The Development of a Roadway Safety Assessment Tool (RSAT) to Evaluate Infrastructure & EMS Along Motorcoach Travel Routes

Center for Transportation Injury Research (CenTIR)
at CUBRC, Buffalo, NY

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State EMS Officials Annual Meeting
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Presentation Outline

1. Who is CUBRC/CenTIR?
2. Why is RSAT being developed?
3. What is RSAT?
4. How does RSAT work?
5. When will RSAT be available?
6. Where can RSAT go from here?

CUBRC/CenTIR Information

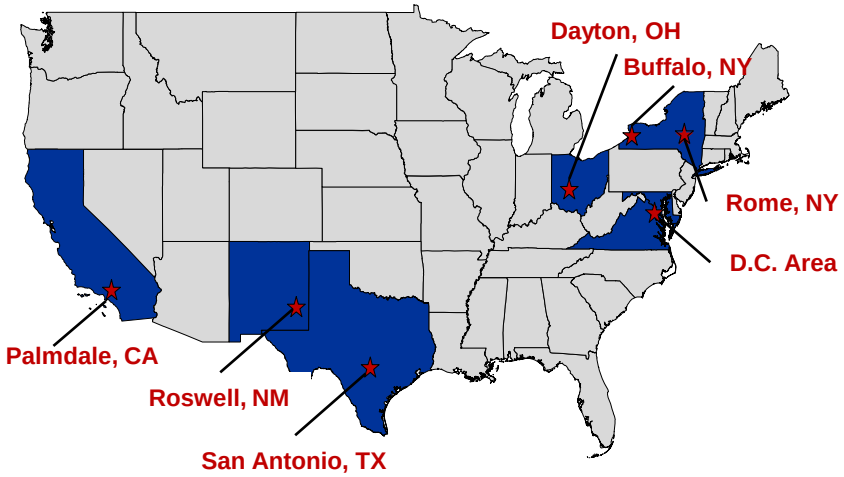
CUBRC is an independent scientific not-for-profit corporation established in 1983

CUBRC is affiliated with the Research Foundation of the State University of New York and has a long history of successful collaborations with SUNY at Buffalo

CUBRC core competencies include:

- Information Exploitation
- Public Safety, Infrastructure & Transportation (PSIT)
- Chem-Bio Defense
- Hypersonics

The Center for Transportation Injury Research (CenTIR) is a program at CUBRC under the PSIT group that is supported by the Federal Highway Administration (FHWA)



Project Genesis

Mexican Hat, UT - 9 Killed, 43 Injured (January 2008)

Rural Multi-Casualty Motorcoach Crashes

NTSB Investigation & Recommendations

FHWA, NASEMSO &AASHTO

FICEMS

CenTIR/CUBRC RSAT Project

NASEMSO MIECE Project

Model **I**nventory of **E**mergency **C**are **E**lements

2008 Mexican Hat Motorcoach Crash

NTSB Recommendation
Develop & implement a risk assessment process to identify stretches of rural roads most vulnerable to large bus accidents (traffic patterns, passenger volume, bus types)

NTSB Recommendation
Develop plan to pursue funding to enhance wireless communication coverage to enable prompt accident notification and emergency response along high risk rural roads.

NTSB Recommendation
Evaluate the system of emergency care response to large scale transportation related rural accidents

Traditional Safety Analyses

There are a variety of metrics which can be utilized for assessing motorcoach route safety. Many of these metrics are currently used by state DOTs to assess general roadway safety. However, response to a motorcoach (mass casualty) crash can present unique challenges.

Examples of traditional metrics which can be used to assess motorcoach route safety include:

- Adequate infrastructure clearance (tunnels and overpasses), sufficient weight capacity (bridges), adequate shoulders, guardrails where appropriate, etc.
- Frequency of injury crashes along route used by motorcoach

I 95 Bronx, NY - 15 Killed, 18 Injured (March 2011)

Exposure data (or frequency of motorcoach travel on a given route) can help quantify the risk & help rank locations where safety improvements are needed most urgently.

Less traditional measures that can also be used to assess route safety include:

- Timely access to EMS and trauma care (should multi-casualty event occur)
- Robust cellular communications with no drop-out areas
- Availability of real time weather information on visibility and road surface condition

Project Objectives & Tasks

Under the guidance of Keith Williams, FHWA (task monitor and originator of initial project concept), the following objectives were defined:

- The purpose of the 'tool' is to provide users with the ability to assess risks associated with a mass casualty crashes (i.e. motorcoaches)
- To be useful the 'tool' needs to enable users to calculate the risk on their roadway segments and also display the results of the risk analysis
- *At the limit*, this 'tool' should provide reasonable answers for a simple, **serious injury crashes**
- The methodology behind the 'tool' is modeled on the MIECE construct (Model Inventory of Emergency Care Elements) developed by NASEMSO

To support these objectives 4 key tasks were identified:

- Identify potential stakeholders and resources
- Establish state partnerships for research
- Compile appropriate EMS, safety, and infrastructure data for a few 'test' states
- Develop a tool to define and evaluate the safety of motor coach routes

Project Synopsis

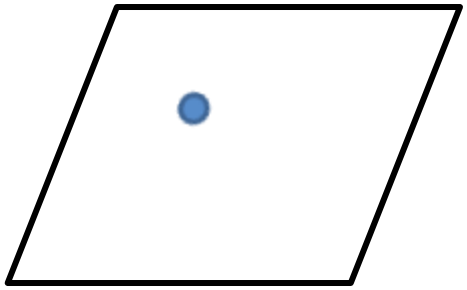
The **Roadway Safety Assessment Tool (RSAT)** is:

- An assessment tool *for states to use* to identify and evaluate the safety of rural routes that are utilized by motorcoaches
- Unique, in that it generates an overall safety score for motorcoach routes based not only on the transportation infrastructure, but also on access to medical and trauma care
- Utilizes inputs from transportation and EMS professionals to measure crash risk along a route, as well as the robustness of communications, EMS response capabilities, and proximity to hospitals and trauma centers
- Based on a geographic information system (GIS) platform and utilizes Google Earth for the end user interface

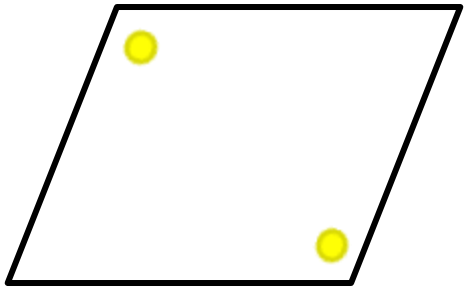
National Data

Preliminary Data for Tool Development & Demonstration

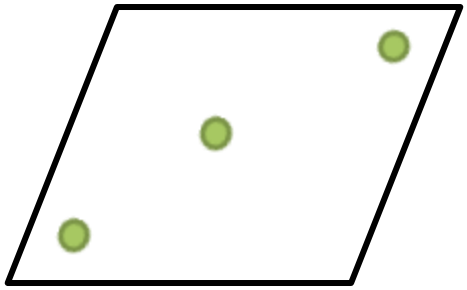
Trauma Center Locations
(TIEP 2010, UPENN /ATS)
866 Level 1, 2, 3



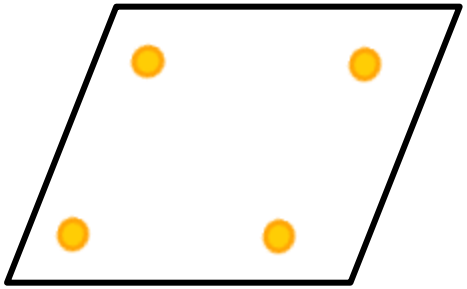
Air Medical Service Helicopter Bases
(ADAMS 2012, CUBRC/AAMS)
883 Bases



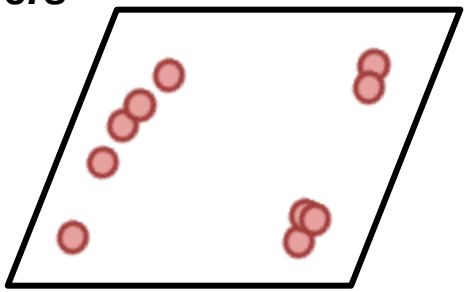
Cellular Tower Locations
(HSIP-Gold 2012**, NGA)
22,491 Towers



GIS Data Map Layers



Ground Ambulance Depots
(HSIP-Gold 2012**, NGA)
35,992 Depots



Fatal Crash Locations
(FARS 2007-2011, NHTSA)
131,962 Crash Locations

****NGA permission granted to use of HSIP-Gold Data on this Project**

Additional attribute information and improved completeness would increase the accuracy of the tool

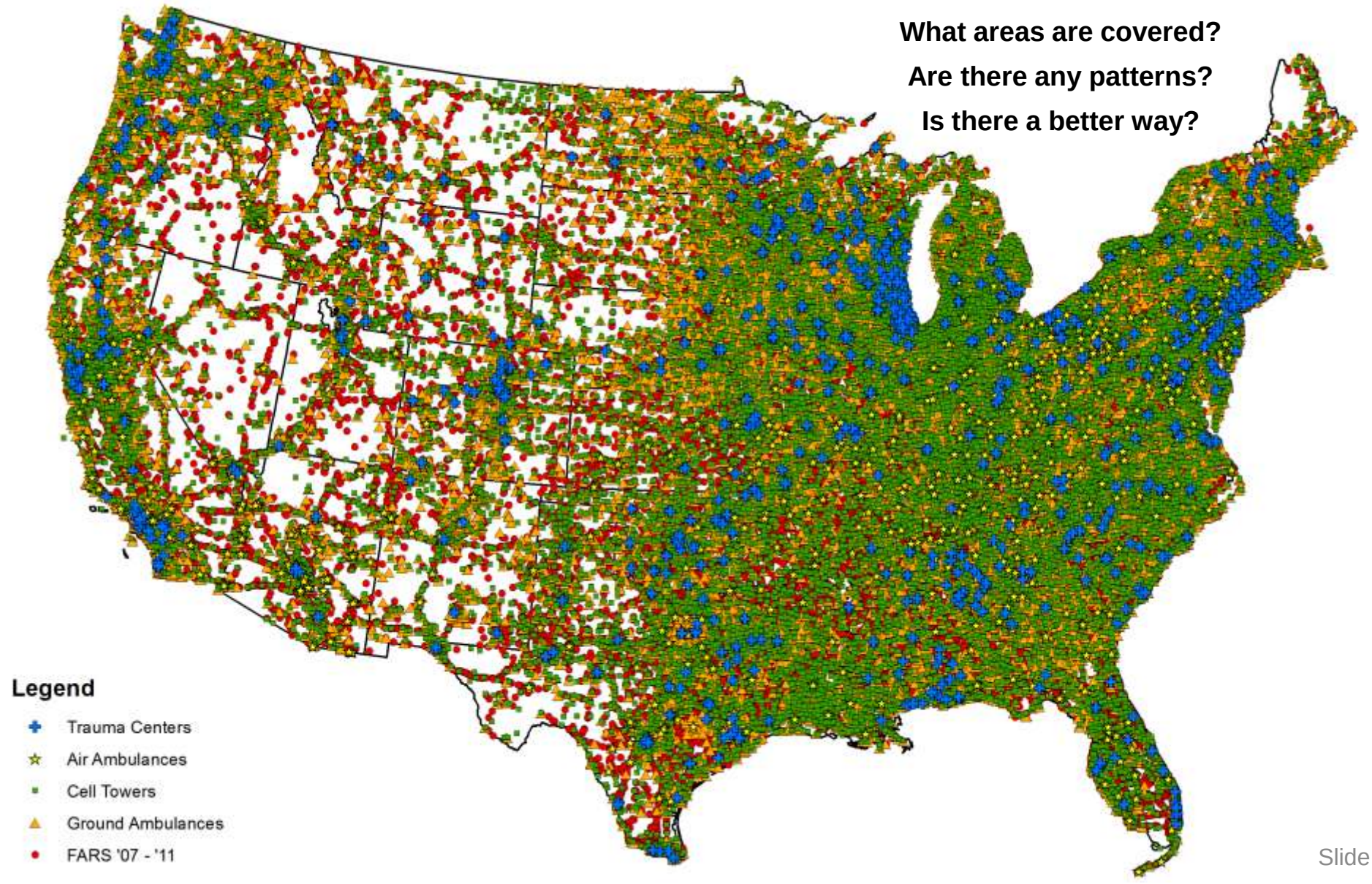
Trauma Centers, Air & Ground Ambulances, Cell Towers & Fatal Crashes

What can we see?

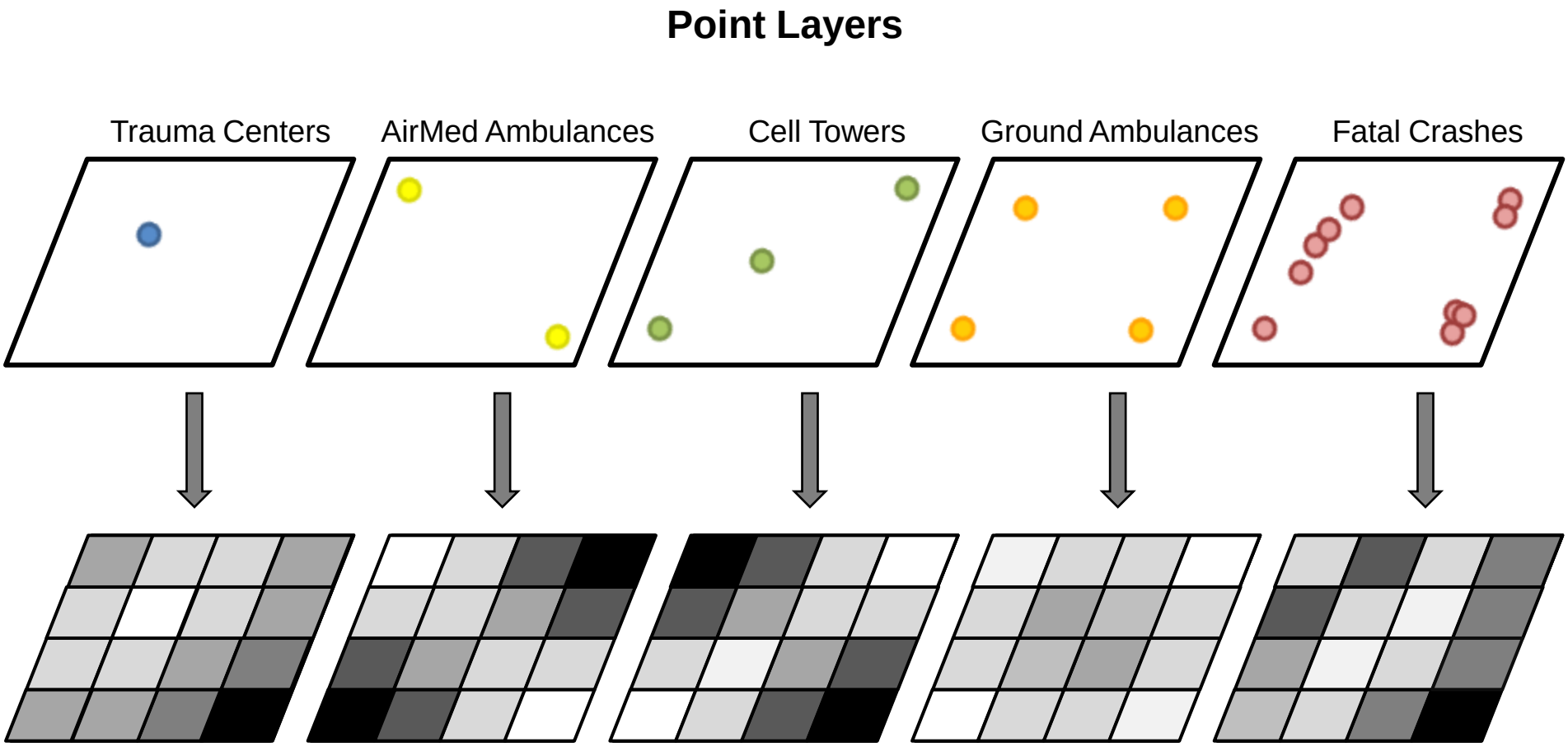
What areas are covered?

Are there any patterns?

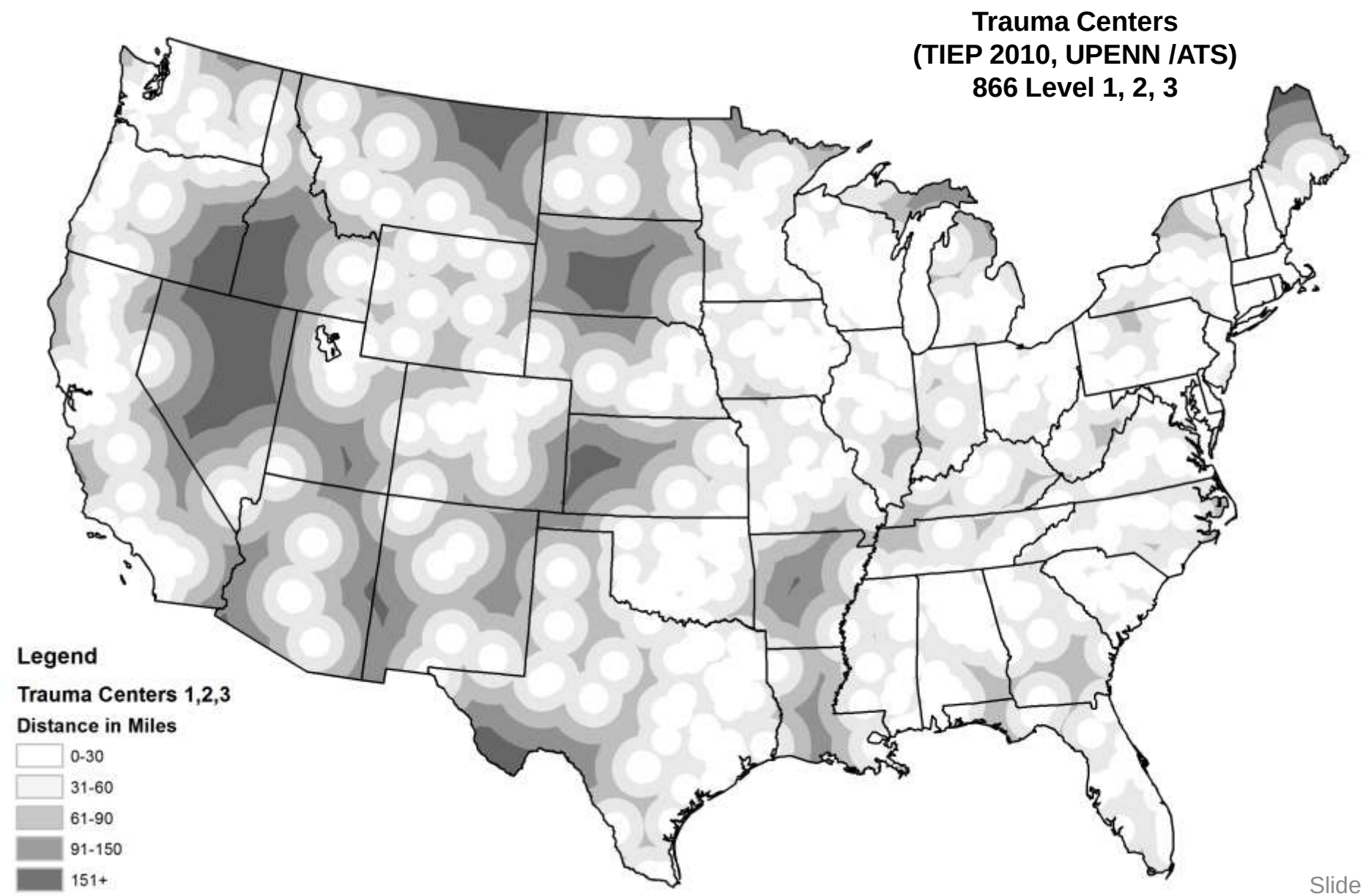
Is there a better way?



Grid Based Raster Values



Distance to Nearest Trauma Center



Methodology for Indexing & Combining Safety Scores

General Methodology for Road Segment Risk Rating for Crash Victim* Access to Emergency Care

$$R_k = \sum_{i}^{n} w_i v_i$$

Where

R_k = relative risk on road segment k

r_i = risk element i

w_i = weight of risk element i

v_i = $f(r_i)$ value of risk element i

n = total number of risk elements

* Risk rating can be applied to single victim or mass casualty events by proper selection of w_i and v_i values

Illustration of Risk Elements (r_i) for 'Mass Casualty' Event

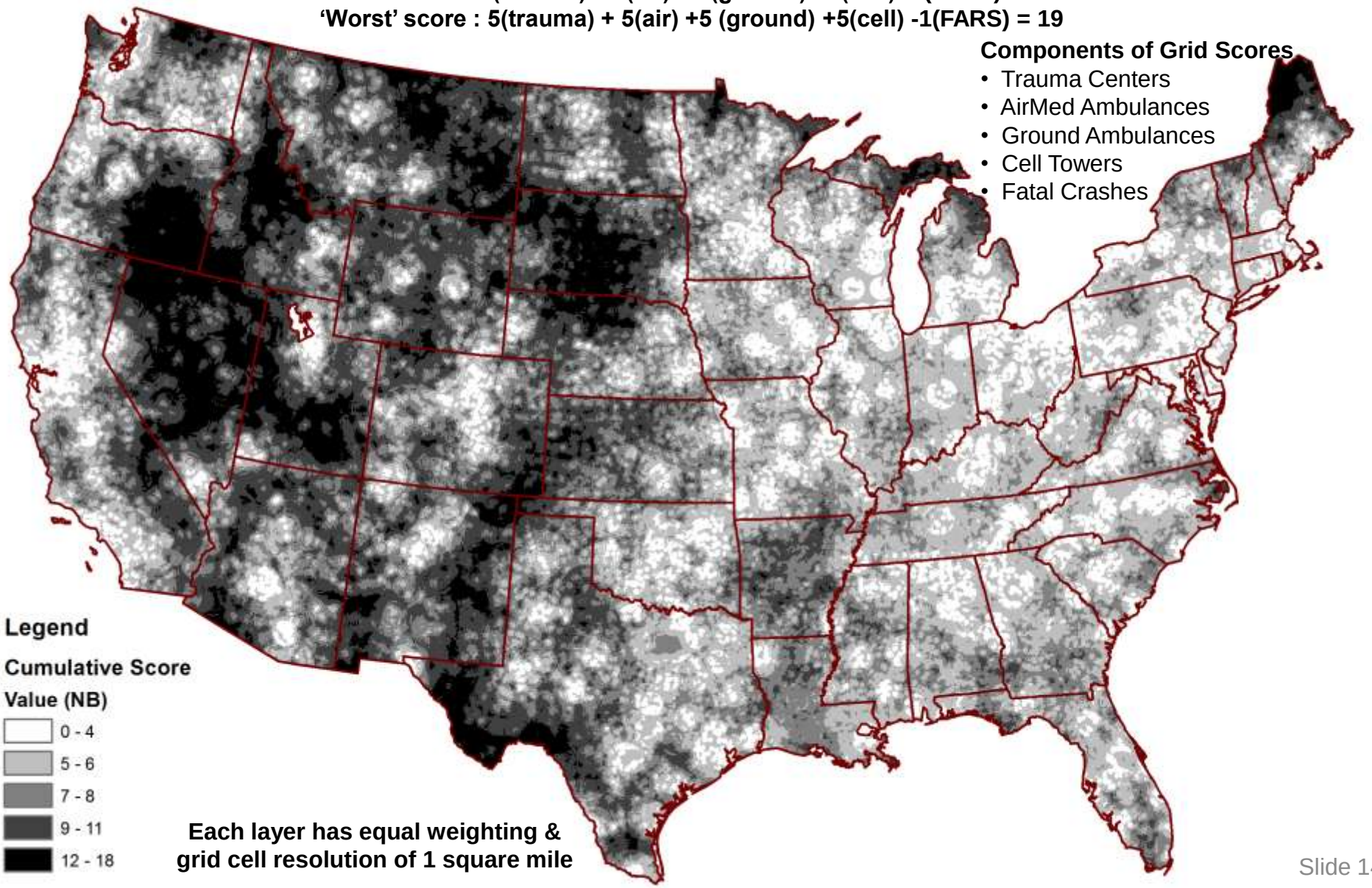
- Principle 1 : Timely Access to a Trauma Center reduces mortality [1]
- Principle 2 : Rapid response of highly trained first responders may also reduce mortality [2-6]

Category	Risk Element(s) (r_i)	
Medical Facilities	• Ground travel time (t) from crash event to nearest L1/L2 trauma center	$t < 40$ mins, $v_i = 1$ $40 \leq t \leq 60$ mins, $v_i = 5$ $t > 60$ mins, $v_i = 10$
Personnel	• No of ALS, EMT-P personnel (N) within 15 miles of crash event	$N > 10$, $v_i = 1$ $2 < N \leq 10$, $v_i = 5$ $N \leq 2$, $v_i = 10$
Communications	• Cellular Coverage Available at crash scene for emergency 9-1-1 call	Yes, $v_i = 1$ No, $v_i = 10$
Transportation	• Travel time (t) from nearest Air Med base to crash event	$t < 20$ mins, $v_i = 1$ 21 min $< t < 40$ mins, $v_i = 5$ $t > 41$ mins, $v_i = 10$
	• No of ambulances (N) within 15 miles of the crash event	$N > 10$, $v_i = 1$ $2 < N \leq 10$, $v_i = 5$ $N \leq 2$, $v_i = 10$

Note: Higher the value of v, the higher the relative risk associated with timely & appropriate patient care

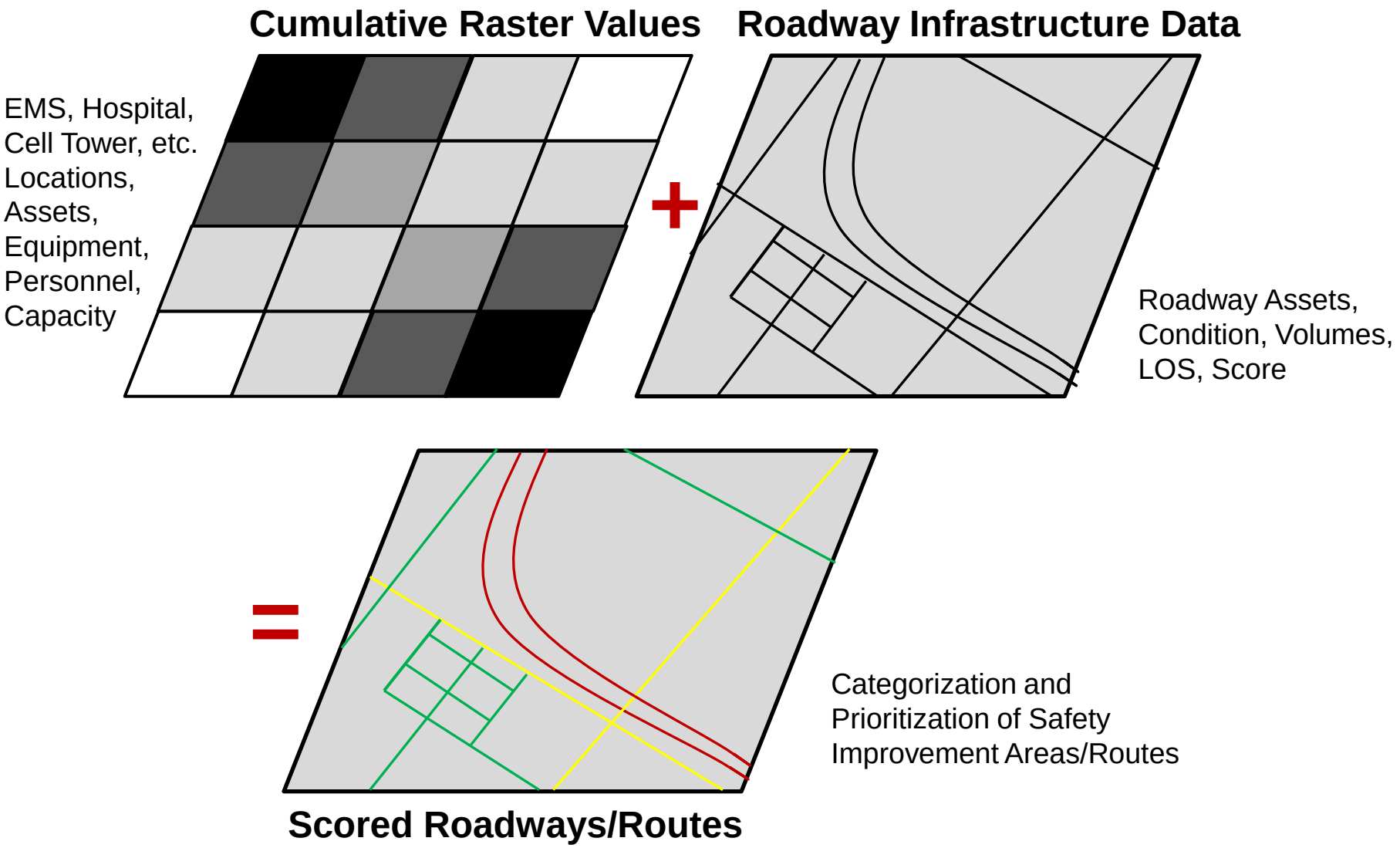
Total Grid Score of Trauma Center, Air & Ground Ambulance, Cell Towers & Crashes

'Best' score: 1(trauma) + 1(air) +1 (ground) +1(cell) -5(FARS) = -1
'Worst' score : 5(trauma) + 5(air) +5 (ground) +5(cell) -1(FARS) = 19

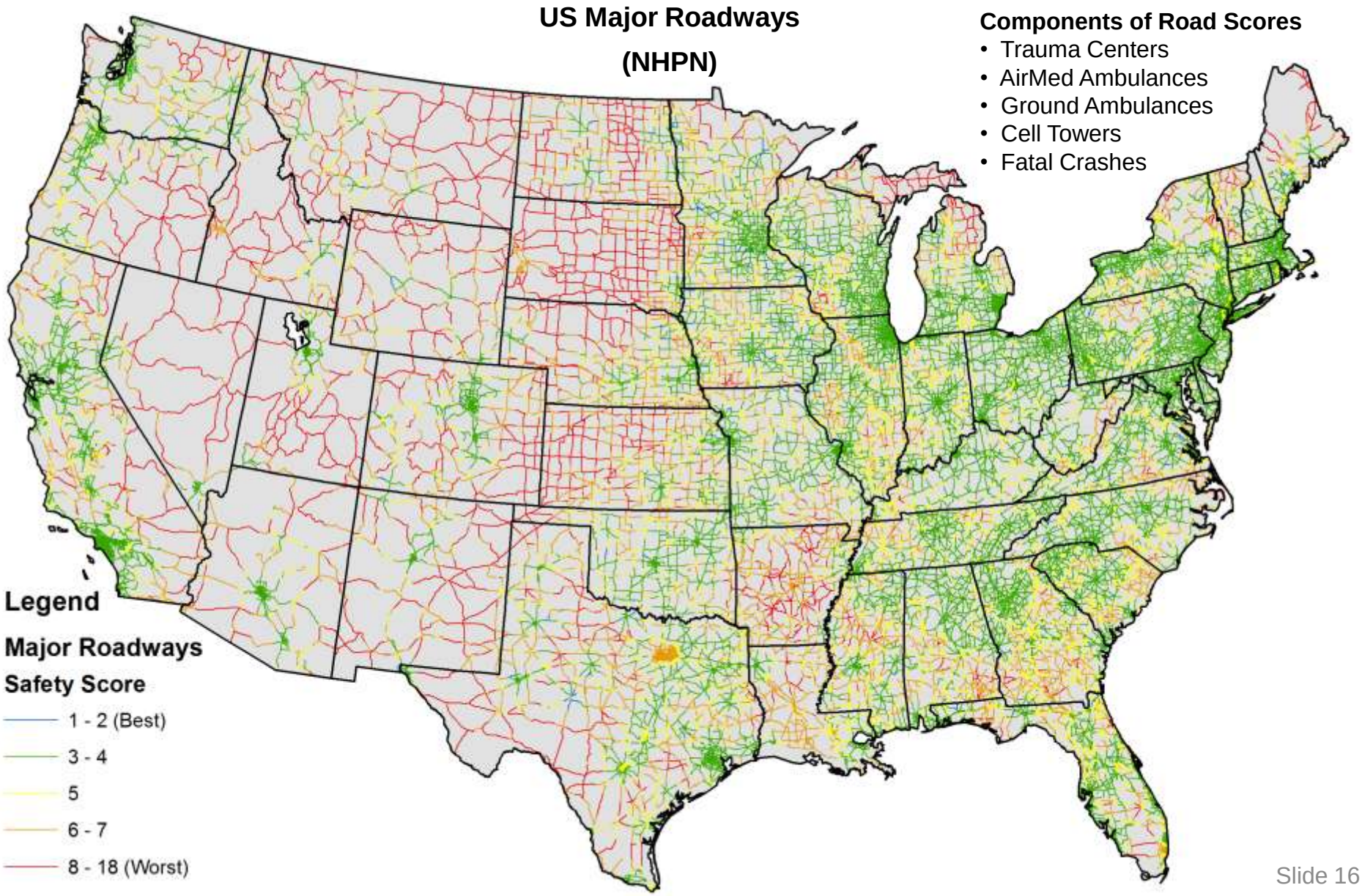


Each layer has equal weighting & grid cell resolution of 1 square mile

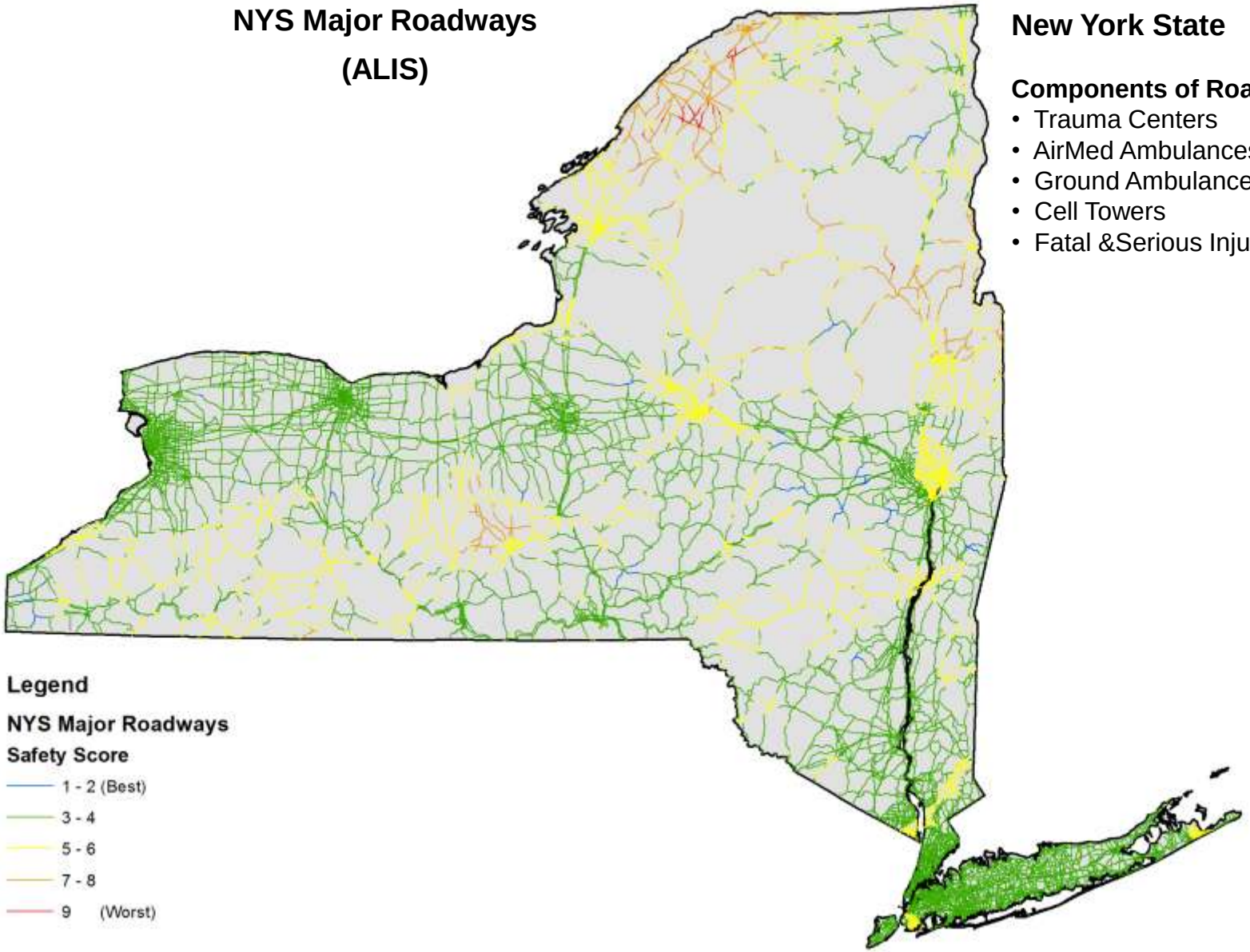
Combining Raster Values with Line Layers



Total Grid Scores Converted to Road Segment Scores



Road Segment Scores for New York State



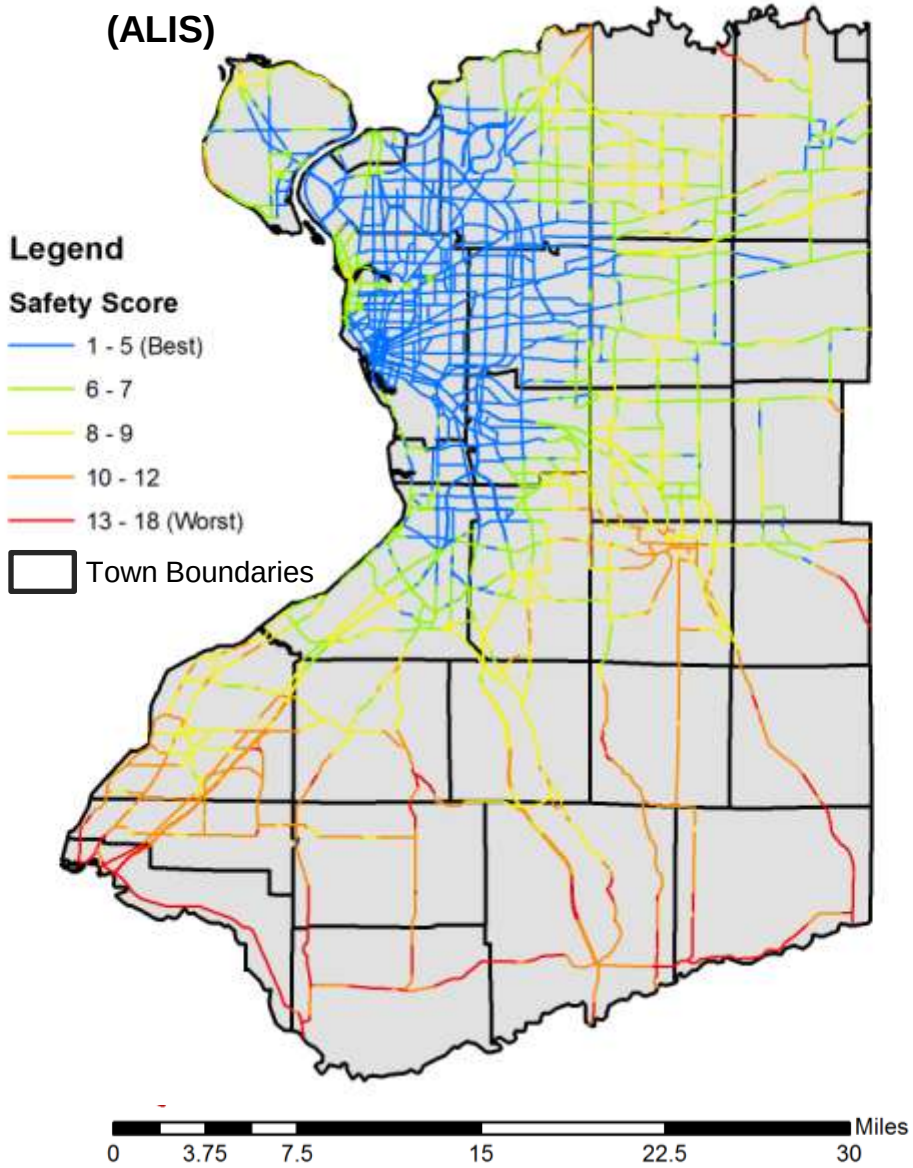
New York State

Components of Road Scores

- Trauma Centers
- AirMed Ambulances
- Ground Ambulances
- Cell Towers
- Fatal &Serious Injury Crashes

Total Grid Scores Converted to Road Segment Scores

Erie County Major Roadways (ALIS)



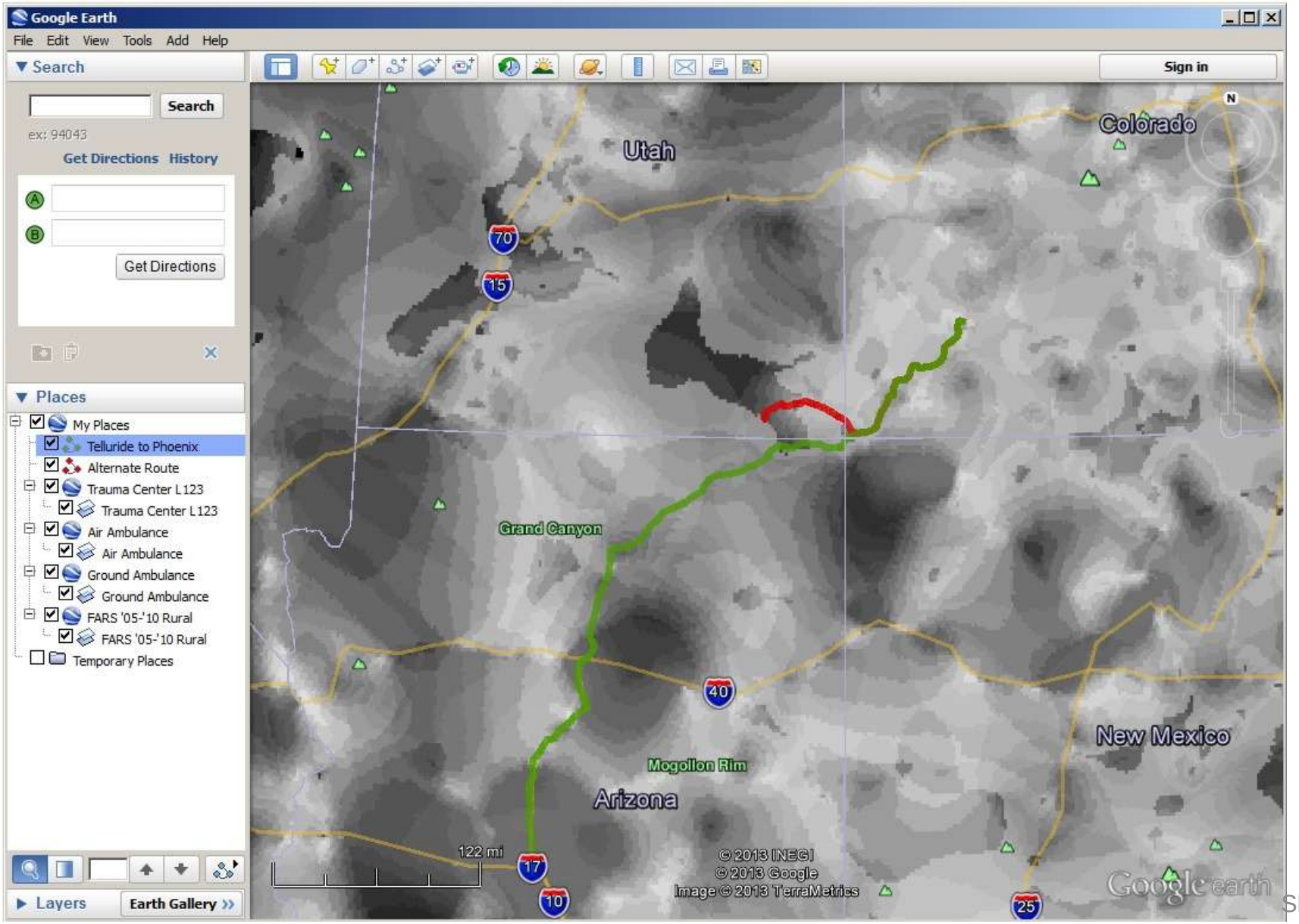
Erie County, New York

Components of Road Scores

- Trauma Centers
- AirMed Ambulances
- Ground ALS/BLS Ambulances
- Cell Towers
- Fatal & Serious Injury Crashes

Motorcoach Tool End User Interface

Demonstrated Using Mexican Hat Route



Current Status of RSAT

- RSAT is planned to be delivered to FHWA in March of 2014
- The tool will be delivered as a functional prototype
- It will provide both automated and analyst-driven procedures to view source data, selectively activate/ deactivate resources, perform quantitative analyses and visualize response information under a variety of conditions.
- Guidance is needed from knowledgeable stakeholders to assess the best way to weight and merge scores from different data layers.
- Currently exploring methods for allowing user defined indexes and layers for inclusion into analysis
- Documentation being developed to aid users in working with the tool in Google Earth
- Feedback from state users and additional attribute data are needed to develop next version.
- Plan to perform outreach by demonstrating the tool to State and Federal DOT, AASHTO, NASEMSO

Current Status of Supporting Data

- Currently have national data (geographic location and selected attributes) for air medical services (ADAMS, CUBRC) and trauma centers (TIEP, ATS/ UPENN)
- Also have national data on cell tower locations (HSIP, NGA) but no attribute information and some tower locations are clearly missing (e.g., Dallas, TX, Albany, NY)
- National data on locations of EMS ground ambulance depots have been acquired (HSIP, NGA). However, attribute data (number of ambulances at depot, service level (ALS, BLS), number of paramedics and EMTs, etc.) are missing
  - Received NYS Ground EMS attribute data from NYS DOH; currently geocoding and assessing quality
  - Currently working with regional (WNY) contacts to obtain ground EMS attribute data for 8 local counties
  - Expect to initiate requests to AL, ND and ME for more complete EMS data
- Currently have geocoded fatal crash data for nation (FARS, USDOT) and geocoded injury crash data for Erie County (SMS, NYSDOT)
- Requested statewide injury crashes and AADT (exposure measure) by vehicle type from NYSDOT

Future Visions for RSAT: An Extension to Support MIECE

- Model Inventory of Emergency Care Elements (MIECE) was proposed as a tool to measure the EMS system's capability to respond to mass casualty incidents within a given geographic area (Proof of Concept Design by NASEMSO, Dec 2010).
- This proposed model inventory includes asset locations and measurable attributes or characteristics of emergency care system (e.g., level of service (ALS/BLS), # of paramedics, # of helicopters, is blood carried, # and level of area trauma centers...)
- Intent is to create a dynamic real-time "dashboard" where EMS or highway officials, motor coach route planners and the public could view a regularly updated highway map showing emergency medical & hospital care system in area.
- RSAT provides the spatial analysis platform and initial data foundation for MIECE. Must still acquire attribute data & develop user interface to support queries (# of assets within 30 min, 60 min, etc. of a roadway location).

Future Visions for RSAT: An Extension to Support MAP 21

MAP 21 Safety Provisions

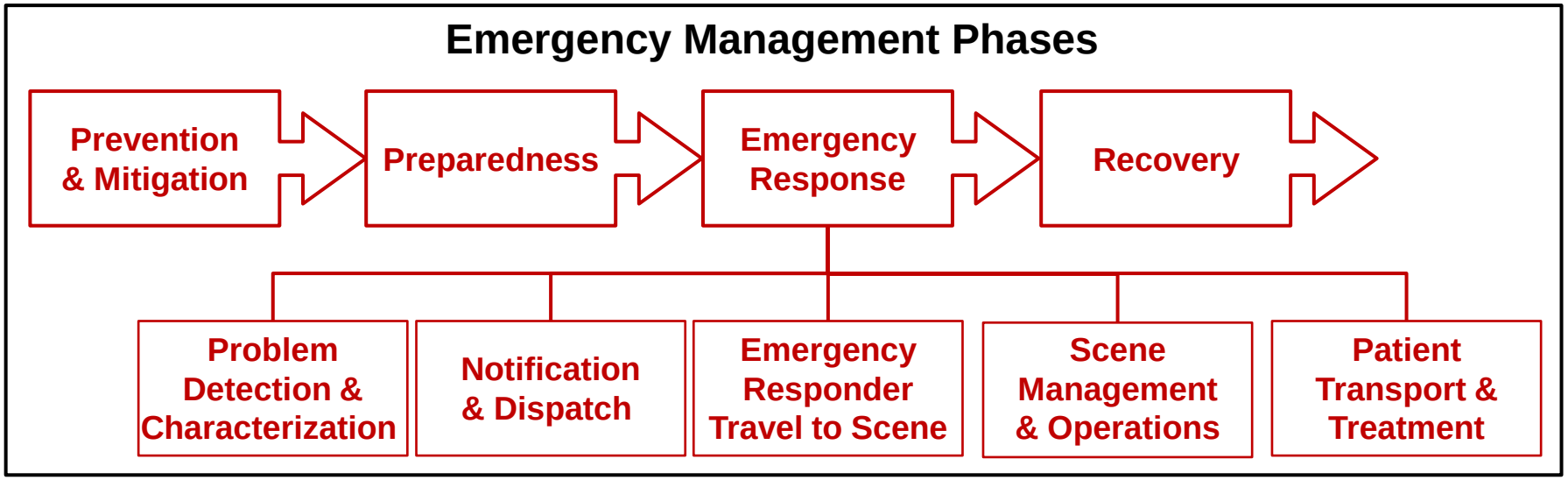
- Under MAP 21, a performance-based, Federal system will be established by states to set targets for total number of injuries and fatalities (per VMT)
- State capabilities for safety data collection, analysis and integration will be advanced according to the state Strategic Highway Safety Plans (SHSP)
- Safety data systems will support problem identification and countermeasure analyses:
  - Identification of all fatalities & serious injuries on all public roads by location
  - Identify hazardous roadway locations, sections, and elements
  - Establish relative severity of safety risk at those locations
  - Consider which projects maximize opportunities to advance safety
- A modified version of RSAT could add another factor (Access to Emergency Care) to support risk assessment and help prioritize roadway safety improvements.

'Other' Crash Types

- A modified tool could easily be used to assess safety of a route with respect to crashes of different kinds of vehicles, such as truck crashes or motorcycle crashes, or to assess safety of route for different types of crashes such as single vehicle run-off-the-road, head-on collisions, etc…

Future Visions for RSAT: In other Phases of Emergency Management

- RSAT was initially envisioned to aid in the 'Prevention & Mitigation' and 'Preparedness' Phases of Emergency Management



- RSAT could be extended to the 'Emergency Response' & 'Recovery' phases to:
  - Identify and locate, in real time, available EMS resources able to respond to emergencies
  - Detect developing gaps in access to care as assets become utilized and prioritize a recovery strategy
- RSAT could also be used to address other issues including:
  - Identify risks associated/correlated with different types of emergencies
  - Identify infrastructure and EMS resource improvements correlated with types of emergency

Questions?

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