

#GWF2020



GWF

GEOSPATIAL WORLD FORUM

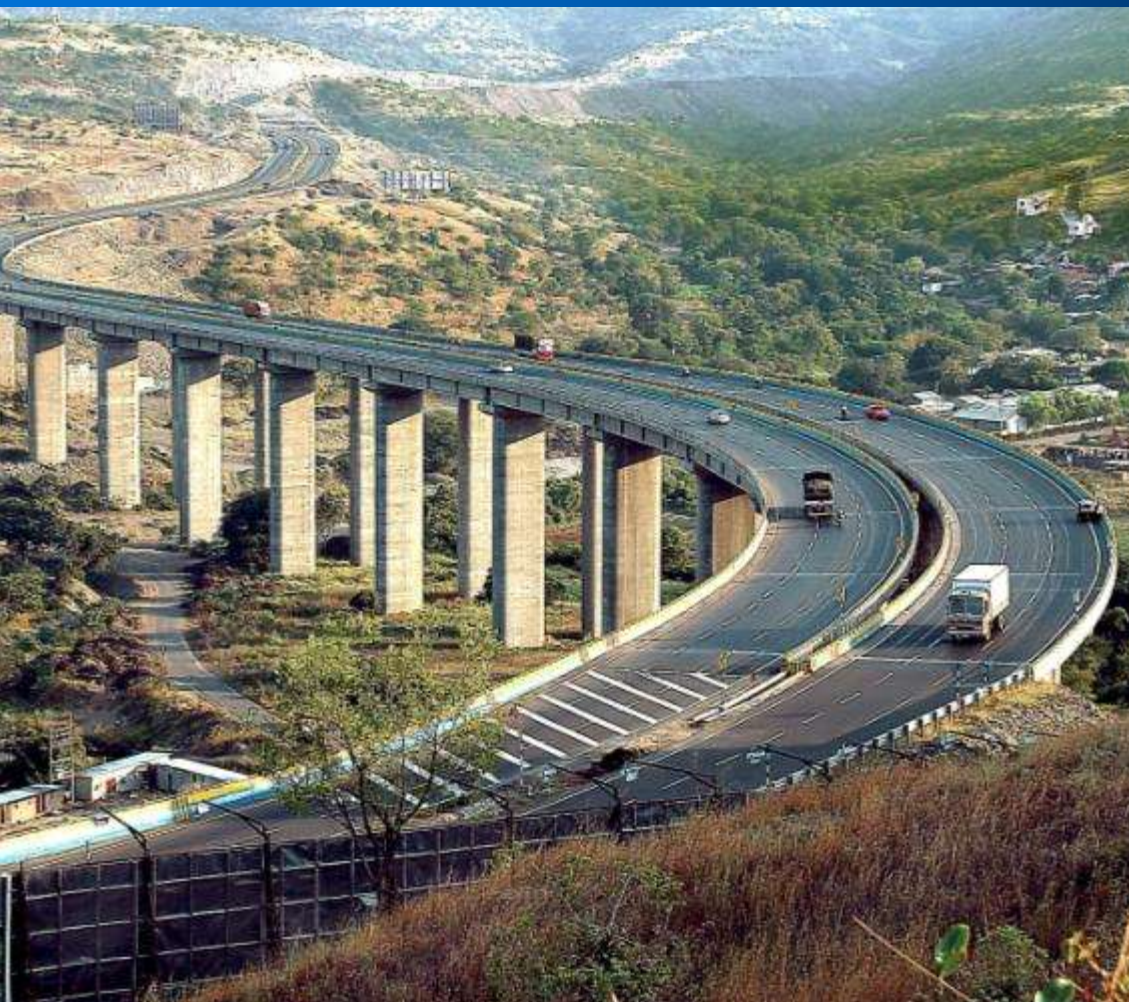
TRANSFORMING ECONOMIES IN 5G ERA

The Geospatial Way!

7-9 April 2020 /// Amsterdam

www.geospatialworldforum.org

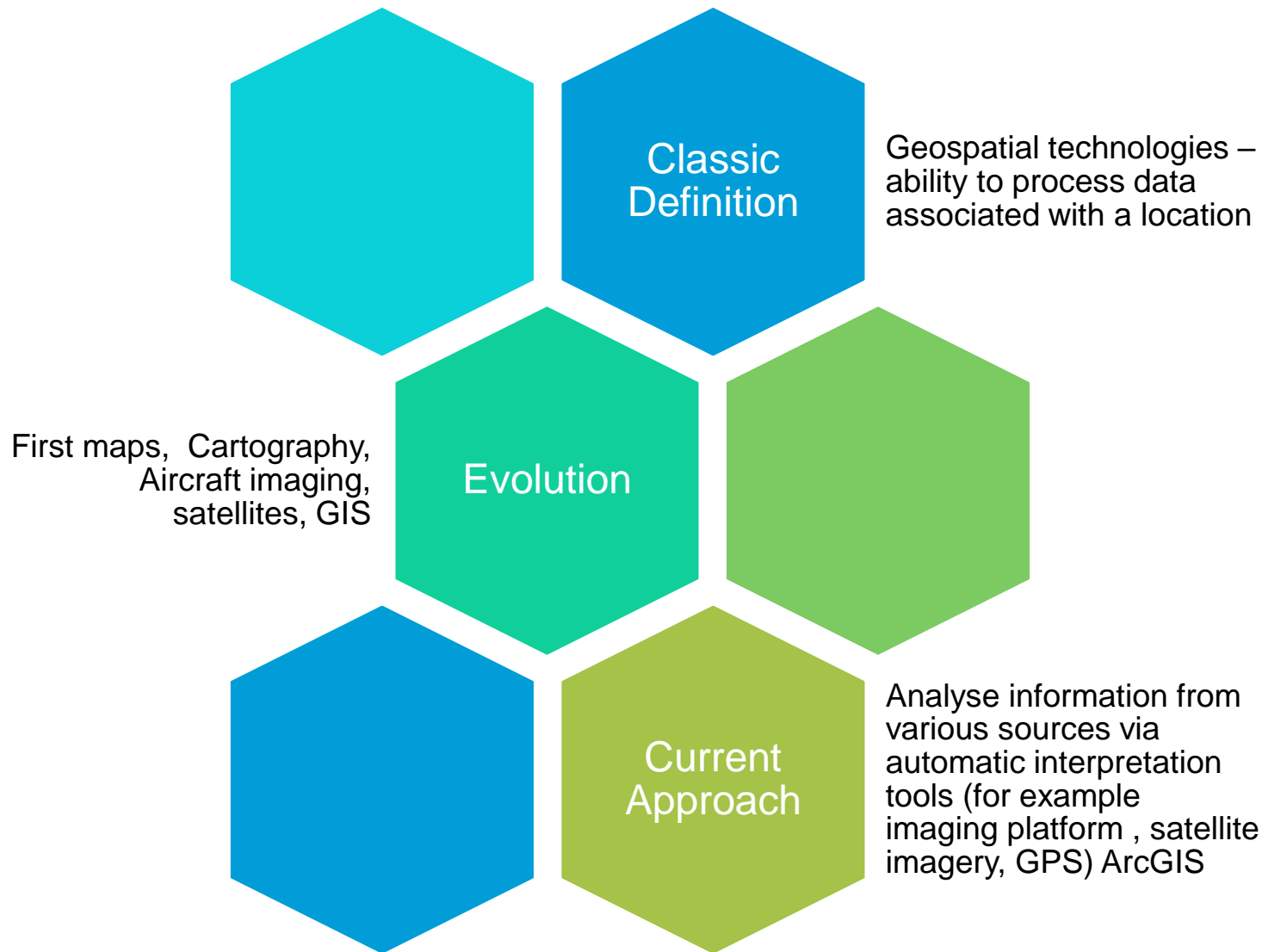




*Building a Nation
Not just Highways*

Geospatial technologies and their uses for highway sector

Geospatial Technologies – defining the boundaries



Why modern technology based interventions are needed in Highway Sector



Transport Supply outstrips Demand — especially in the growing economies like India

Low technology adoption

- Barely 6% companies globally use digital planning tools
- Less than 1% of industry's revenue is used for R&D activities

Inaccurate estimation and implementation

- Cost and time overrun in majority of projects
- World Bank analysis reveals that 62% of highways projects are overestimated

Key expectations from technology interventions



Reliable - To optimise the Infrastructure availability

Safe - Ensure that the solutions reduce the incidents via monitoring and design

Sustainable - Minimising the impact on Environment

Future Ready - Designing solutions that are in line with future disruptions

Key Uses of GIS for highway sector



- Transportation is a requirement for every nation regardless of its industrial capacity, political stability, population, size or technological development. Moving goods and people from one place to another is crucial to maintaining strong economic and political ties between the various components of any given nation and among nations
- **The geographic information system (GIS) and the global positioning system (GPS) are the 2 geospatial technologies that are being used in monitoring of transportation generally**
- **The geospatial techniques are being used by NHAI to generate digitalized map of National Highways. Consequently, it is possible to determine the location of any object, incident, accident or event along these roads and determine distances between points thereby enhancing efficient monitoring of vehicles along these roads and safe driving.**

Key Uses of GIS for highway sector



Highway Planning & Designing

- Overlay various maps in one combined map and perform integrated analysis
- Alignment finalization
- Land susceptibility mapping
- Identifying source of Man & Material & Estimation

Project Monitoring

- GIS based project monitoring - NHAI PMIS

Pavement Management

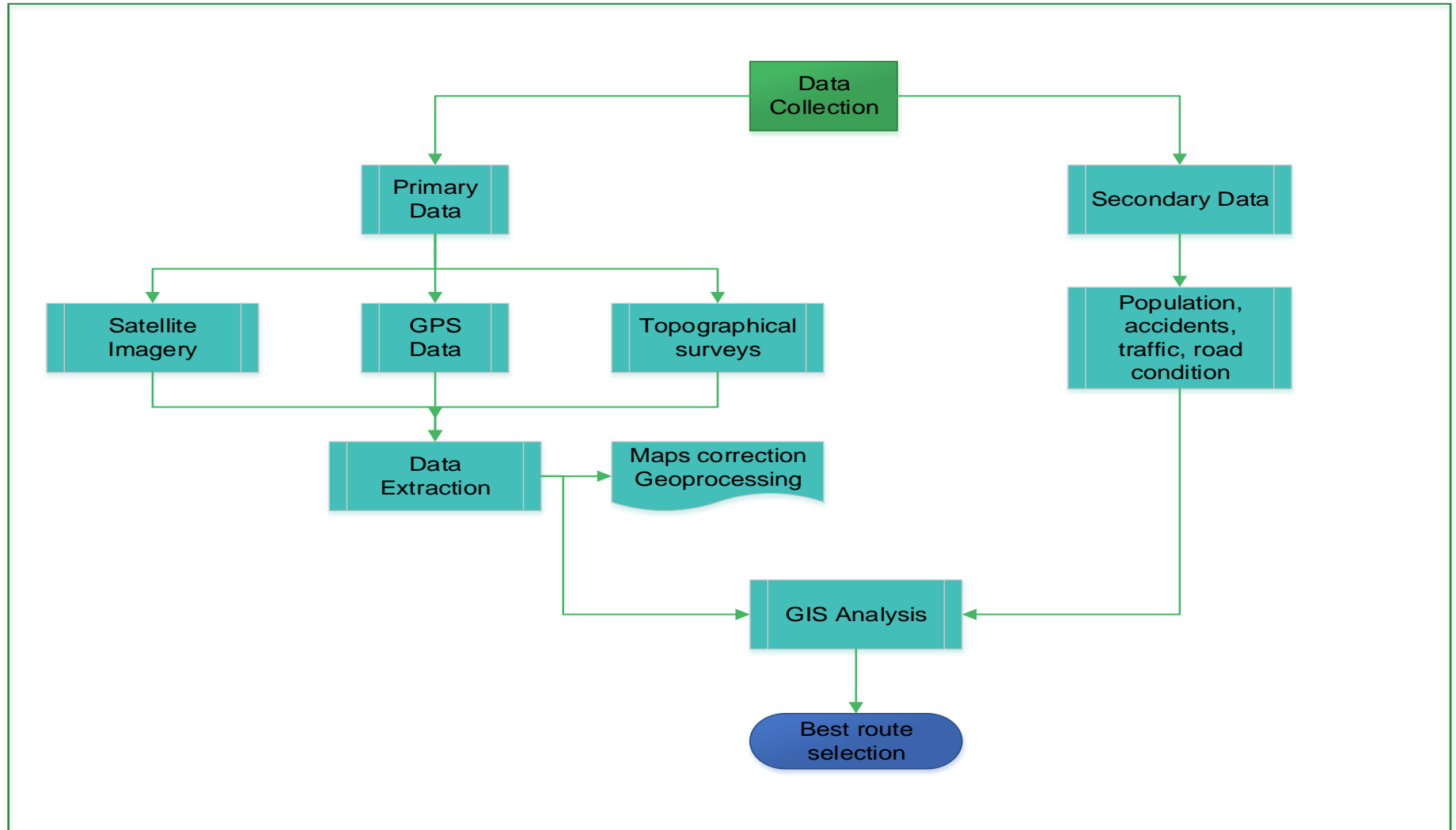
- Creating physical inventory of road assets
- Condition mapping of development work
- Investment analysis by comparing options, and their relative investments

Traffic Engineering & Safety

- Understanding and predicting traffic trends
- Comparing options and their impact on traffic trend
- Map the exact position of incident and alert rescue team
- Identify blackspots and do a causal analysis

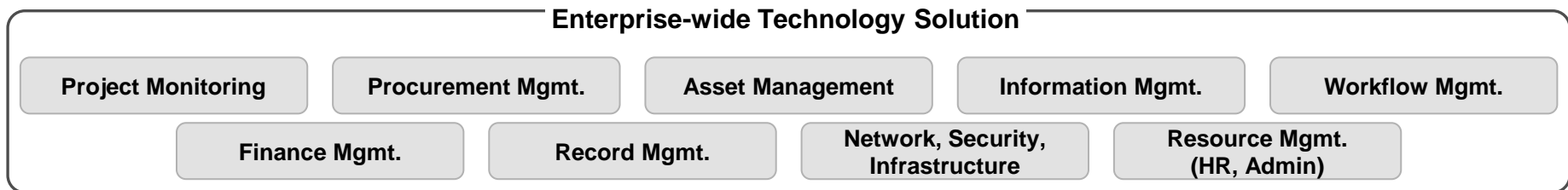
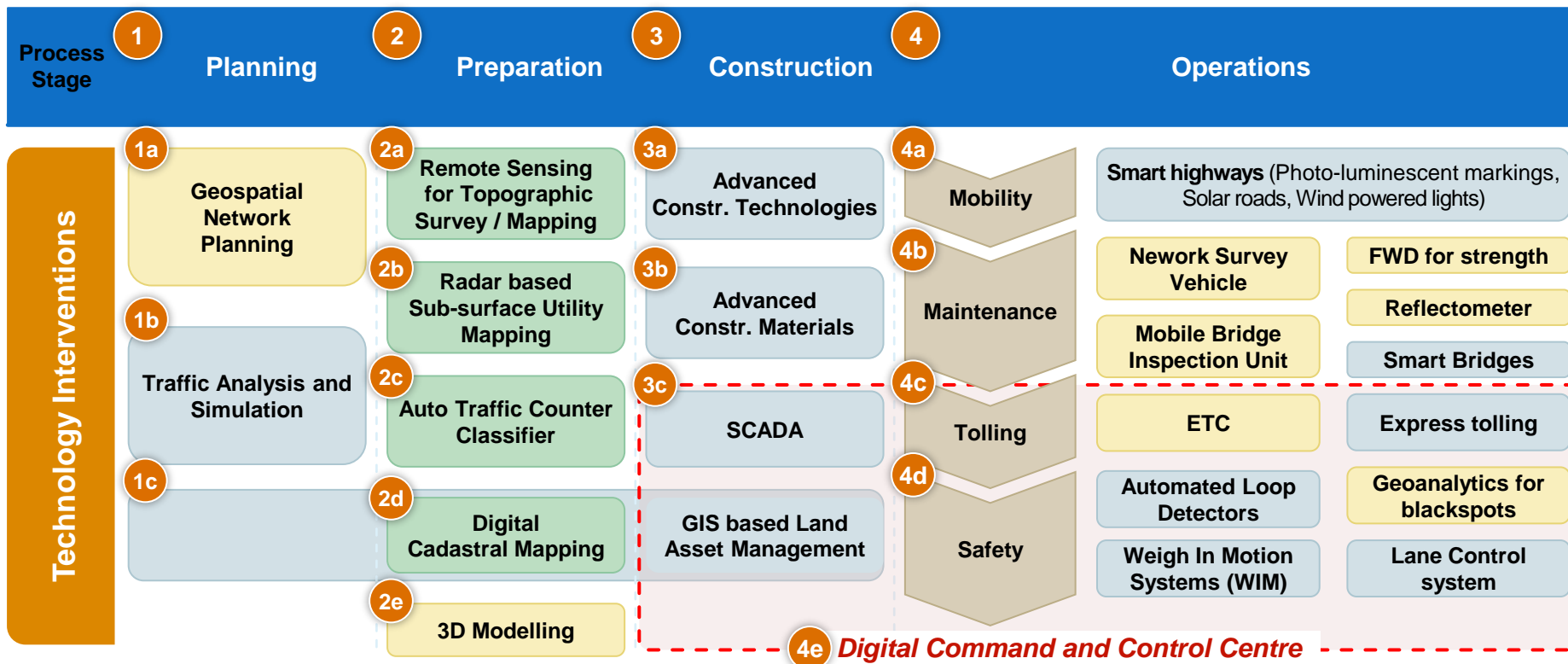
NHAI's examples of road designing and cost savings

Case study – Best route selection



Technology deployed globally across Highway Value Chain

NHA has already begun to adopt certain technology interventions



 Already implemented

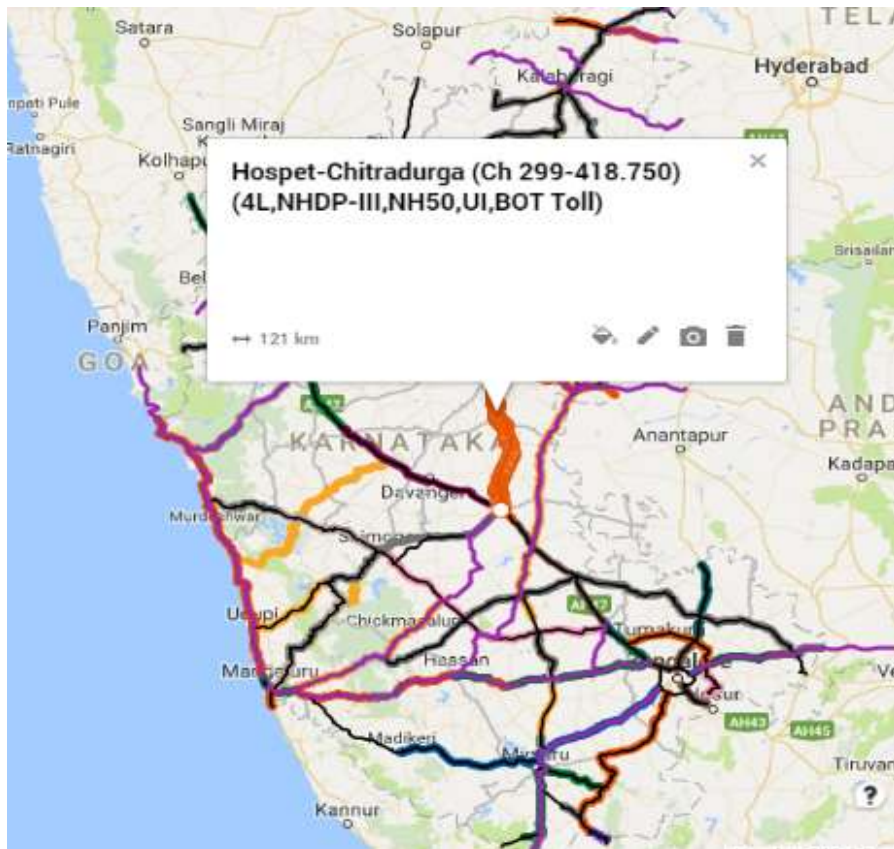
 Under implementation

 To be implemented

1a GIS based planning: For holistic identification of lane augmentation requirements



Screenshot of GIS based solution used for augmentation study



Methodology followed to identify lane augmentation requirements

1. GIS mapping of NH and IP network, including projects currently underway

2. Superimposing traffic data with lane configuration

- Traffic data collected from traffic surveys
- TS points plotted on each stretch

3. Identifying stretches for augmentation

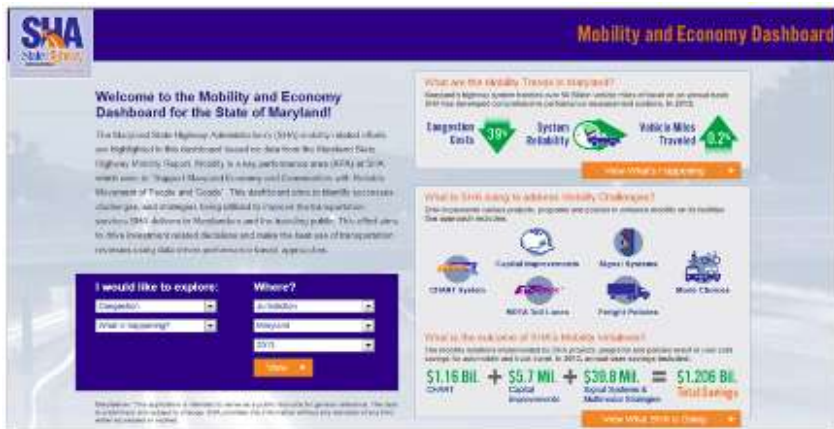
- <10,000- No augmentation
- 10k- 40k- 4L
- 40k-80k- 6L
- >80k- 8L or parallel road

4. Prioritizing the lane augmentation stretches

- Budget
- Criticality for logistics efficiency of corridor
- Existing level of congestion / black spots
- ...

Under development for MoRTH, NHA and other impl. Agencies through PMIS

1a GIS solution extensively being used for planning and decision making

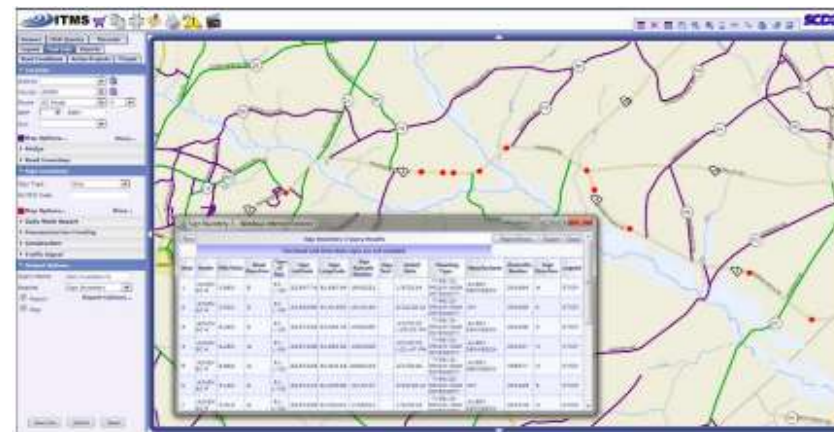


GIS is primary data management system for planning

- Not used standalone but integrated to several additional tools

GIS is helping in performance driven approach to planning

- Monitoring mobility performance
- Identifying freight performance metrics



2 GIS based tools used by SC DOT

- ITMS (Integrated Transportation Management System) for asset management
- Project Management support in geospatial database

GIS offers the ability to layer different types of information

GIS based solution integrated with various types of systems for planning, monitoring & management

1c GIS based Land Asset Mgmt.: Parcel level planning and tracking of land acquisition



GIS based system for land asset management-Key features



- Visual representation of asset details
- Integration with cadastral maps and land records
- Dynamic land status updation
- Integration with Google/Bing Maps

Key Features

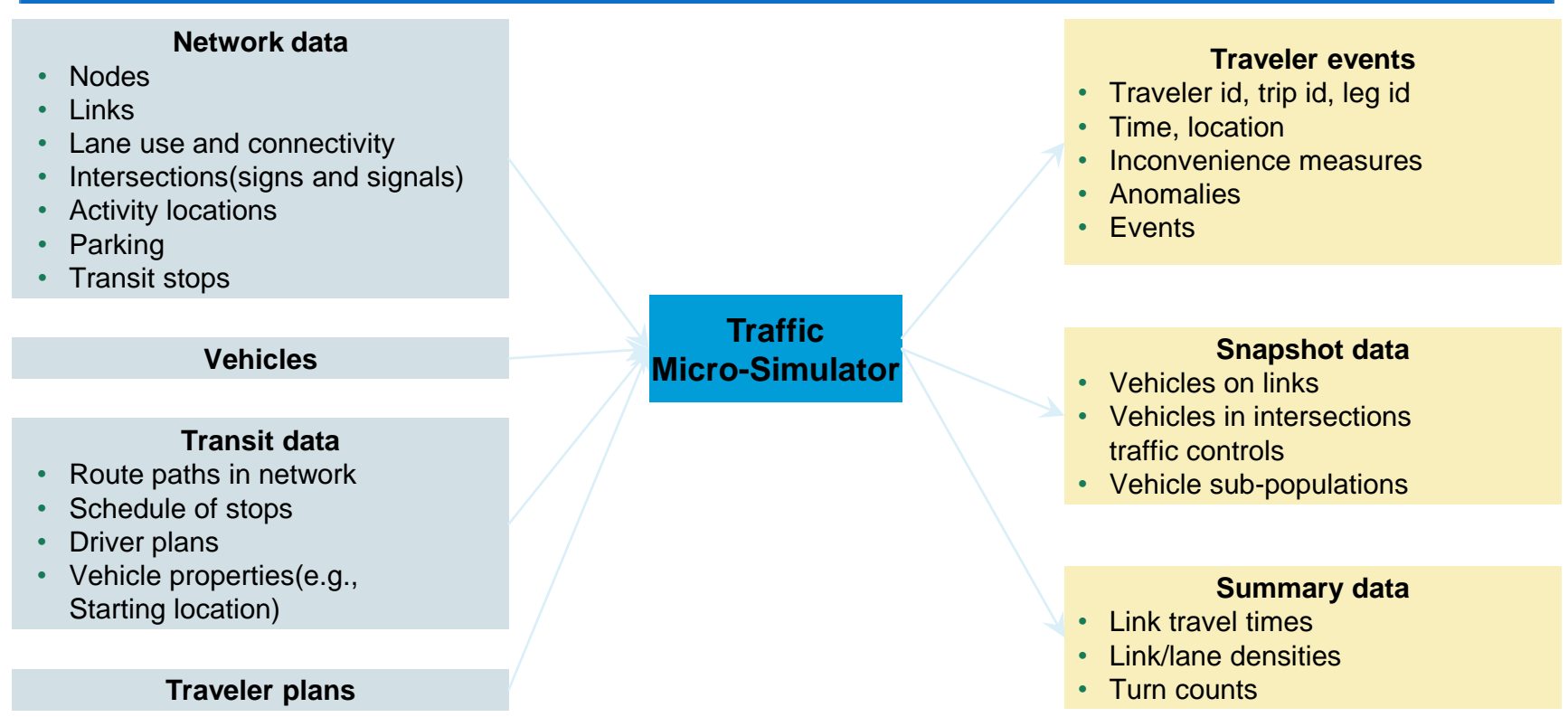
Benefits of an online Land Asset Management System

- a Improved Planning**
 - Ready access to Right of Way availability / vacant land details
 - Easy determination of land acquisition costs and consequent budgeting
 - Effective alignment planning to optimize costs
- b Improved Monitoring**
 - Parcel level monitoring of 3A, 3D, 3G, 3H and disbursement status
- c Dispute Resolution**
 - Ready availability of historical ownership records and sale/transfer transactions
 - Automate detection of illegal settlements
- d Better Asset management**
 - Efficient identification and implementation of monetization / revenue opportunities

TRANSIMS: Micro simulation for conducting regional transportation system analyses



Transportation Analysis and Simulation System



- Integrated tools to conduct transportation system analyses based on cellular automata¹ microsimulator
- Models individual travelers and their multi-modal transportation
- Represents time consistently and continuously, as well as detailed persons and households

Note: (1) A cellular automaton consists of a regular grid of *cells*, each in one of a finite number of *states*, such as *on* and *off* (in contrast to a coupled map lattice). The grid can be in any finite number of dimensions.

Sub-surface utility mapping: Ground Penetrating Radar (GPR) being used in DPR Preparation



Ground penetrating radar (GPR)



Description of system

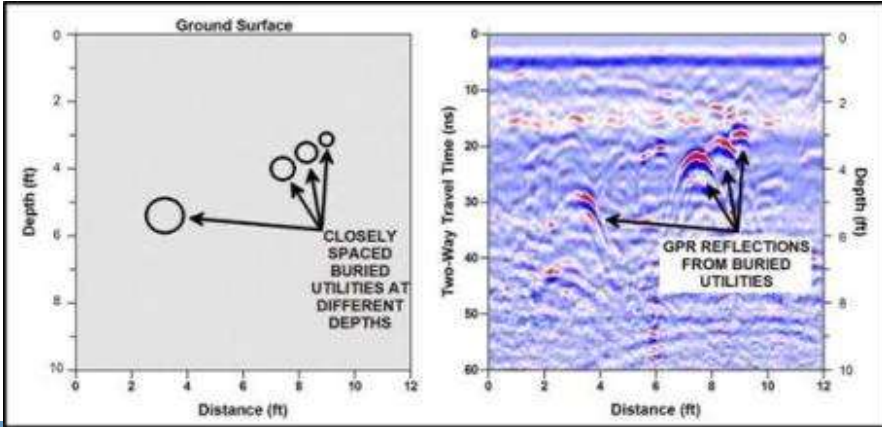
- High frequency radio waves emitted into ground
- Reflected signals returned to receiver
- Graphic display to view waveforms digitally
- Used for mapping of underground cables and pipes

Benefits

- Rapid ground coverage – Towed by hand/ vehicle
- Can accurately determine location/depth (x,y,z coordinate)
- Instant graphic display enables on-site interpretation
- High-resolution coverage of the survey area
- Useful for detecting even small objects
- Induction locator can be used to further differentiate electrical vs. non-electrical utility

Limitations

- Signal may be scattered by boulders etc.
- Data acquisition maybe slow over hilly / difficult terrain
- Depth of penetration dependent on soil conditions



2d Digital Cadastral Maps: DPR consultants mandated to digitize land cadastral maps

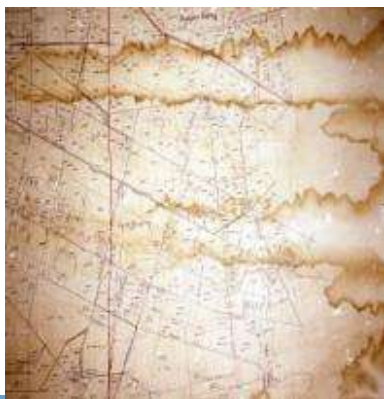


Procure revenue map from local authorities

Procure revenue map from local authorities

Map typically on paper/ clothes

Some states already have digital maps (E.g., WB, KN)



Trace and scan map using scanner

Scan revenue map using flat bed/ roller type scanner

In case map on cloth/ unclear, trace map first and then scan

Establish control points on map



Digitise map using software-AutoCAD etc

Digitize map using any raster to vector conversion software such as AutoCAD, R2V

Cross check control points on map with ground conditions



Superimpose alignment on map

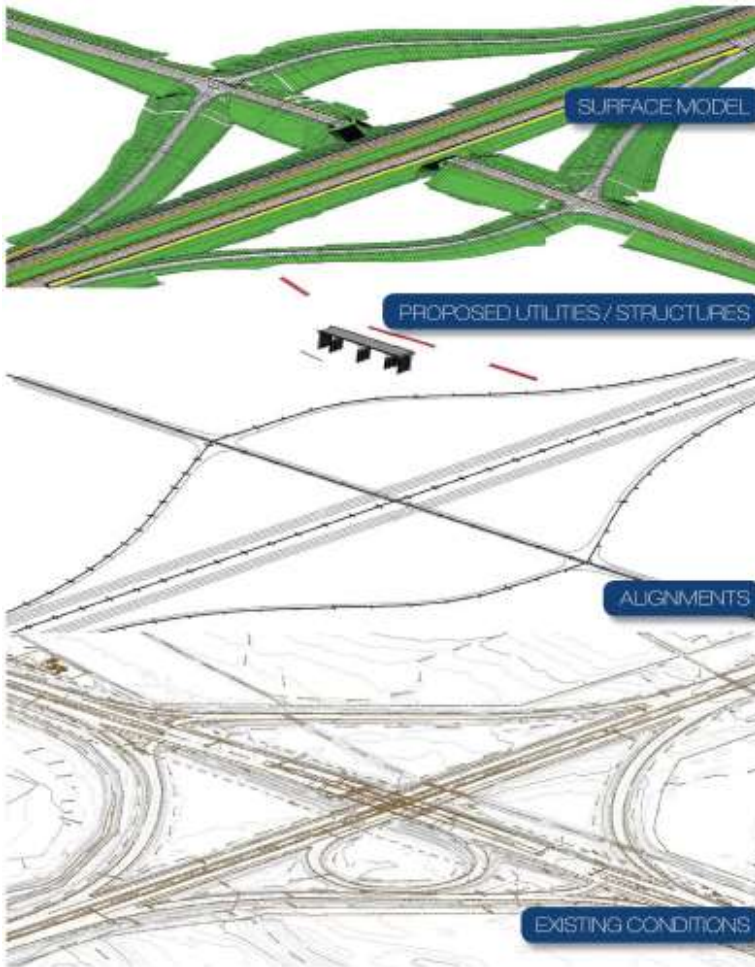
Superimpose alignment on digital cadastral map to find out land/ survey numbers to be acquired



2e 3D Engineering models: Highway alignment and design can now be done in 3D



Four elements of 3D engineering



Surface models

Comprehensive 3D model of existing site including:

- topographic survey data
- digital terrain models
- surface and subsurface layers
- utility information

Proposed utilities and structures

Horizontal alignment and vertical profile of roadway

Road alignments

Grading and pavement surface model of proposed project- e.g. top of pavement, subgrade, subbase, topsoil etc.

Existing conditions

3D models of proposed structures (bridges, culverts, RE walls) and utilities (drainage, power lines, traffic signals, street lights, amenities etc.

3D engineered models can be further enhanced with time (4D) and cost (5D) information

3c SCADA (Supervisory Control and Data Acquisition) system can be used for quality control of road construction



Monitoring & control system

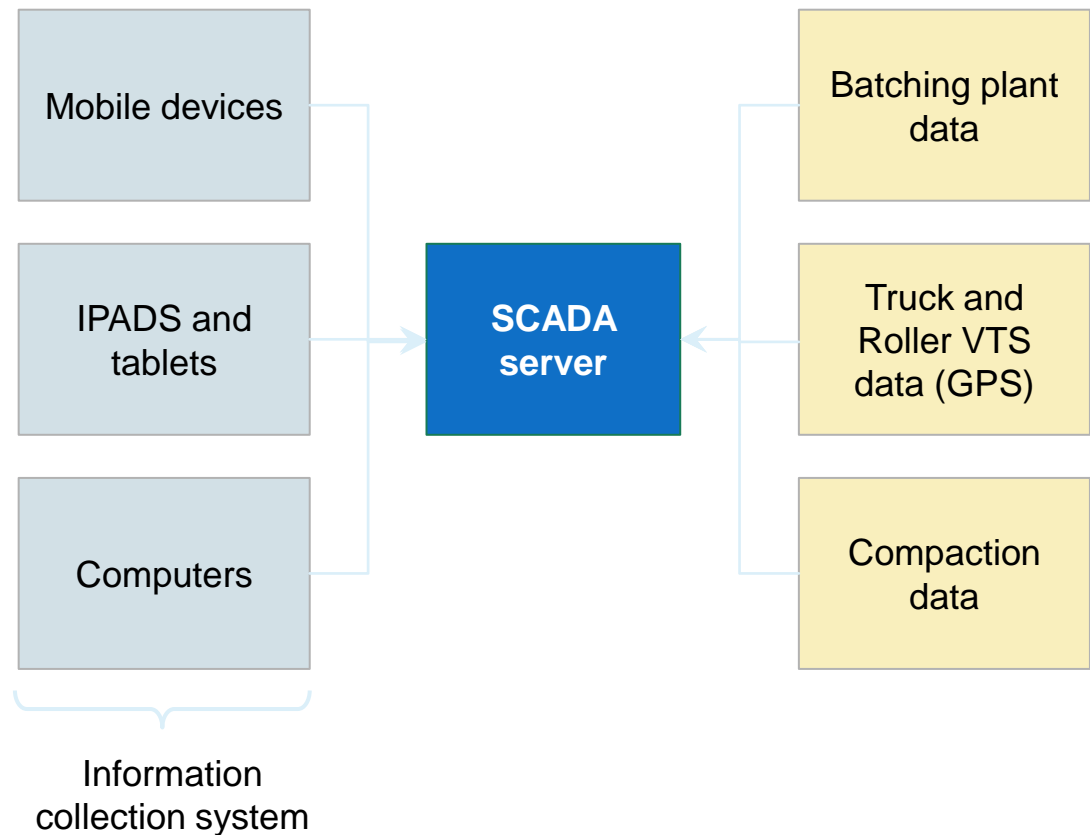
- SCADA system is an assemblage of computer and communications equipment
- Designed to work together for controlling a commercial process

In road construction, SCADA system with sensors remotely monitors large no of parameters

- Covers entire process starting from production of BC to levelling of pavement
- System can give a **warning beforehand of equipment failure**

SCADA is modern day's information technology tool for quality construction of roads

SCADA architecture for road works



4a Smart highways: Development of new innovative solutions underway (I/II)



Concrete healing bacteria



Researches developed bacteria that when exposed to water produce limestone which seals cracks in concrete

- Currently double the price than normal concrete
- Bacteria able to survive for up to a staggering 200 years without oxygen or food.

Photo-luminescent road markings



Photo-luminising powder for road markings: charge during the day & emit green glow at night

- Temperature-sensitive paint to create giant snow flake-shaped warning signs on the roads to indicate icy conditions
- Currently pilot project in the Netherlands under ways

Energy transmitting roads



South Korea utilizing electric cables embedded in asphalt to power e-vehicles

- No more large batteries, no more stops to recharge, and messy overhead trolley
- Cables produce magnetic fields, which receiving devices in the vehicles' undersides pick up & convert into electricity

4a Smart highways: Development of new innovative solutions underway (II/II)



Solar cells embedded roads



| Surface Features | Solar Roads | Concrete | Asphalt |
|----------------------------|-------------|----------|---------|
| Flat place to drive | ✓ | ✓ | ✓ |
| Provides traction | ✓ | ✓ | ✓ |
| Doesnt soften at high temp | ✓ | ✓ | |
| Intelligent | ✓ | | |
| LED lights for signage | ✓ | | |
| Charge EVs | ✓ | | |
| Independent Energy | ✓ | | |

Interactive wind powered lights

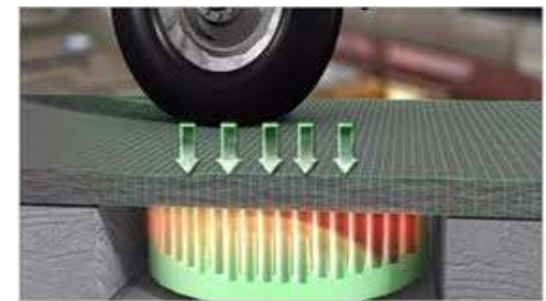


Road lights that only light up as cars pass by the area by using pinwheels to generate electricity

Pinwheel generators will be set up along the car's path at the roadside, to continuously light up paths as cars drive through

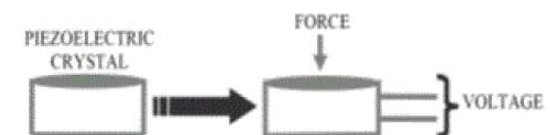
Pilot in Netherlands

Piezoelectric Energy roads



Piezoelectric devices can be embedded in roads to capture the energy created from passing traffic

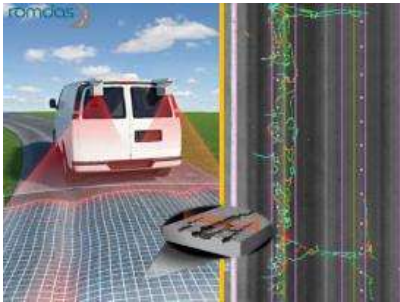
Integrates with existing infrastructure requiring no additional real estate



4b Equipment based road inspection plays key role in assessing road conditions and identifying maintenance needs



1 Network Survey Vehicle



- Used for measuring **surface defects** such as cracking, rutting & **roughness**
- Consists of multiple modules- laser profilometer, TPL, crack detection sys

2 Falling Weight Deflectometer



- Used for measuring **pavement strength**
- Measure vertical deflection response of a surface to an impulse load

3 Mobile Bridge Inspection Unit



- Electro-mechanical device mounted on a truck
- Provides access to hidden parts of **bridges for their proper inspection**

4 Retro reflectometer



- Used for measuring **retroreflection of road signs** and markings
- Portable hand held device

Under implementation by NHA as part of IE's scope of work in the new RFP document

4d GeoAnalytics can be used to identify "black spots" and secondary crash zones



Can leverage multiple data sources on a GIS based map

Algorithms to provide early detection/ warning of road incidents

Analysis to "hot spots" for safety and congestion



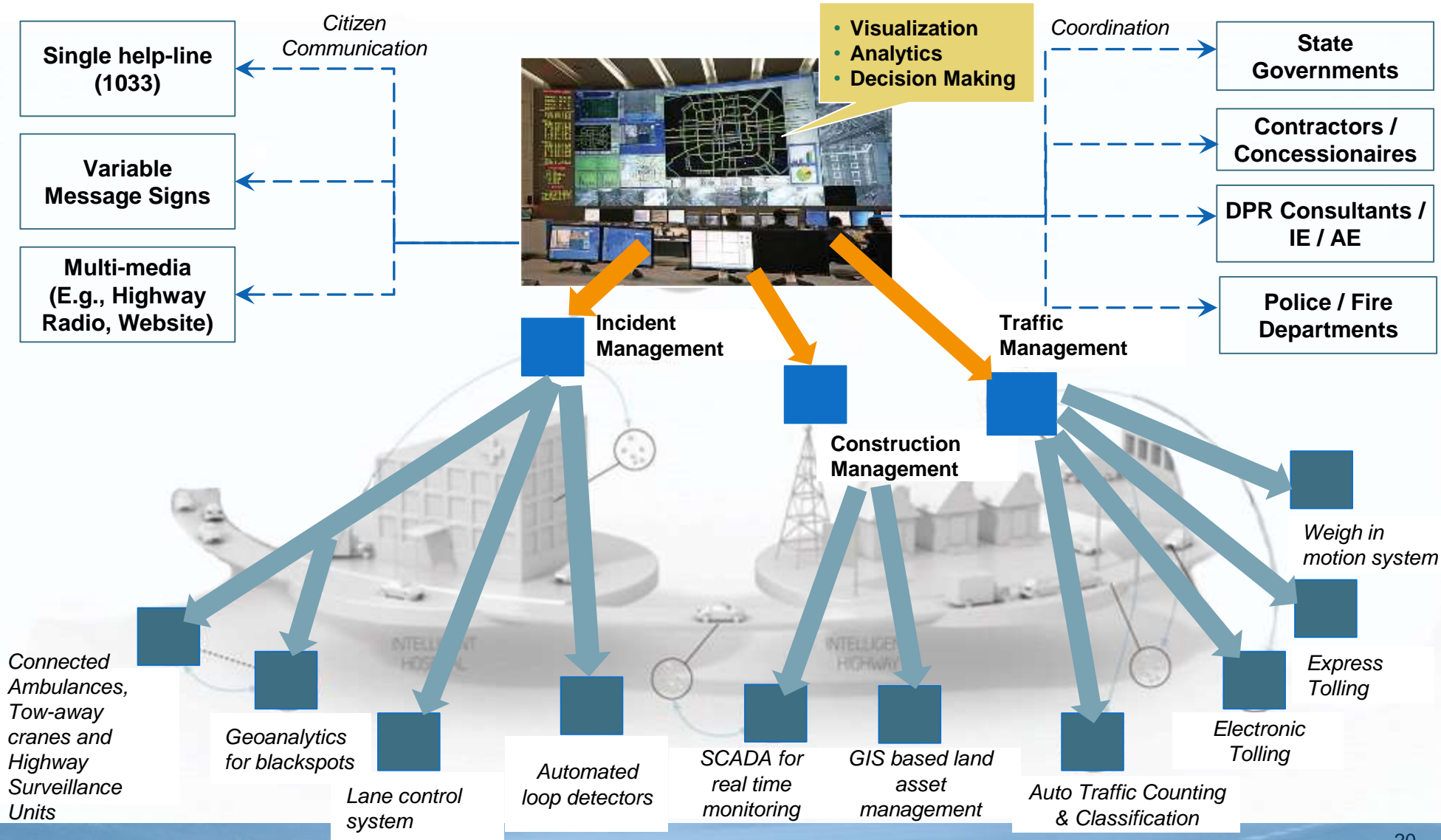
Analysis to identify secondary crash zones



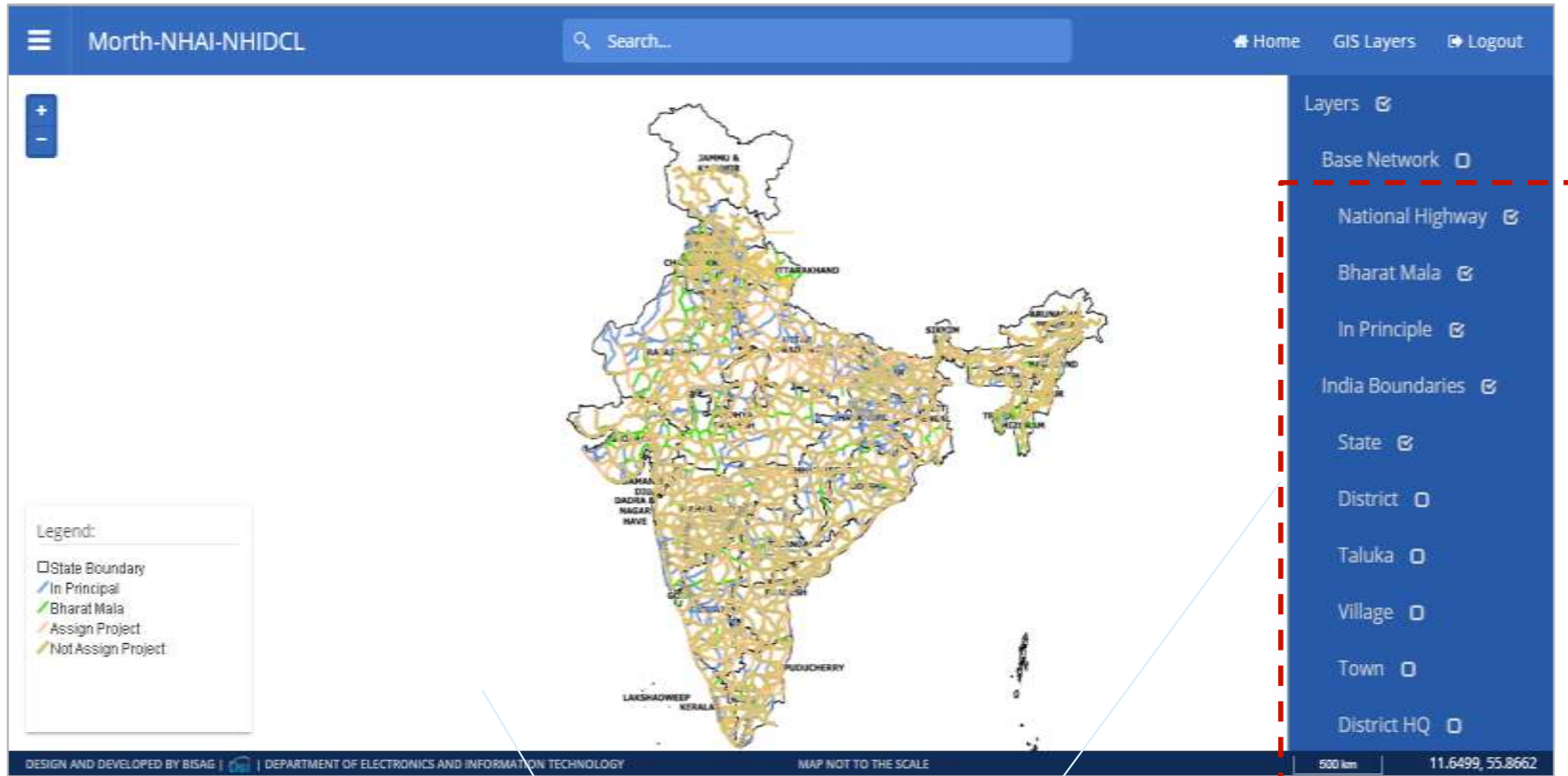
Potential applications/ insights:

- Placement of On-Road Incident Mgmt. units & Security units
- Optimal routes and zones for alternative planning
- Optimization of CCTV camera placement
- Effective use cases for on-road units

4e Digital Command & Control Centre: Nerve centre for Highway management

GIS Interface developed for easy tracking of projects



1

2

- GIS map with entire base network – National Highway, Bharat Mala, In-principle NH
- Projects and related details data mapped

Layers for customizing the visualizing on the map



Ensuring interoperability between data formats

Creating data library across organizations

Data

Ensuring backward and forward compatibility

Adapting technology as per local requirements

Technology

Creating pool of experts

Educating decision makers regarding the possibilities

Institutions

Reducing the cost of technology

Exploring new avenues of monetizing the existing information

Market



THANK YOU

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