Analyzing the Benefits of Incident Management Programs in Utah

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ite Austin 19
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Overview of Report

- Introduction
- Literature Review
- Data Availability and Collection
- Data Reduction
- Results of Statistical Analysis
- Conclusions and Recommendations

1. Introduction

› Need

› Objectives

Need

- No quantified benefits of Traffic Incident Management (TIM) in Utah
- There was a need to begin coordinating data exchange with UHP so that UDOT could evaluate the performance of TIM in terms of roadway clearance time (RCT) and incident clearance time (ICT)

Objectives

- Investigate data availability at UDOT and UHP for conducting a TIM performance analysis on RCT and ICT
- Collect performance measures from the available data and estimate user impact from crashes
- Conduct statistical analyses on the performance measure data collected and share the analysis results

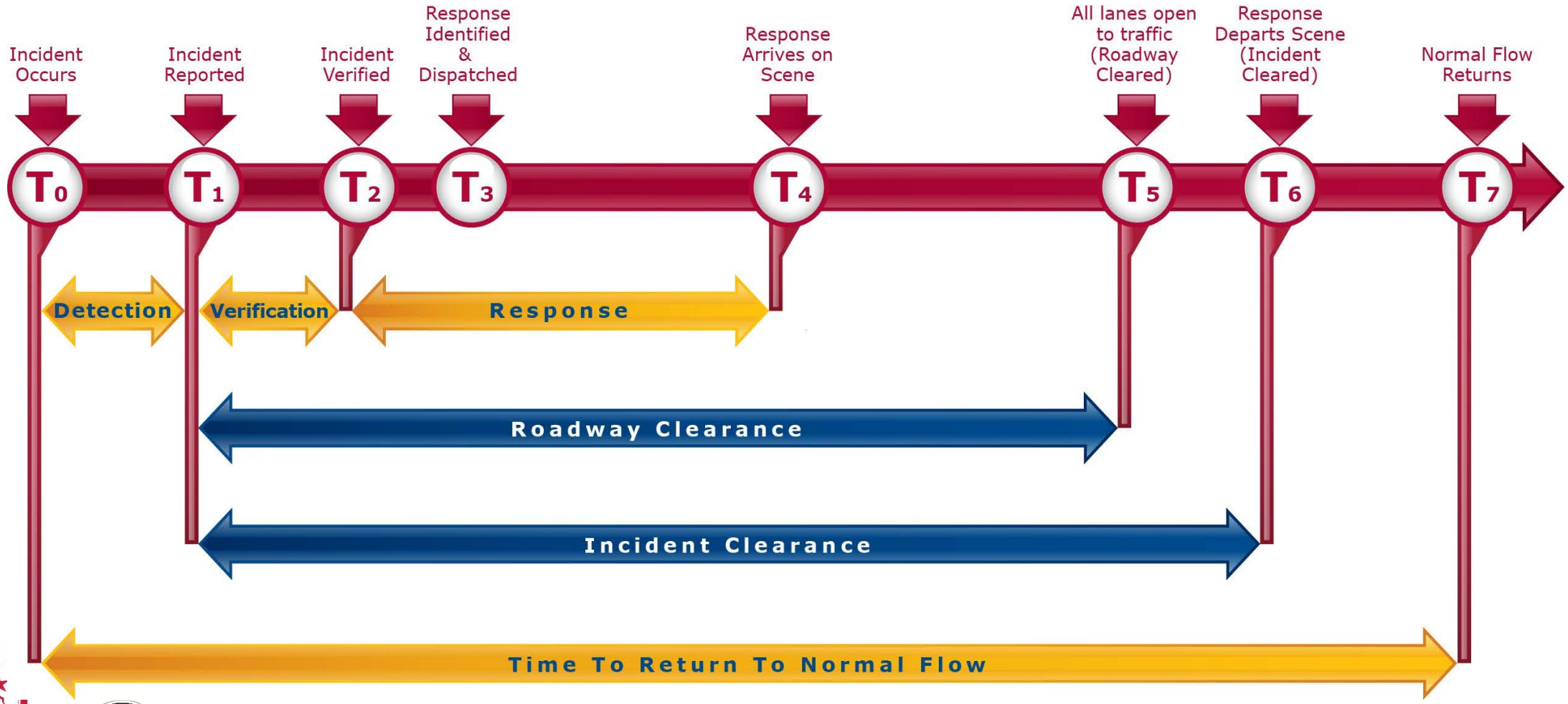
2. Literature Review

- Focus States Initiative
- TIM Timeline

Focus States Initiative

- **Reduce RCT**: Time between first recordable awareness of incident by a responsible agency and first confirmation that all lanes are available for traffic flow
- **Reduce ICT**: Time between first recordable awareness of incident by a responsible agency and time at which the last responder has left the scene

TIM Timeline



3. Data Availability and Collection

- Data Sources
- Performance Measure Data
- Incident Criteria for Analysis
- Excess Travel Time and Affected Volume
- Excess User Cost

Data Sources

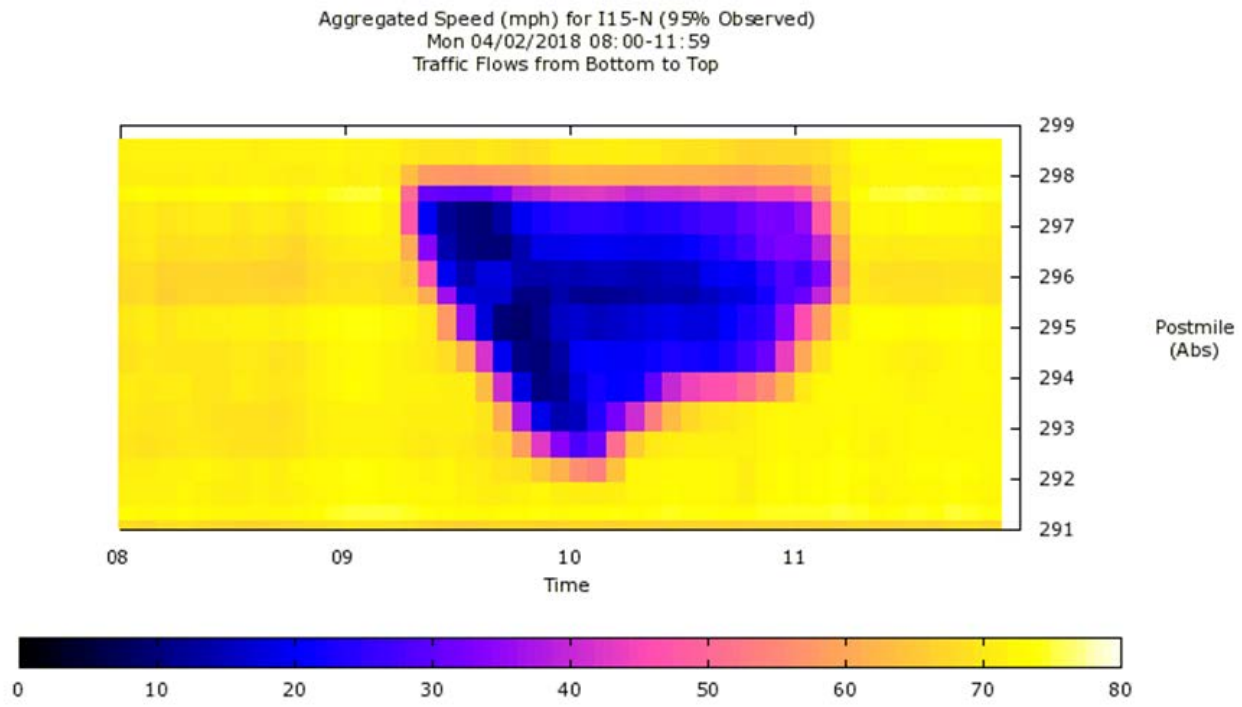
Call ID Number	Call Received Time	Call Type	Call Address	Status Time Stamp	Status	Unit Number
180068343	4/6/2018 13:35	PI Accident	245979 I15 NB	4/6/2018 15:54	CMPLT	315
180068343	4/6/2018 13:35	PI Accident	245979 I15 NB	4/6/2018 15:51	CMPLT	T391
180068343	4/6/2018 13:35	PI Accident	245979 I15 NB	4/6/2018 15:38	CMPLT	520
180068343	4/6/2018 13:35	PI Accident	245979 I15 NB	4/6/2018 15:03	CMPLT	9A324
180068343	4/6/2018 13:35	PI Accident	245979 I15 NB	4/6/2018 14:59	ARRVD	T391
180068343	4/6/2018 13:35	PI Accident	245979 I15 NB	4/6/2018 14:44	C	T391
180068343	4/6/2018 13:35	PI Accident	245979 I15 NB	4/6/2018 14:44	ENRT	9A324
180068343	4/6/2018 13:35	PI Accident	245979 I15 NB	4/6/2018 14:17	ARRVD	315
180068343	4/6/2018 13:35	PI Accident	245979 I15 NB	4/6/2018 14:09	ENRT	315
180068343	4/6/2018 13:35	PI Accident	245979 I15 NB	4/6/2018 14:03	VHREG	520
180068343	4/6/2018 13:35	PI Accident	245979 I15 NB	4/6/2018 13:58	VHREG	520
180068343	4/6/2018 13:35	PI Accident	245979 I15 NB	4/6/2018 13:55	VHREG	520
180068343	4/6/2018 13:35	PI Accident	245979 I15 NB	4/6/2018 13:53	ARRVD	520
180068343	4/6/2018 13:35	PI Accident	245979 I15 NB	4/6/2018 13:49	ARRVD	T391
180068343	4/6/2018 13:35	PI Accident	245979 I15 NB	4/6/2018 13:43	ENRT	T391
180068343	4/6/2018 13:35	PI Accident	245979 I15 NB	4/6/2018 13:38	ENRT	520

UHP Computer Aided Dispatch (CAD) Data

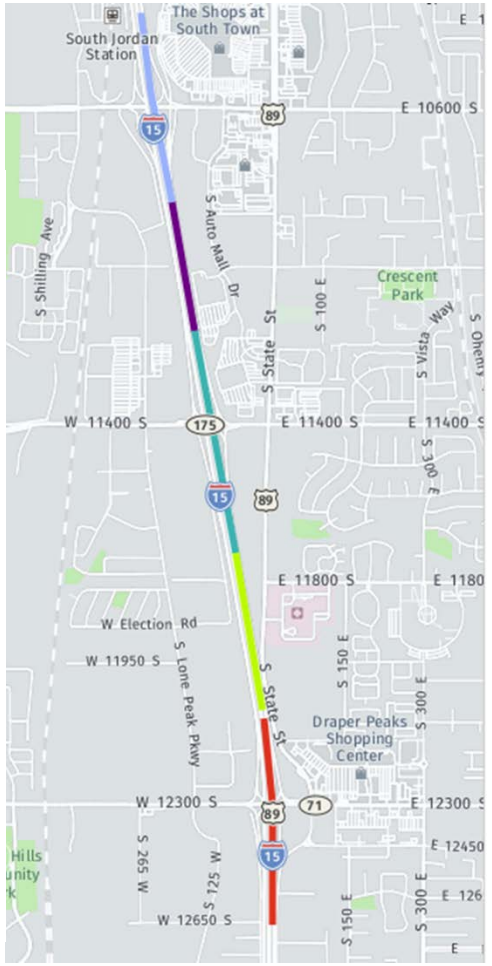
Time of interest	UHP CAD Status Code
T_0	---
T_1	"Call Received Time"
T_3	ENRT
T_4	ARRVD
T_5	C
T_6	CMPLT
T_7	---

CAD File and Performance Measure Correlation Table

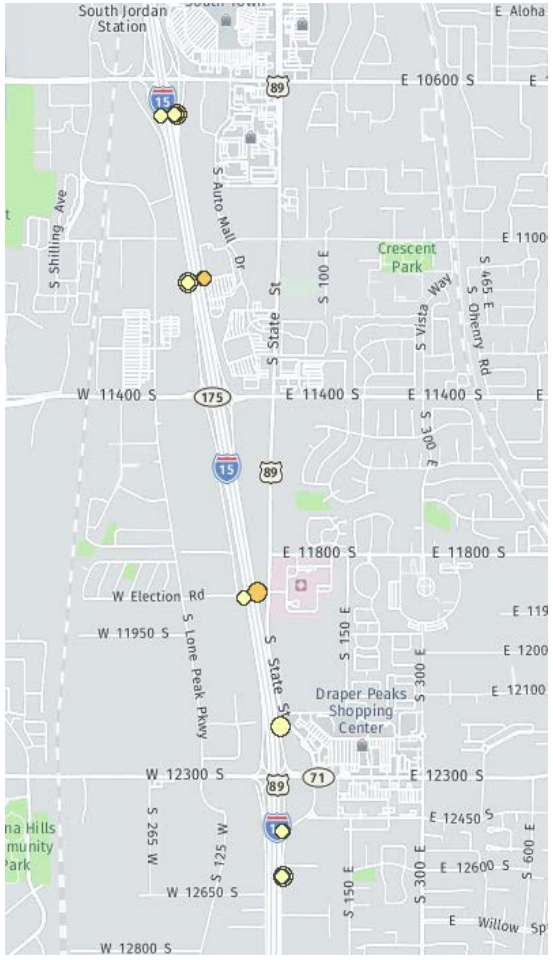
Data Sources



PeMS Speed Contour Plot



iPeMS Sub Routes



PeMS Loop Detector Locations

Performance Measure Data

› Performance measure data was analyzed using an automated VBA algorithm for IMT units and UHP units

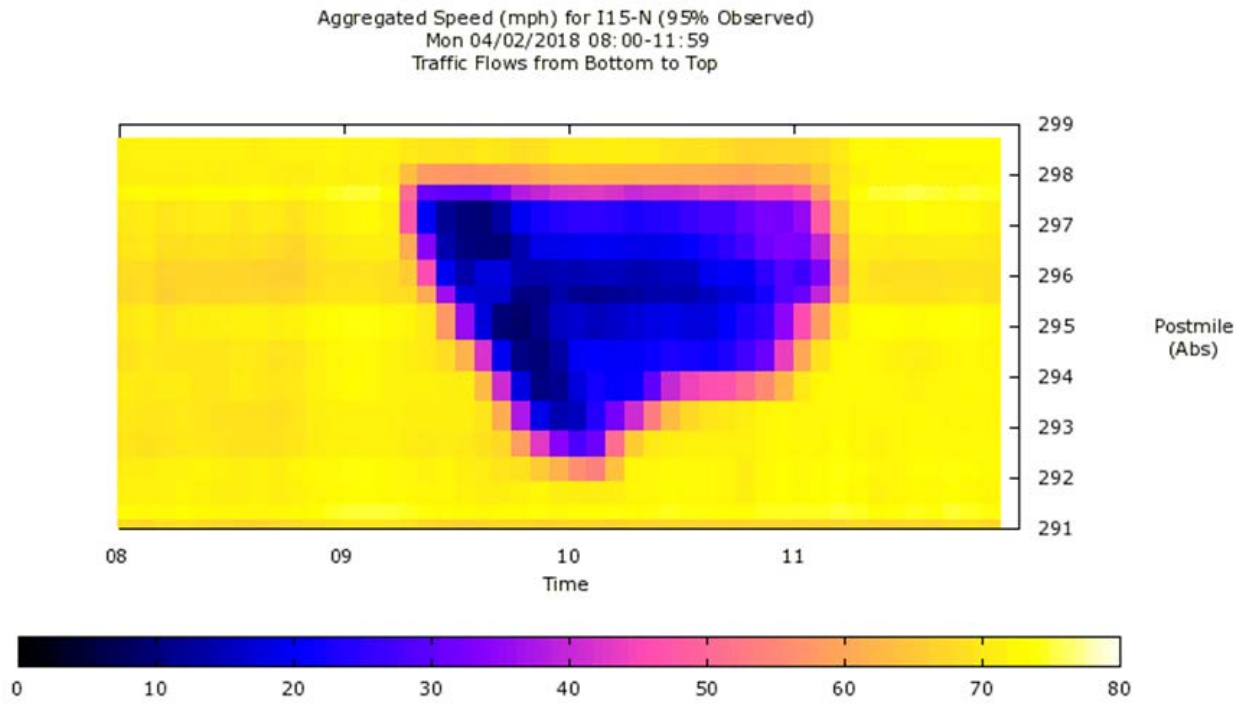
Time of interest	UHP CAD Status Code	All IMT units	All UHP units
T0 (Incident Occurrence)	---	9:20:00 AM	9:20:00 AM
T1 (Incident Reported)	"Call Received Time" Column	9:20:28 AM	9:20:28 AM
T2 (Incident Verified)	---	---	---
T3 (Responder Dispatched)	ENRT	9:27:10 AM	9:25:32 AM
T4 (Responder Arrived)	ARRVD	9:33:17 AM	9:26:26 AM
T5 (Roadway Cleared)	C	11:01:30 AM	11:01:30 AM
T6 (Responder/Incident Cleared)	CMPLT	11:07:13 AM	11:07:06 AM
T7 (Normal Flow Returns)	---	11:10:00 AM	11:10:00 AM

Performance Measures		
	All IMT units	All UHP units
Incident Clearance Time (T6-T1)	1:46:45	1:46:38
Roadway Clearance Time (T5-T1)	1:41:02	1:41:02
Response Time (T4-T1)	0:12:49	0:05:58

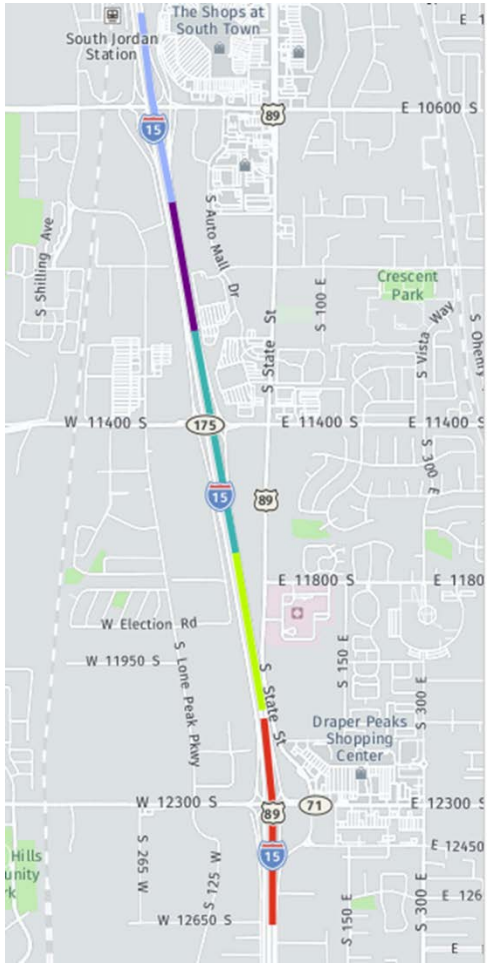
Incident Criteria for Analysis

- Incident occurred on an interstate in Utah
- Incident did not occur on a ramp
- Exclude any secondary incident that significantly exacerbates congestion
- Have available loop detectors without missing data on the road segments where the incident occurred
- Incident has a distinct and decipherable queue

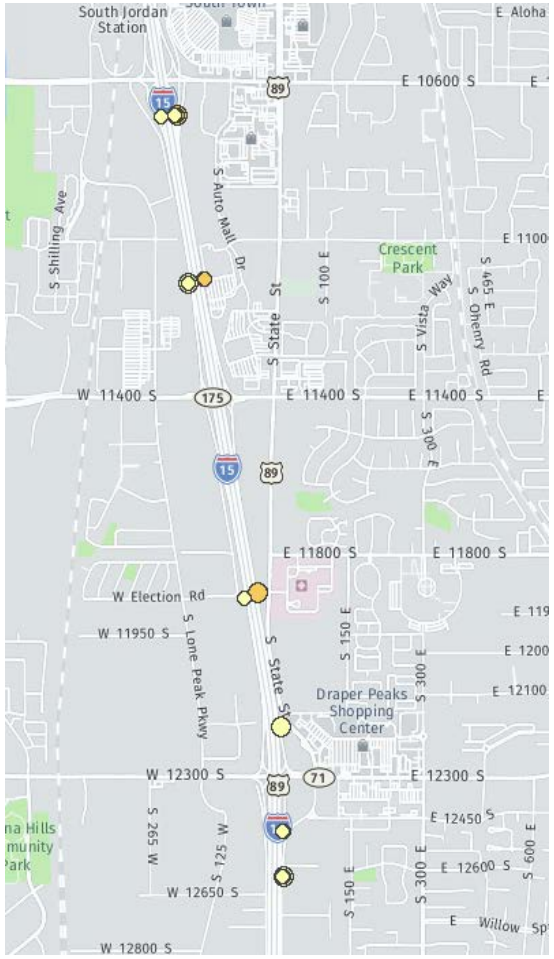
Excess Travel Time and Affected Volume



PeMS Speed Contour Plot

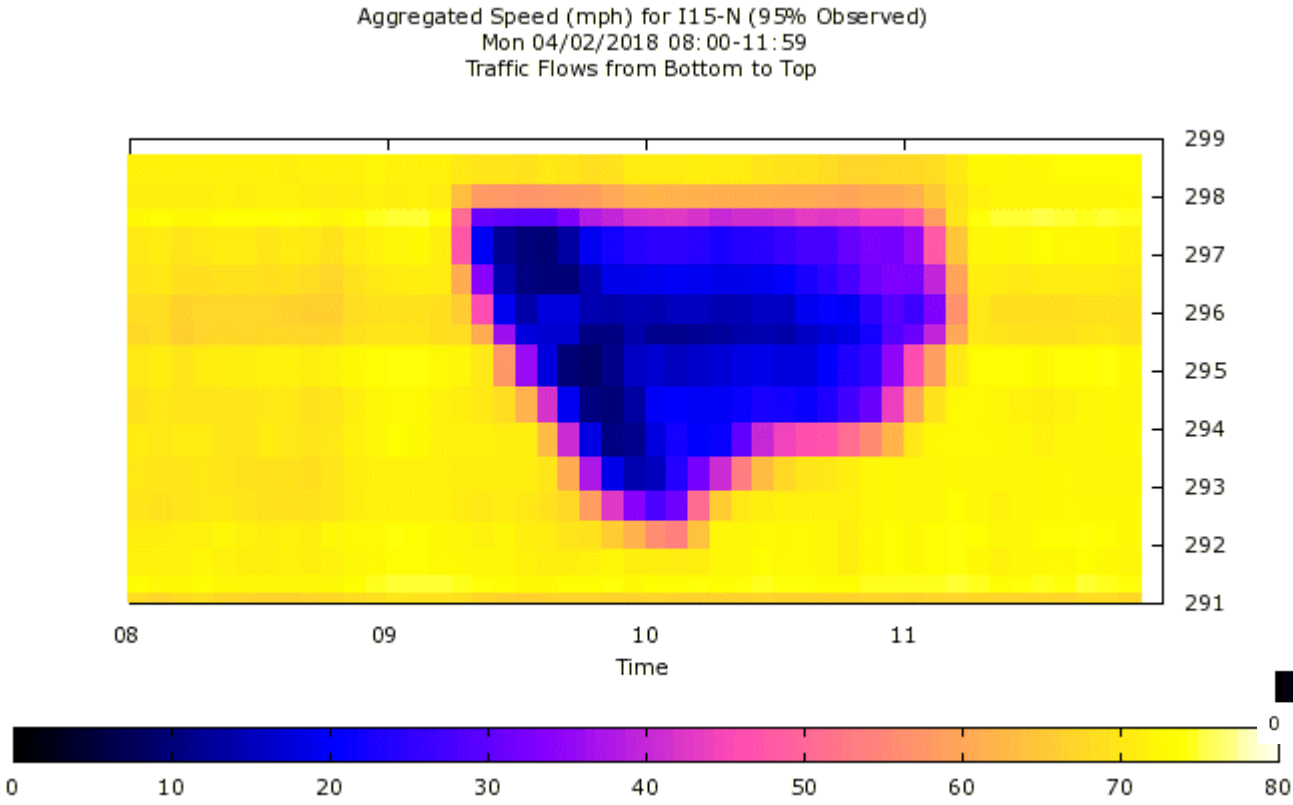


iPeMS Sub Routes

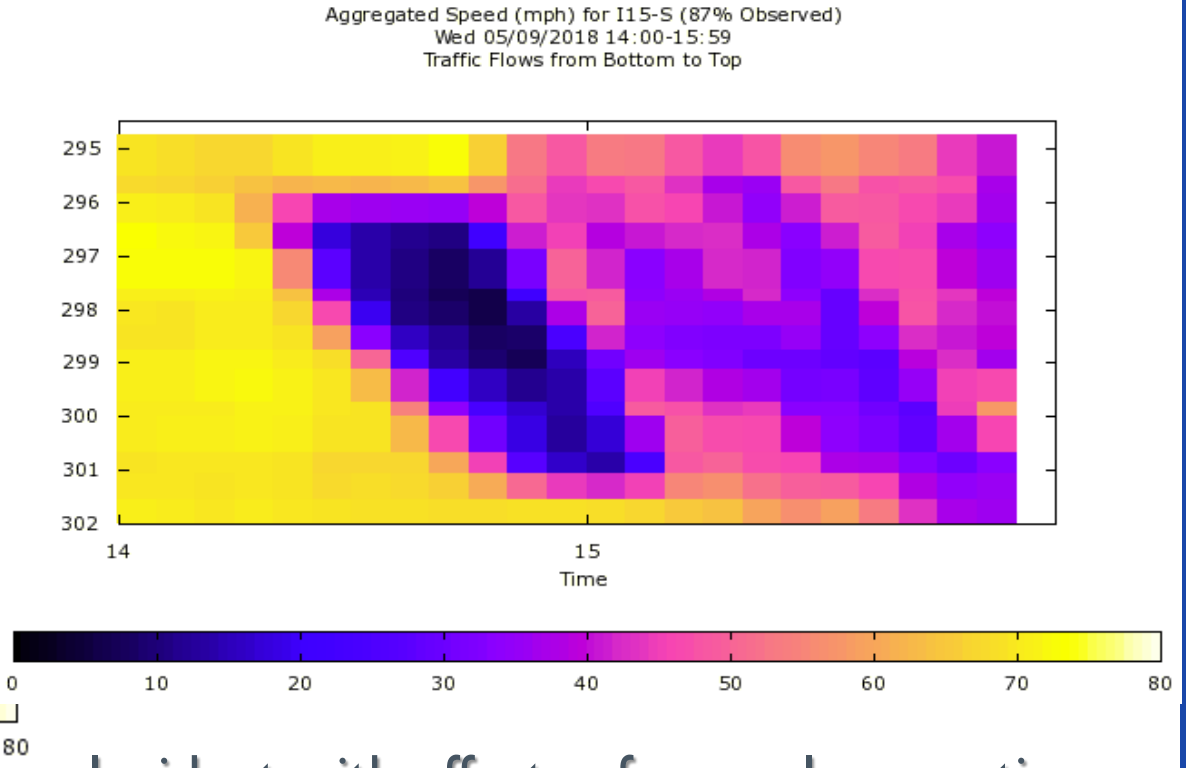


PeMS Loop Detector Locations

Excess Travel Time and Affected Volume



Incident without effects of normal congestion



Incident with effects of normal congestion

Excess User Cost

Symbol	Meaning	Units
ETT	Excess Travel Time	hours
Truck%	Percent of vehicles that are trucks	Percent
AVO	Average Vehicle Occupancy	People per passenger car
IHC	Individual Hourly Cost	Dollars per person per hour
THC	Truck Hourly Cost	Dollars per truck per hour

Excess User Cost

$$EUC = Cost\ of\ Passenger\ Time + Cost\ of\ Truck\ Time$$

$$Cost\ of\ Passenger\ Time = ETT * (1 - Truck\%) * AVO * IHC$$

$$Cost\ of\ Truck = ETT * Truck\% * THC$$

$$EUC = ETT * ((1 - Truck\%) * AVO * IHC + Truck\% * THC)$$

4. Data Reduction

- UHP Data Funnel
- IMT Data Funnel
- Data Samples
- Performance Measure Box Plots
- Response Time Histograms
- Excess User Cost Estimate

UHP Data Funnel

UHP Crash Response Data		
Data Type	Number of Data Points	Percent of Total
Crashes	6242	100.0%
ICT	6162	98.7%
RT	4886	78.3%
RCT	201	3.2%
ICT, RT, and RCT	201	3.2%
Analyzed Crashes	82	1.3%

UHP Data Funnel for March 1, 2018 to August 31, 2018

IMT Data Funnel

IMT Crash Response Data		
Data Type	Number of Data Points	Percent of Total
Crashes	1216	100.0%
ICT	1206	99.2%
RT	1042	85.7%
RCT	138	11.3%
ICT, RT, and RCT	129	10.6%
Analyzed Crashes	63	5.2%

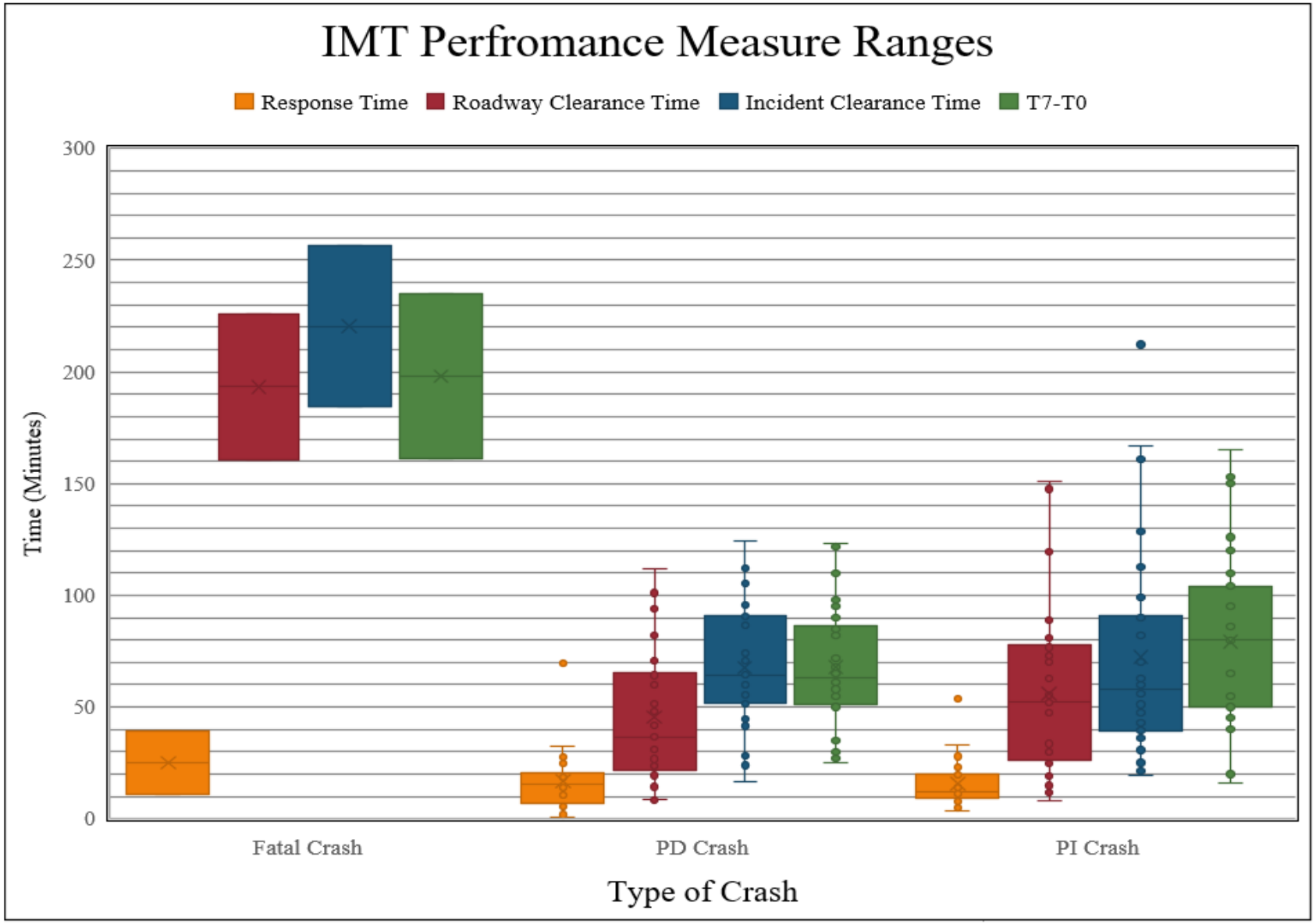
IMT Data Funnel for March 1, 2018 to August 31, 2018

Data Samples

	Performance Measures	Performance Measures with IMT	Incidents Analyzed for EUC	Incidents with IMT Analyzed for EUC
All Lane Configuration	168	121	82	63
12-Lane Highway	2	1	1	0
10-Lane Highway	58	42	28	21
8-Lane Highway	66	45	36	25
6-Lane Highway	28	23	16	16
4-Lane Highway	12	9	1	1
2-Lane Highway	2	1	0	0

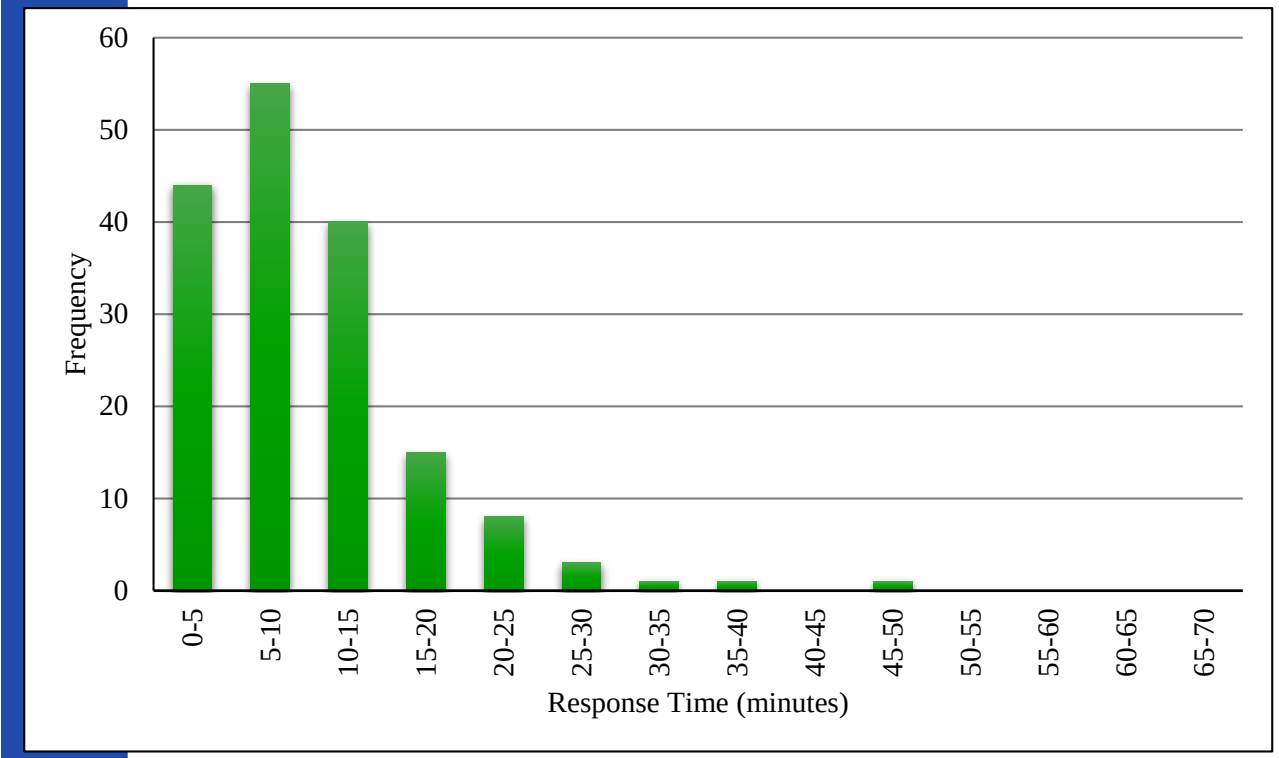
Total Data Samples

Performance Measure Box Plots

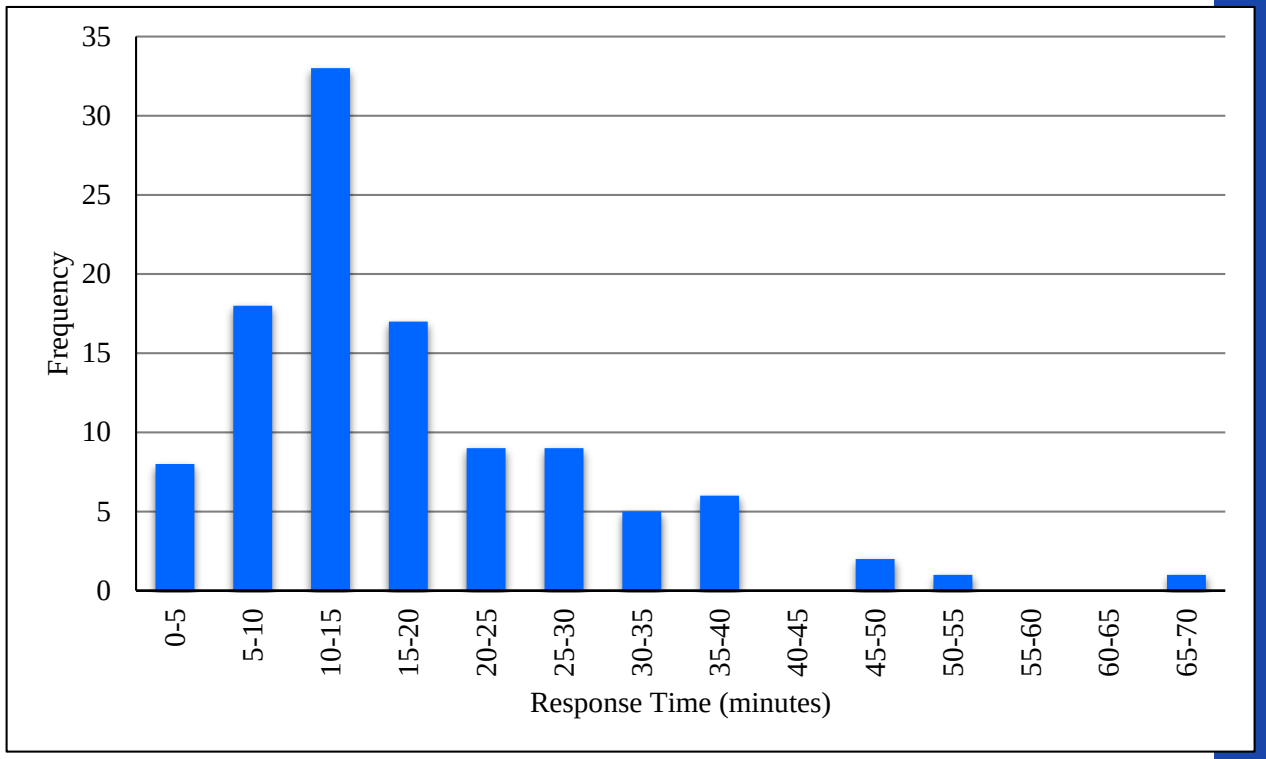


Box plot showing spread of performance measure data for different crash severity types

Response Time Histograms



UHP Response Time Histogram



IMT Response Time Histogram

Excess User Cost Estimate

Crash Severity Type	Average Cost	Number of Crashes	Cost Estimate (For 6 Months)	Cost Estimate (Yearly Cost Assuming Similar Crash Occurrence Trend)
FI	$ 123,702	14	$ 1,731,832	$ 3,463,664
PI	$ 16,090	326	$ 5,245,315	$ 10,490,629
PDO	$ 25,198	876	$ 22,073,546	$ 44,147,091

Yearly Total	$ 58,101,384

Yearly Excess User Cost Estimate

5. Results of Statistical Analysis

- Overview of Statistical Analysis
- Performance Measure Analyses
- User Impact Analyses
- Statistical Findings

Overview of Statistical Analysis

- Analyses were performed both for performance measures of the IMT program and for user impacts of incidents including ETT, AV, and EUC
- Analyses presented in the paper are for the whole data set collected on all lane configurations, but similar analyses have been performed for 8-lane and 10-lane configurations
- Independent variables are confounded, so results from individual analyses must be considered independently

Performance Measure Analyses

Independent Variable	Dependent Variable		
	RCT (minutes)	IMT ICT (minutes)	TID, T_7-T_0 (minutes)
# IMT Units	✓	✓	✓
# UHP Units	✓	✓	✓
IMT RT (minutes)	✓	✓	✓
UHP RT (minutes)	✓	✓	✓
# Lanes at Bottleneck	✓	✓	✓
Time Range	✓	✓	✓
RCT (minutes)			✓

User Impact Analyses

Independent Variable	Dependent Variable		
	AV (vehicles)	ETT (minutes)	EUC (dollars)
# IMT Units	✓	✓	✓
# UHP Units	✓	✓	✓
RT IMT (minutes)	✓	✓	✓
RT UHP (minutes)	✓	✓	✓
# Lanes at Bottleneck	✓	✓	✓
Time Range	✓	✓	✓
RCT IMT (minutes)	✓	✓	✓
RCT UHP (minutes)	✓	✓	✓
ICT IMT (minutes)	✓	✓	✓
ICT UHP (minutes)	✓	✓	✓
T_7-T_5 (minutes)	✓	✓	✓
TID, T_7-T_0 (minutes)	✓	✓	✓

Statistical Findings

- For each minute delay of IMT RT, there is an average estimate of 0.77 minutes added to the RCT of the incident, with a range of 0.10 to 1.43 minutes
- For every minute increase of delay in IMT RT, an average estimate of 34.59 minutes of ETT are incurred, with a range of 10.32 to 58.86 minutes
- For every minute increase of delay in IMT RT, an average estimate of $925 are added to the incurred EUC, with a range of $274 to $1,576

Statistical Findings

- For every minute increase of delay in RCT by IMT, an average estimate of $267 are added to the incurred EUC, with a range of $23 to $512
- For every minute increase in TID, an average estimate of $352 are added to the incurred EUC, with a range of $166 to $539

6. Conclusion and Recommendations

- Findings
- Limitations and Challenges
- Recommendations

Findings

- UDOT currently has the data necessary to determine performance measures of its IMT program
- Reducing RT of IMT teams will have positive impacts on RCT and user impacts
- Average EUC for PDO crashes is greater than for PI crashes, and IMT teams should patrol at locations and times susceptible to these high congestion crashes

Limitations and Challenges

- Confounding effects of several variables in determining relationships between performance measures, incident characteristics, and user impacts
- Unavailability of lane closure data as a variable
- Incomplete data for most incidents in the CAD files, leading to a smaller sample of analyzed data

Recommendations

- Continue to collect T_5 data in the form of status code “C” for future analysis of IMT performance
- Make lane closure data for incidents accessible for a better understanding of severity in the context of TIM
- Perform a second phase of research to study effects of the recent program expansion or determine optimal IMT deployment

Questions/Comments?

For questions, contact:

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