MDOT-MSU Traffic State Monitoring System

Phase II: Traffic Signal Performance Monitoring based on high-resolution traffic signal event data

(Preliminary design)

3rd Project Progress Meeting

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Mississippi State University

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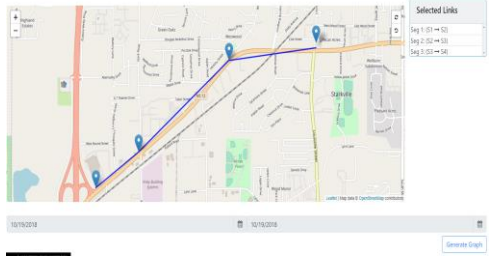
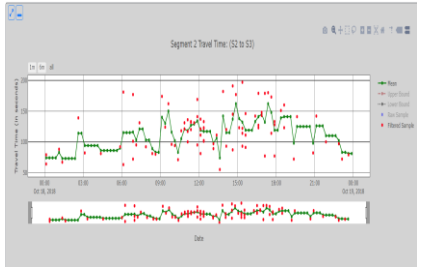
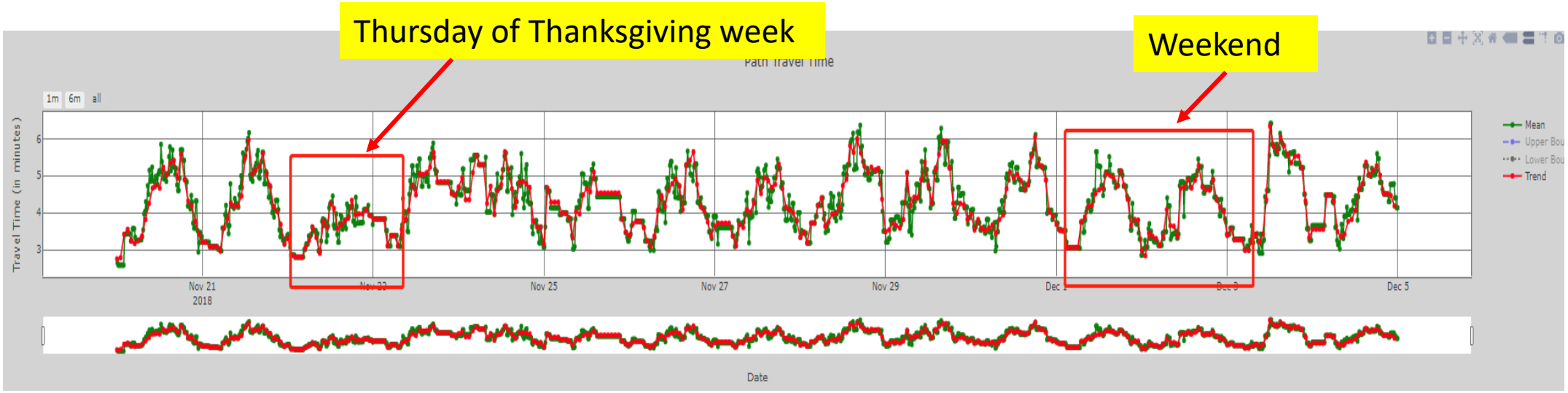





Outline

- Introduction of high-resolution traffic signal event data
- Modification to Detectors (Wavetronix)
- System UI design
- Background database design
- Data visualization Algorithm
- Discussion for new projects

Some new findings of the Wi-Fi system



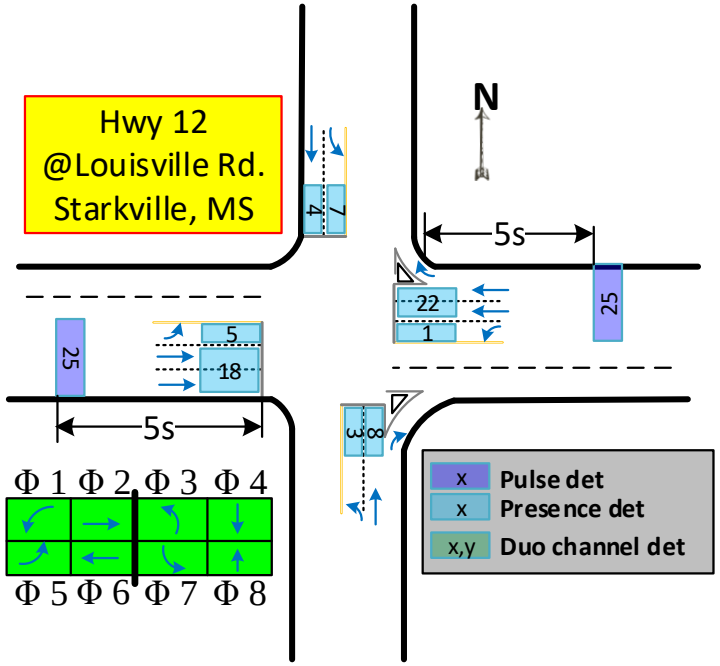
Introduction

- System detectors (connected to traffic signal cabinet) have been used to collect traffic states on arterials
  - Traditionally, The reported data, such as counts, occupancies or green usages, are aggregated from individual traffic signal events every 5, 10, 15 min or hour
- Dr. D. Bullock and his research group at Purdue University first proposed the concept of “high-resolution” (i.e., individual) traffic signal events and design new traffic state methods with the type of data
  - They also developed the “de facto” standards for traffic signal event definitions
  - Most Linux controllers today generate such data, such as Siemens M60

References: https://docs.lib.purdue.edu/jtrpaffdocs/3/

Modification of traffic signal detectors

- Phase-related events (e.g., green start, overlap start, etc.) are collected by default
- Detector configuration must be modified to generate the traffic signal performance diagram
  - Advance detectors (pulse): to estimate arrivals during the green in conjunction with phase events
  - Stop-bar detectors (presence): to estimate cycle failure in conjunction with phase events
  - Detectors after stop bar (presence): to estimate red/yellow-light runners



http://10.131.12.68/
(Wavetronix Phase 2 and 6 for this intersection)

Active Phase Events
- 0 Phase On
- 1 Phase Begin Green
- 2 Phase Check
- 3 Phase Min Complete
- 4 Phase Gap Out
- 5 Phase Max Out
- 6 Phase Force Off
- 7 Phase Green Term
- 8 Phase Begin Yellow Cl
- 9 Phase End Yellow Cl
- 10 Phase Begin Red Cl
- 11 Phase End Red Cl
- 12 Phase Inactive

Active Pedestrian Events
- 21 Ped Begin Walk
- 22 Ped Begin Clearance
- 23 Ped Begin Don't Walk
- 24 Ped Dark

Ped Dark Barrier/Ring Events
- 31 Barrier Term [1]
- 32 FYA Begin Perm [2]
- 33 FYA End Perm [2]

Phase Control Events
- 41 Phase Hold Active
- 42 Phase Hold Released
- 43 Phase Call Registered
- 44 Phase Call Dropped
- 45 Ped Call Registered
- 46 Phase Omit On
- 47 Phase Omit Off
- 48 Ped Omit On
- 49 Ped Omit Off

Notes:
[1] Barrier is identified by the number of the phase preceding it in the ring
[2] FYA is identified by the number of the corresponding protected phase.
[3] Event is not yet supported.
* Underlying feature not supported.

Overlap Events
- 61 Overlap Begin Green
- 62 Overlap Begin Trailing Green
- 63 Overlap Begin Yellow Cl
- 64 Overlap Begin Red Cl
- 65 Overlap Off
- 66 Overlap Dark
- 67 Ped Overlap Begin Walk *
- 68 Ped Overlap Begin Clearance *
- 69 Ped Overlap Begin Don't Walk *
- 70 Ped Overlap Dark *

Detector Events
- 81 Detector Off
- 82 Detector On
- 83 Detector Restored
- 84 Detector Fault – Other
- 85 Detector Fault – Watchdog
- 86 Detector Fault – Open Loop
- 87 Detector Fault – Shorted Loop
- 88 Detector Fault – Excess Change
- 89 Ped Detector Off
- 90 Ped Detector On
- 91 Ped Detector Failed
- 92 Ped Detector Restored

Preemption Events
- 101 Preempt Adv Warning *
- 102 Preempt Input On
- 103 Preempt Gate Down *
- 104 Preempt Input Off
- 105 Preempt Entry Started
- 106 Preempt Begin Track Cl
- 107 Preempt Begin Dwell
- 108 Preempt Link Active On
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- 111 Preempt Begin Exit
- 112 TSP Check In
- 113 TSP Adjust Early
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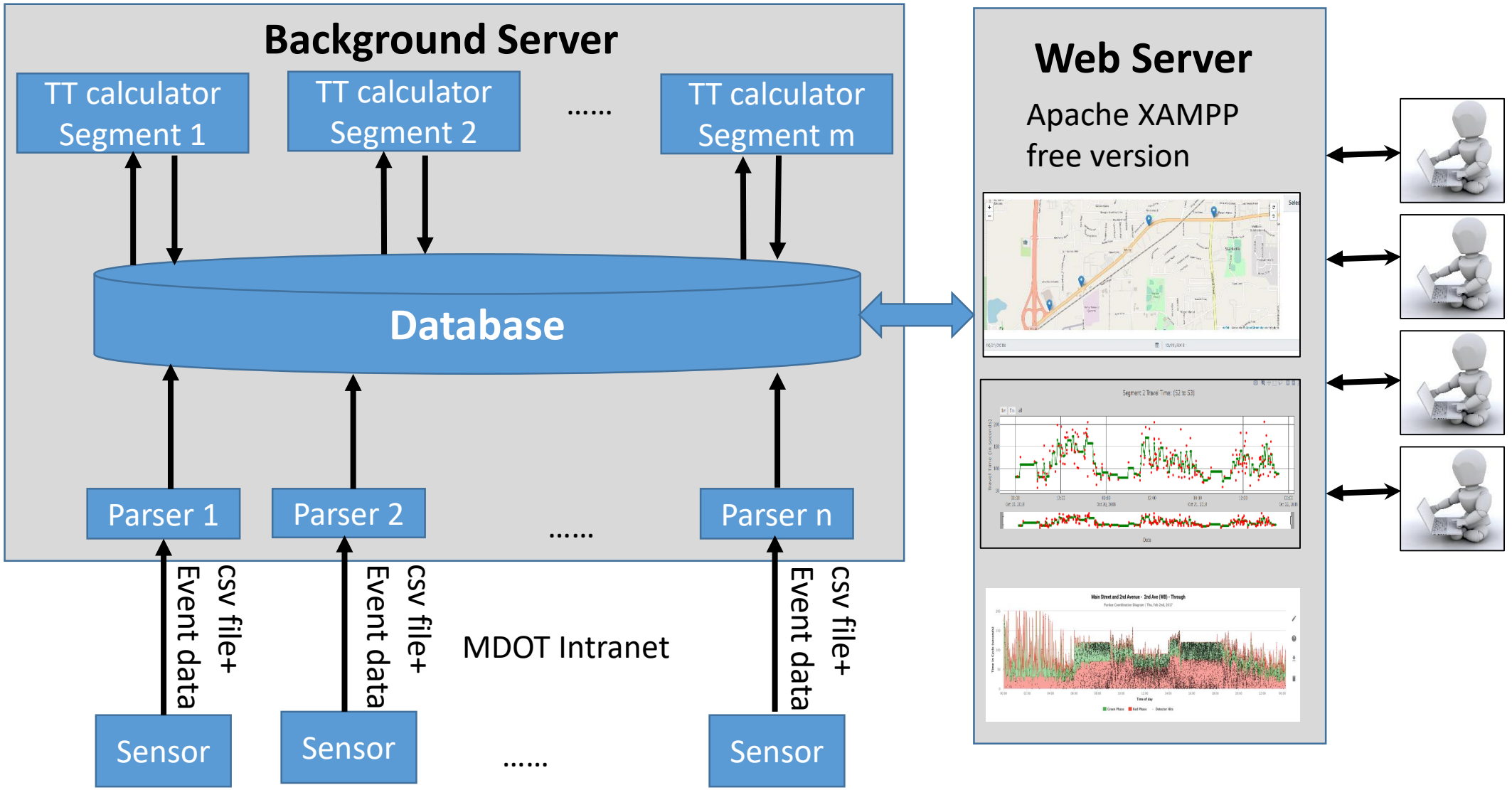
- 115 TSP Check Out

System Architecture (with modified sensor)



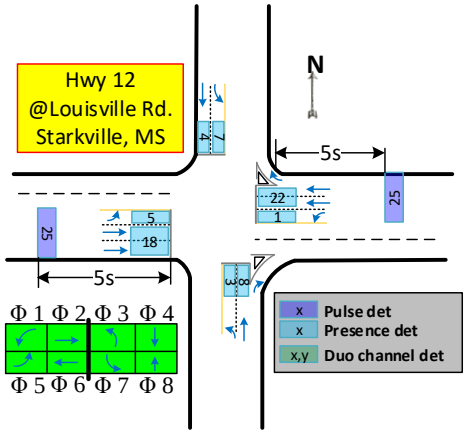
Background database design

- Two new database tables are generated:
  - Intersection List:

rec_id	int_id	latitude	longtitude	description	owner	layout	diagram
1	4	33.454168	-88.821822	hwy12@Lousville Rd. Starkville, MS	MDOT	4	BLOB
NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

  - PCD segment List:

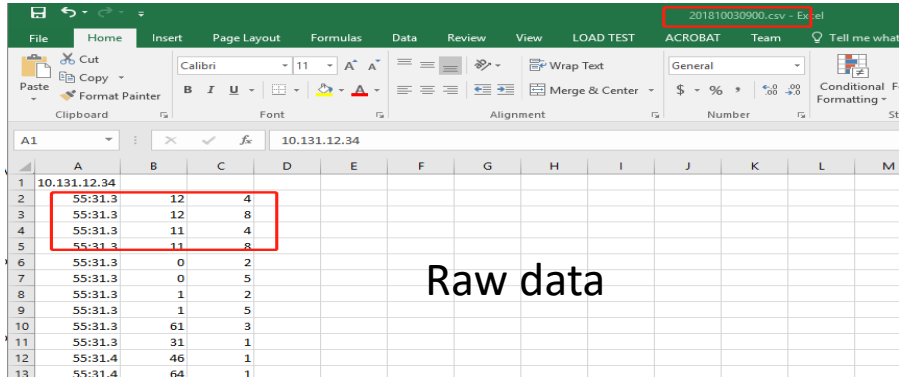
rec_id	int_id	phase_id	advance_dets	tti_sec	red_light_dets	presence_dets	queue_dets	wi-fi_link_id
1	4	2	25	5	0	18	0	0
2	4	6	26	5	0	22	0	5
NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL



A snapshot of raw and “enhanced raw” signal event data and interpretations

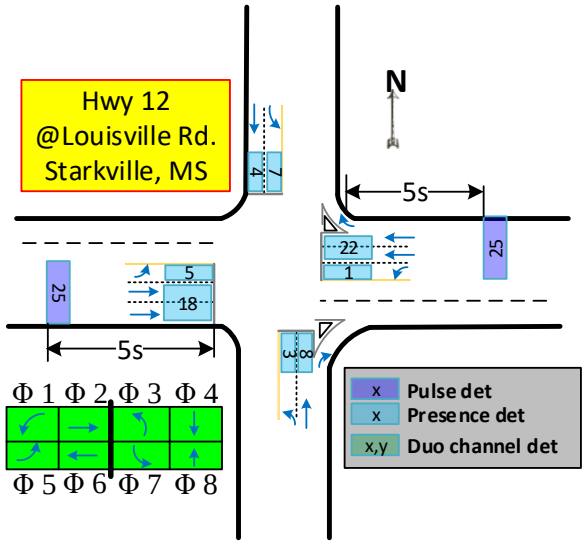
Enhanced raw data

rec_id	epoch_time	local_time	event_type	event_idx
16971906	1544088319.3	12-06-2018 03:25:19.3	81	1
16971907	1544088319.3	12-06-2018 03:25:19.3	44	1
16971905	1544088318.8	12-06-2018 03:25:18.8	4	2
16971901	1544088318.7	12-06-2018 03:25:18.7	4	5
16971902	1544088318.7	12-06-2018 03:25:18.7	46	1
16971903	1544088318.7	12-06-2018 03:25:18.7	46	5
16971904	1544088318.7	12-06-2018 03:25:18.7	64	1
16971891	1544088318.6	12-06-2018 03:25:18.6	12	4
16971892	1544088318.6	12-06-2018 03:25:18.6	12	8
16971893	1544088318.6	12-06-2018 03:25:18.6	11	4
16971894	1544088318.6	12-06-2018 03:25:18.6	11	8
16971895	1544088318.6	12-06-2018 03:25:18.6	0	2
16971896	1544088318.6	12-06-2018 03:25:18.6	0	5
16971897	1544088318.6	12-06-2018 03:25:18.6	1	2
16971898	1544088318.6	12-06-2018 03:25:18.6	1	5
16971899	1544088318.6	12-06-2018 03:25:18.6	61	3
16971900	1544088318.6	12-06-2018 03:25:18.6	31	1
16971890	1544088317.2	12-06-2018 03:25:17.2	81	26
16971889	1544088317	12-06-2018 03:25:17.0	82	26



Raw data

Intersection layout



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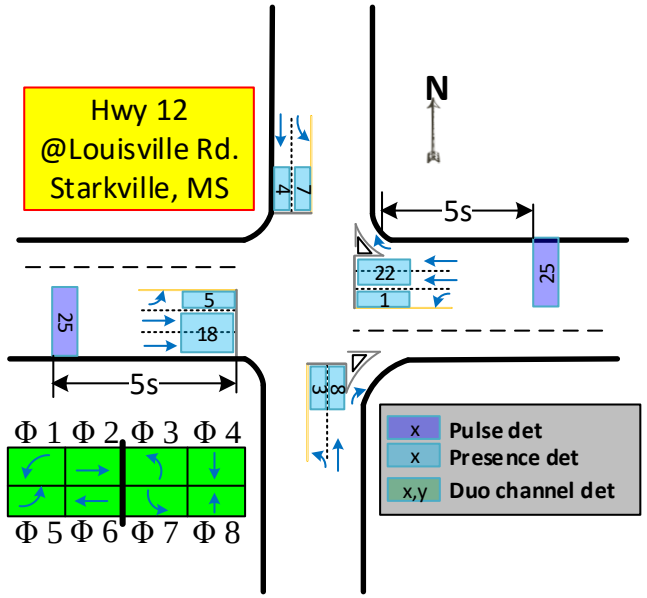
Definitions

Algorithms to generate Purdue Diagram(s)

- Diagram: Arrivals During Green
  - Green starts, ends and durations of each cycle
    - Step 1: Check Event type 1 (phase start) and 7 (phase end) for the subject phase (e.g., 2)
      - Cycle length is calculated as the time elapsed between two phase-ends event.
    - Step 2: For each cycle, scan all the event type 82 for the corresponding advance pulse det (e.g., 25)
      - Plot according time (x) and the time difference to the phase end event (y)



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1	4	2	25	5	0	18	0	0
2	4	6	26	5	0	22	0	5
NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

New research ideas?

- Installation at new locations?
  - We have deployed the system on the MDOT server
  - It’s ready to deploy at new locations
- Safety related?
  - Red-light-running?
  - FLA impact on the safety?
  - Dilemma zone and dilemma zone protection?
  - Continuous turning movement counts?