


gps data, vehicle in collision
gps data, nearby vehicle
© OpenStreetMap contributors


seconds from collision: -3
seconds from collision: -3
vehicle in collision, forward view frames
nearby vehicle, forward view frames
vehicle in collision, rear view frames
nearby vehicle, rear view frames


seconds from collision: 0
seconds from collision: 0
vehicle in collision, forward view frames
nearby vehicle, forward view frames
vehicle in collision, rear view frames
nearby vehicle, rear view frames

Conclusion and potential next steps

The tech memo discussed the interactive data appliation developed to identify and visualize Lytx vehicles nearby other Lytx vehicles in collisions and the extent of automation possible. The main step that cannot be automated is interpretation based on video evidence, however that step would not even be desired to be automated for legal reasons. Otherwise, the precise time and position of collisions recorded by Lytx devices, and the fact that time and position data are recorded consistently by Lytx devices enables a high degree of automation for the application.

The coverage of all collisions by nearby Lytx vehicles within a 40m radius and a ±10sec time window is currently appx 4% and may be as high as 10% if the fleet size grows to 2B vehicles. At the current volume of collisions, the implication is **Lytx can provide 'additional video evidence' from a nearby Lytx vehicle in close proximity to a collision for between 100-150 collisions per month.** Coverage of collisions up to ±5min before or after a collision is currently appx 30% and may be as high as 80% if fleet size grows to 2B vehicles (tbd if customers are interested in that scenario).

Potential next steps may include the following –

- more documented examples to share with customers and assess feedback
- legal review to assess customer video sharing within same or different companies
- additional development of the interactive application

Appendix 1 – query details

Extract metadata for all collisions over a time window for a set of Lytx devices –

```
WITH ERS AS (
   SELECT
      ERA.EventRecorderId, ERA.VehicleId, ERA.CreationDate, ERA.DeletedDate, ERA.GroupId, ER.Model,
      G.Name as GroupName, C.CompanyId, C.CompanyName, C.IndustryDesc, D.SerialNumber
   FROM hs.EventRecorderAssociations AS ERA
      LEFT JOIN flat.Groups AS G ON ERA.GroupId = G.GroupId
      LEFT JOIN flat.Companies AS C ON G.CompanyId = C.CompanyId
      LEFT JOIN flat.Devices AS D ON D.DeviceId = ERA.EventRecorderId
      LEFT JOIN hs.EventRecorders AS ER ON ER.Id = ERA.EventRecorderId
   WHERE ERA.VehicleId <> '00000000-0000-0000-0000-000000000000'
   AND ERA.CreationDate < '2023-10-15 00:00:00'
   AND ERA.DeletedDate > '2023-10-22 00:00:00'
   AND ER.Model IN ('ER-SF300','ER-SF300V2','ER-SF64','ER-SF400'))
   SELECT B.RecordDate, B.Latitude, B.Longitude, B.EventId, B.EventRecorderId, value AS BehaviorId,
      B.SpeedAtTrigger, B.EventFilePath, B.EventFileName, HSB.Name AS BehaviorName, ERS.*
   FROM flat.Events AS B
      CROSS APPLY STRING_SPLIT(COALESCE(B.BehaviourStringIds, '-1'), ',')
      INNER JOIN ERS ON ERS.VehicleId = B.VehicleId
      LEFT JOIN hs.Behaviors_i18n AS HSB ON value = HSB.Id
   WHERE B.Deleted = 0
   AND B.RecordDate BETWEEN '2023-10-15 00:00:00' AND '2023-10-22 00:00:00'
   AND value = 47
   AND NOT ((B.Latitude = 0) AND (B.Longitude = 0))
```