Intelligent Transportation Systems

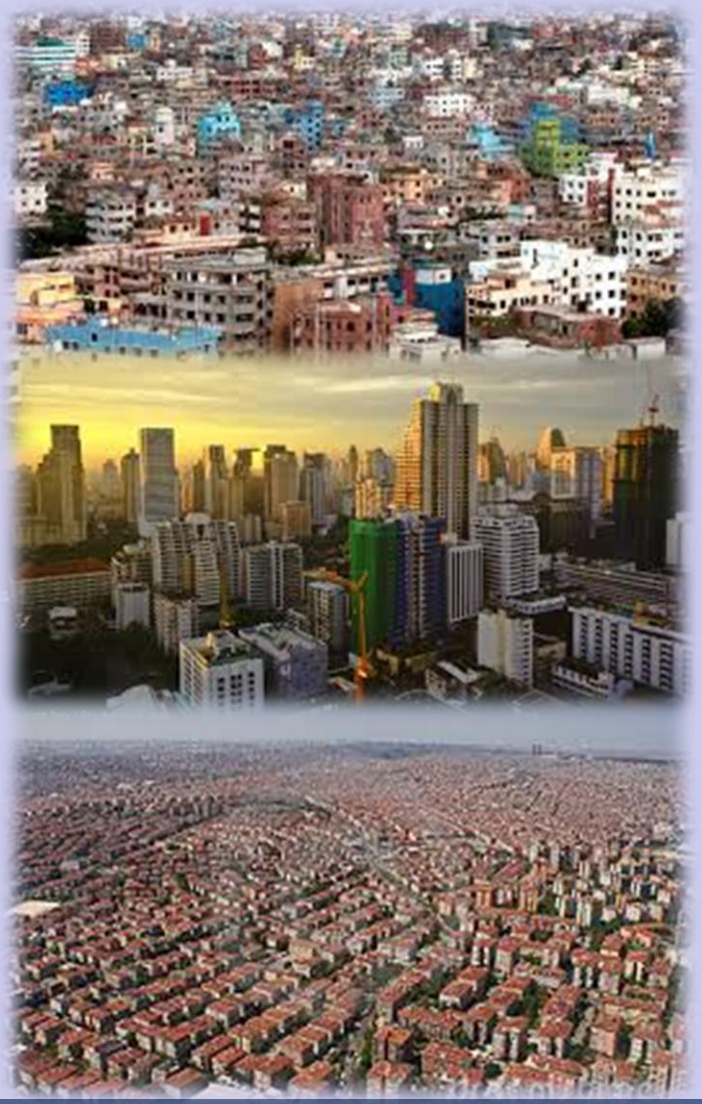
Tom Mathew

Outline

1. Urbanization
2. ITS Concepts
3. User services
4. Architecture
5. Standards
6. Evaluation
7. ~~Applications~~

Urbanization

- **Trends**
  - Rising personal income
  - Affordable vehicle
  - Growth in private vehicle
  - Low density urban sprawl



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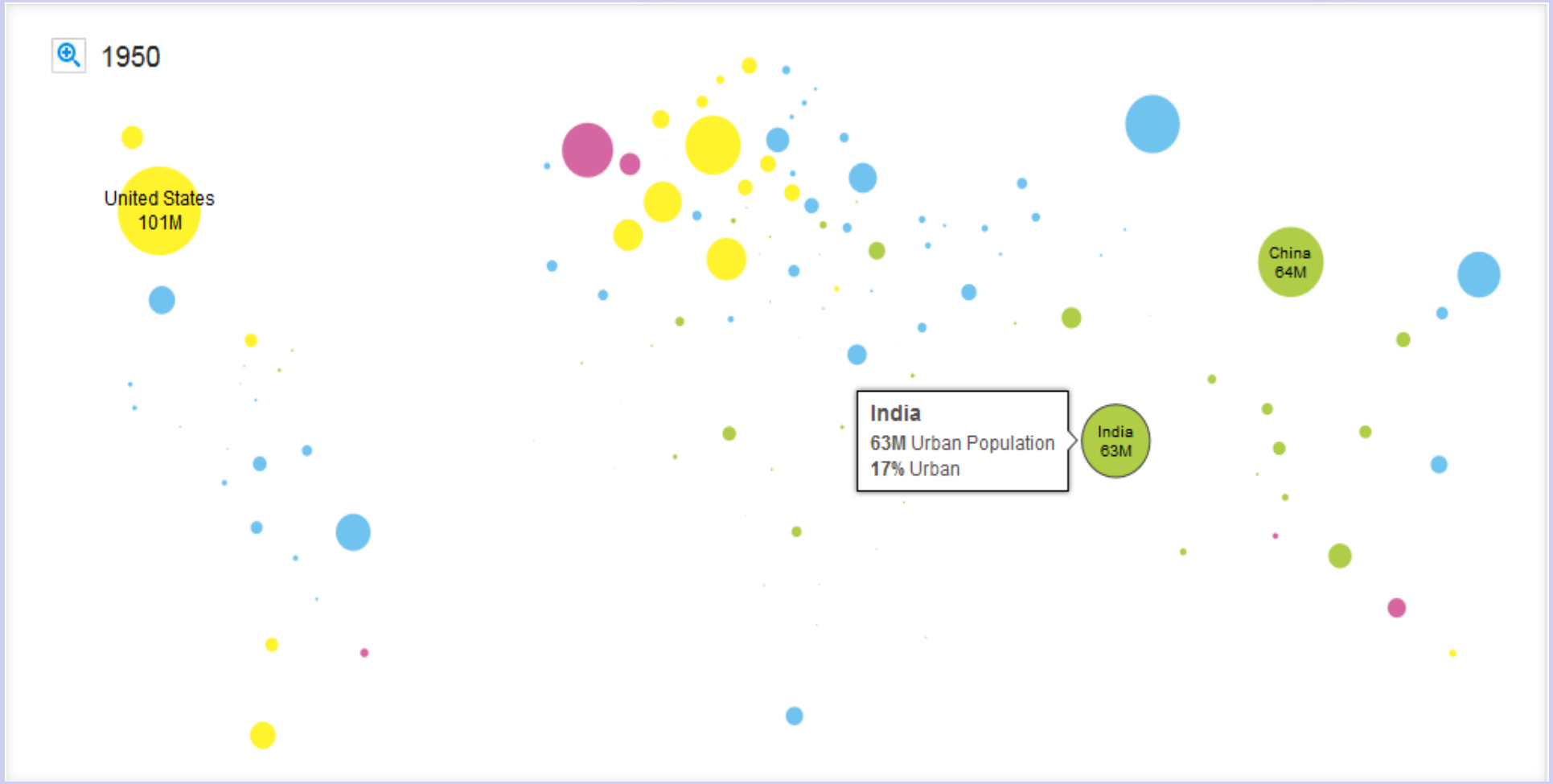

http://www.unicef.org/sowc2012/urbanmap/#

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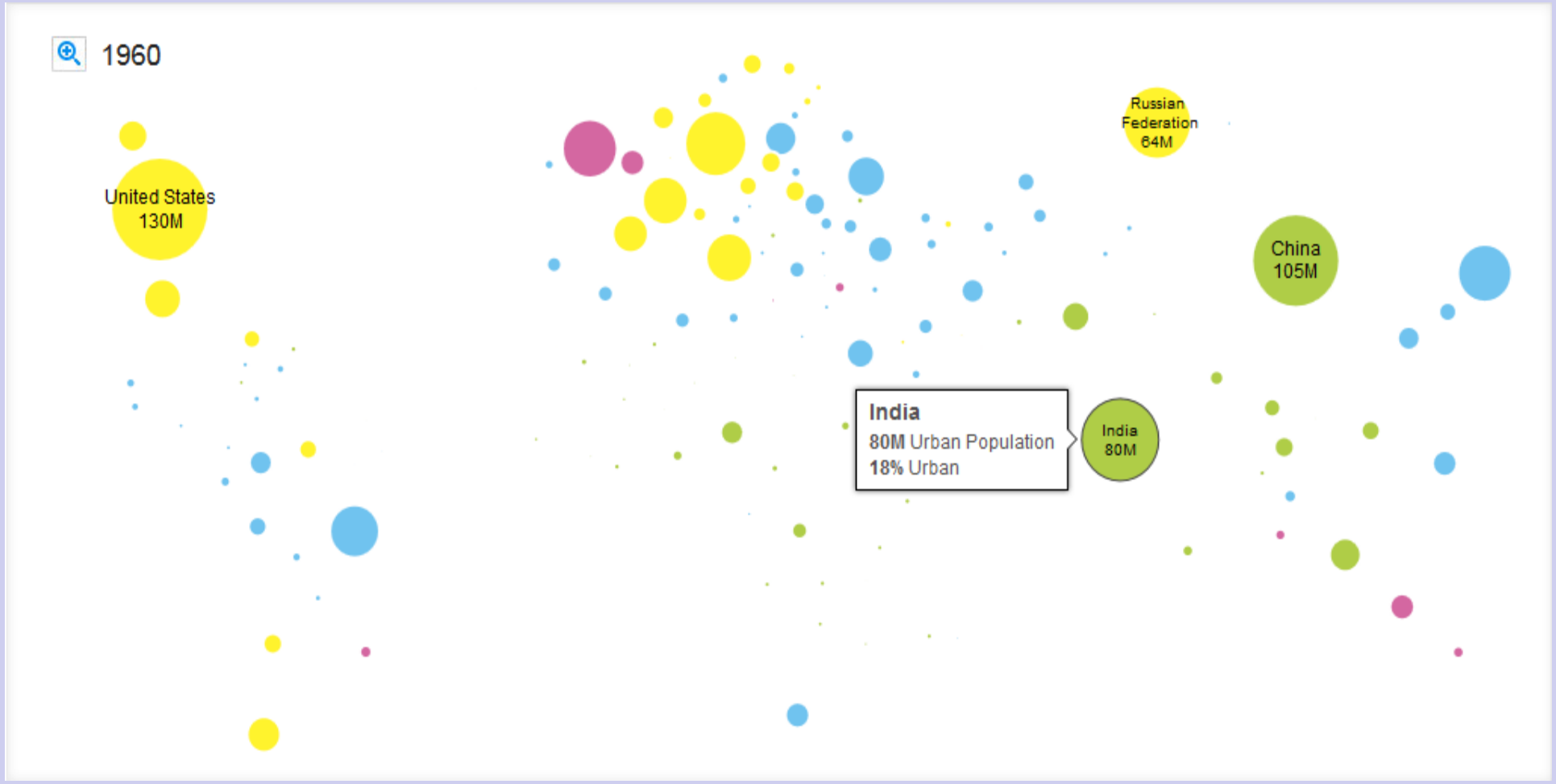

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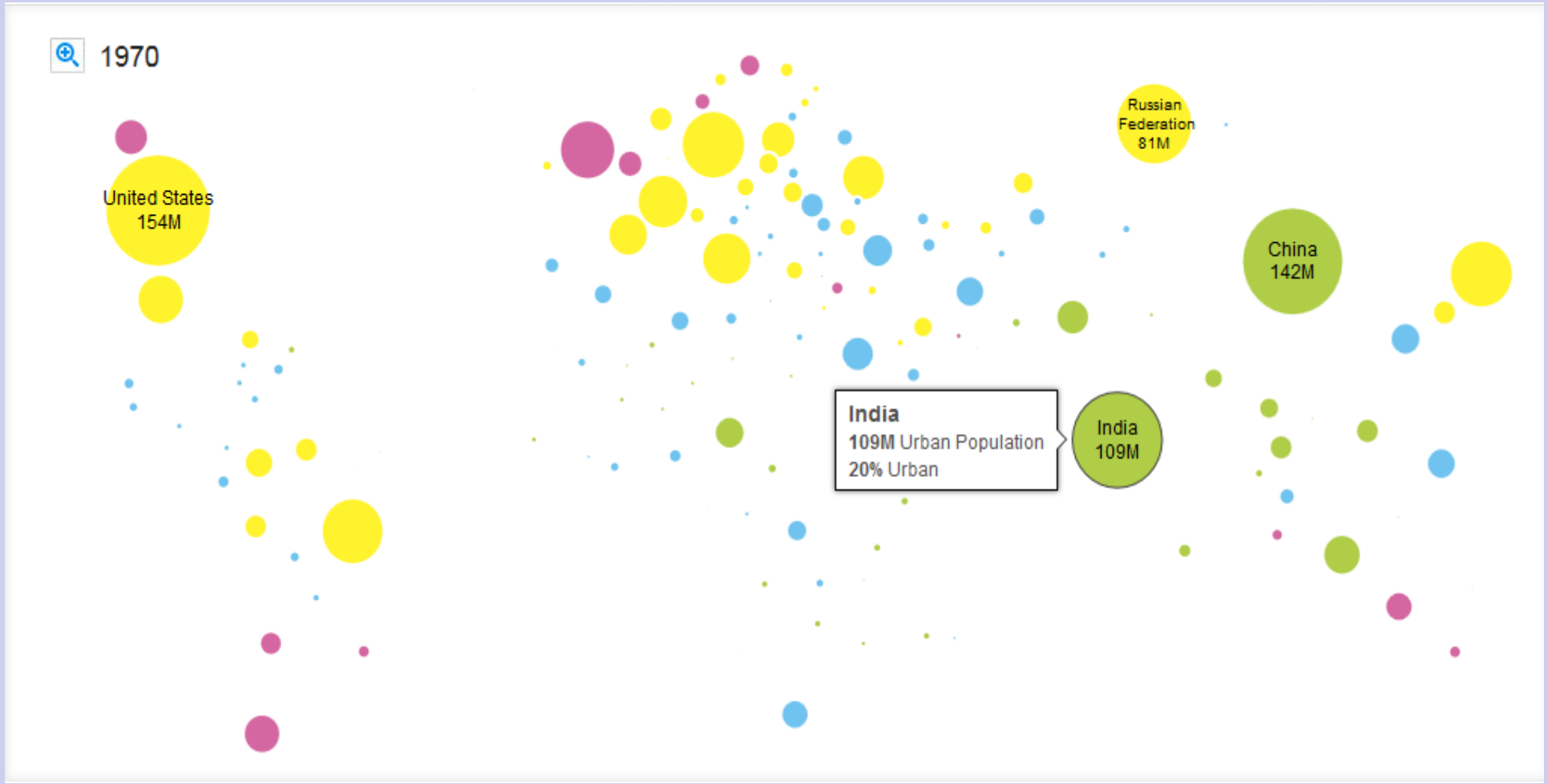

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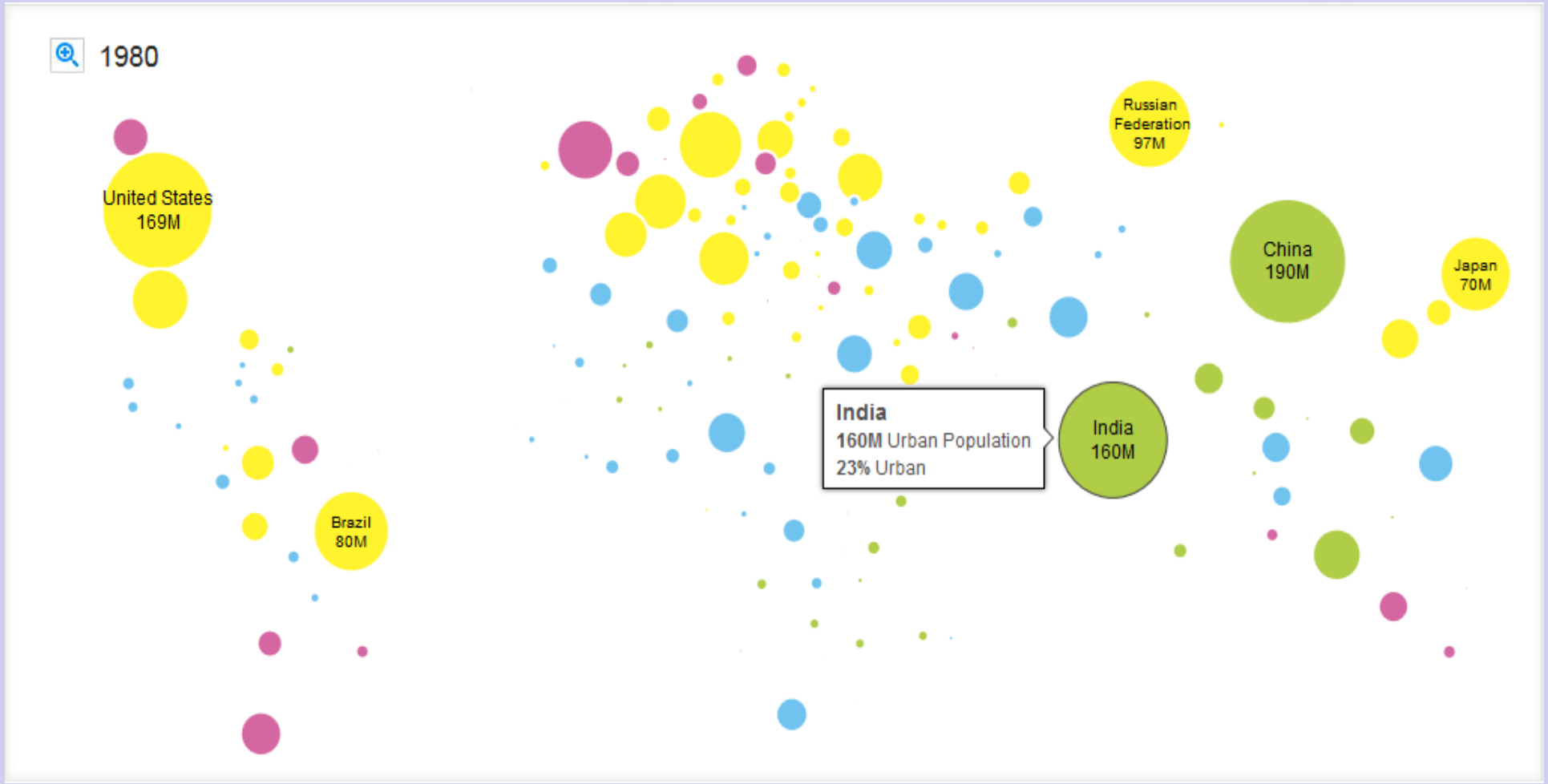

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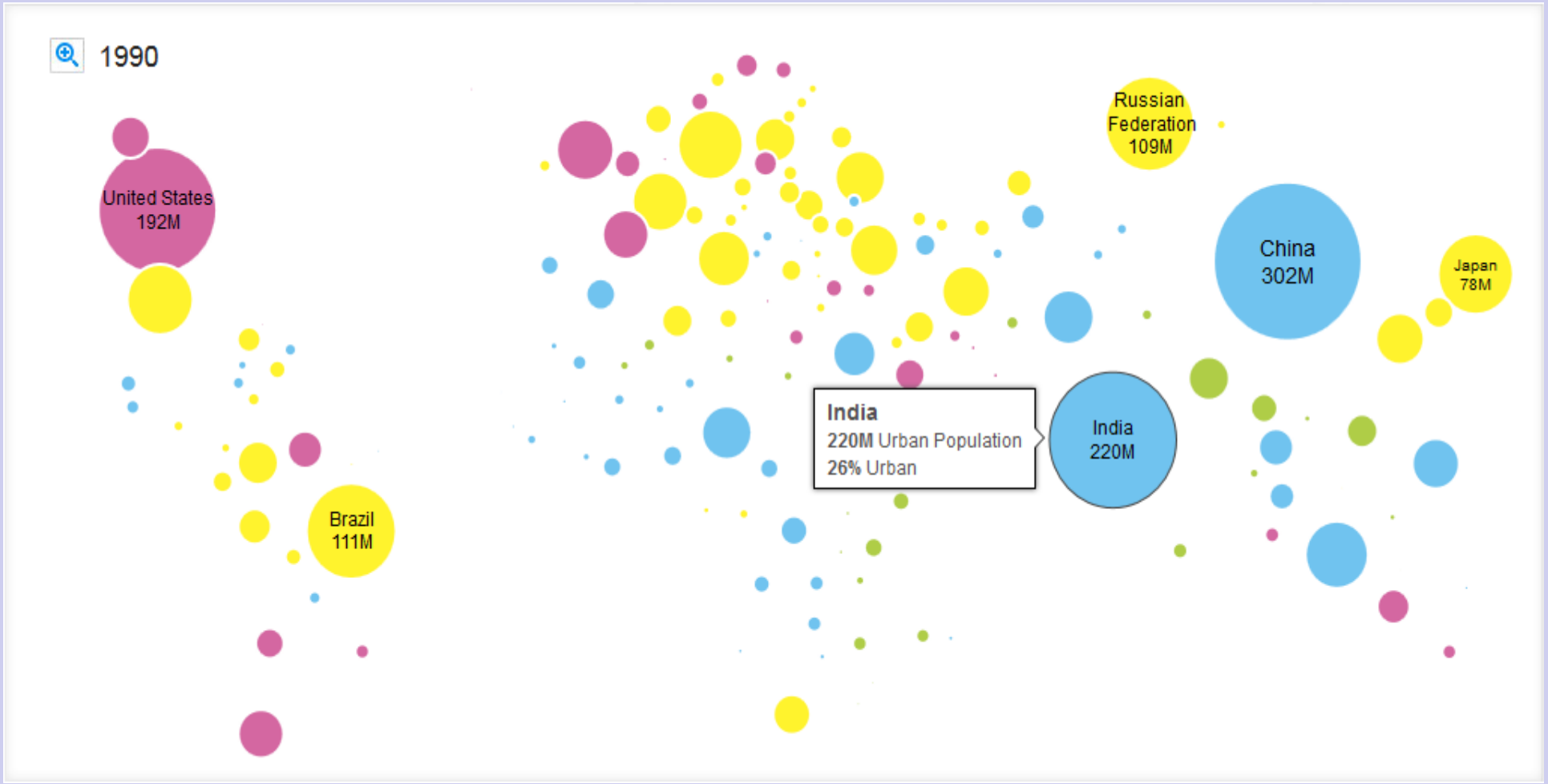

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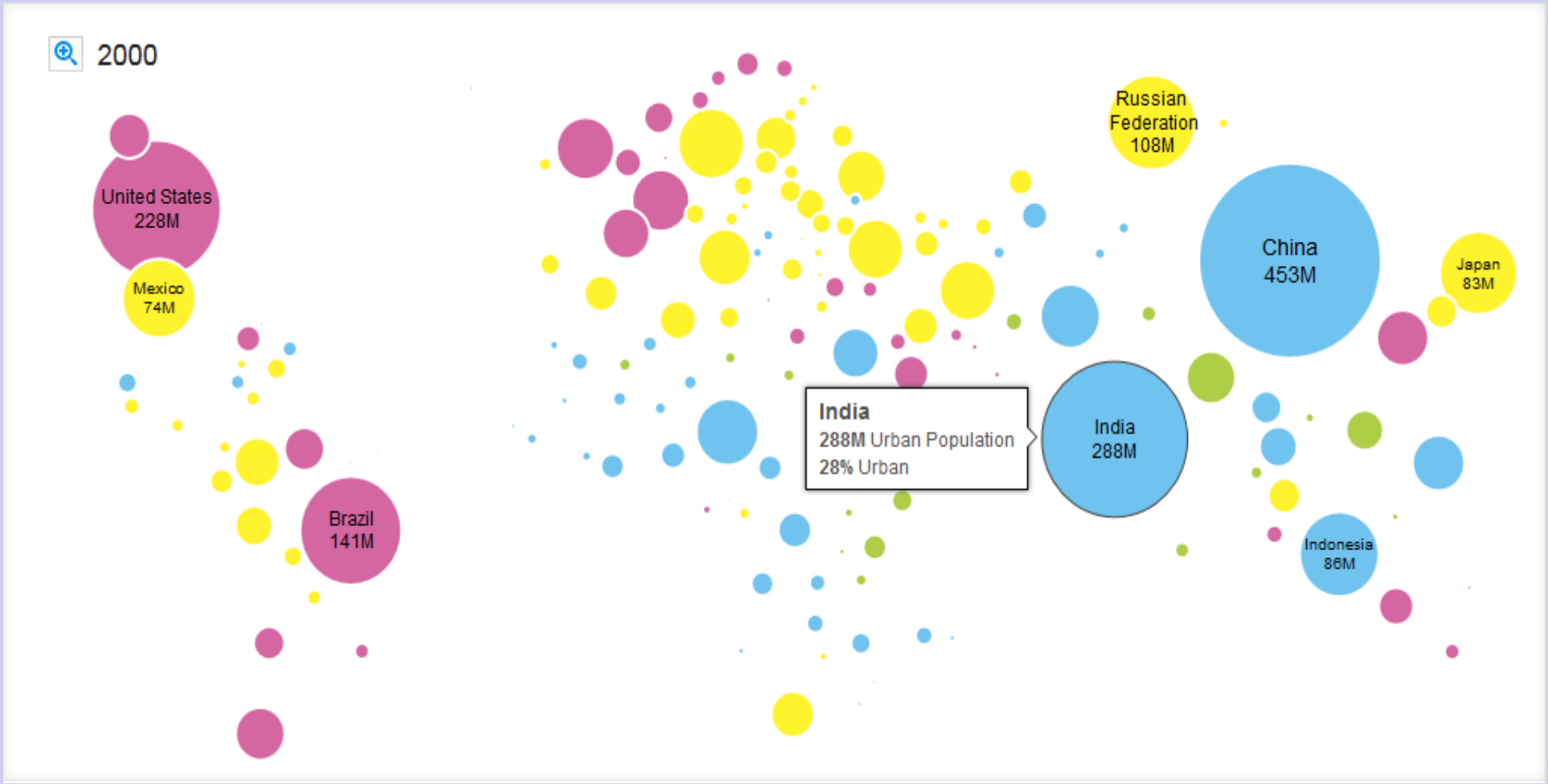

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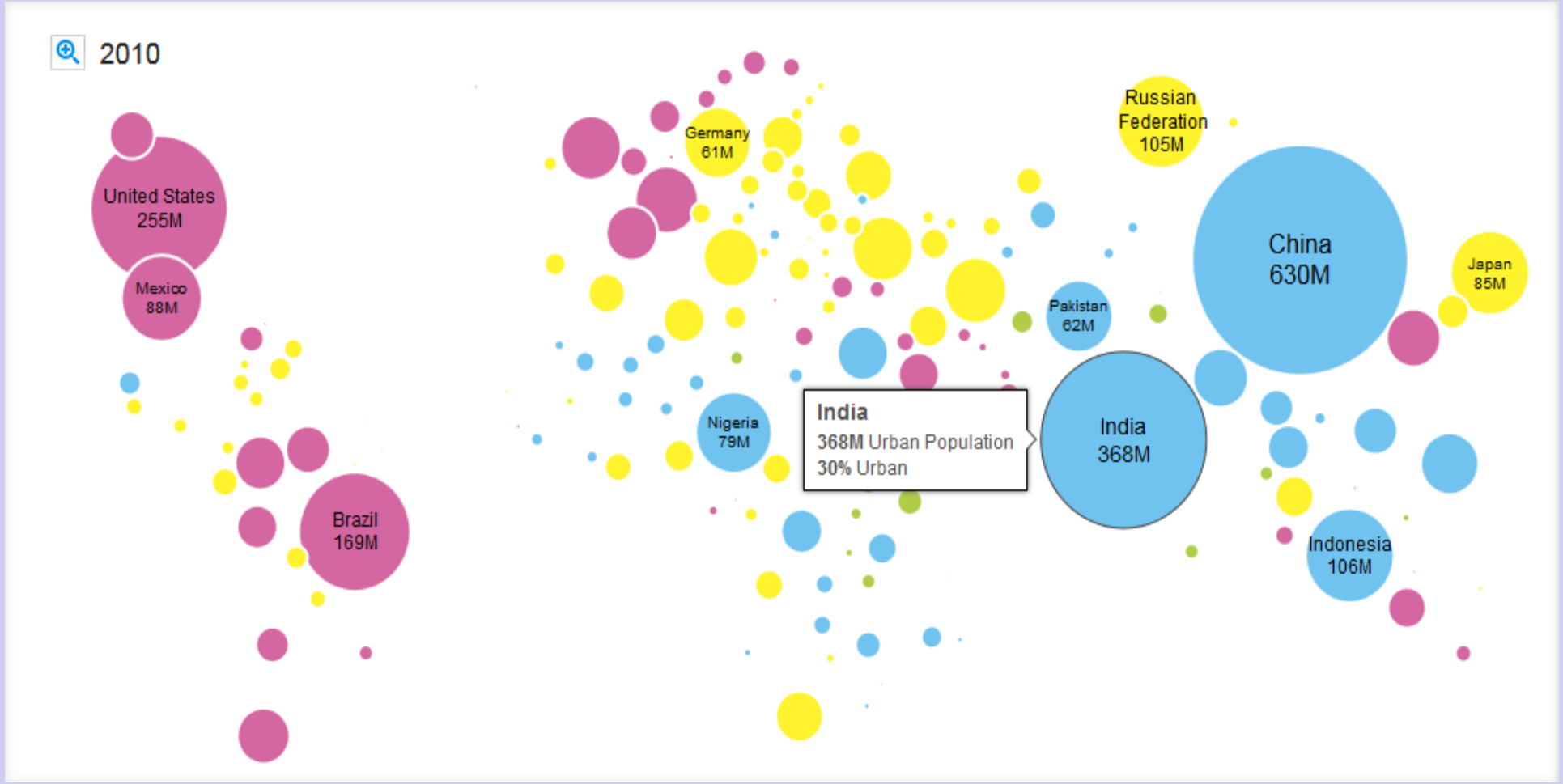

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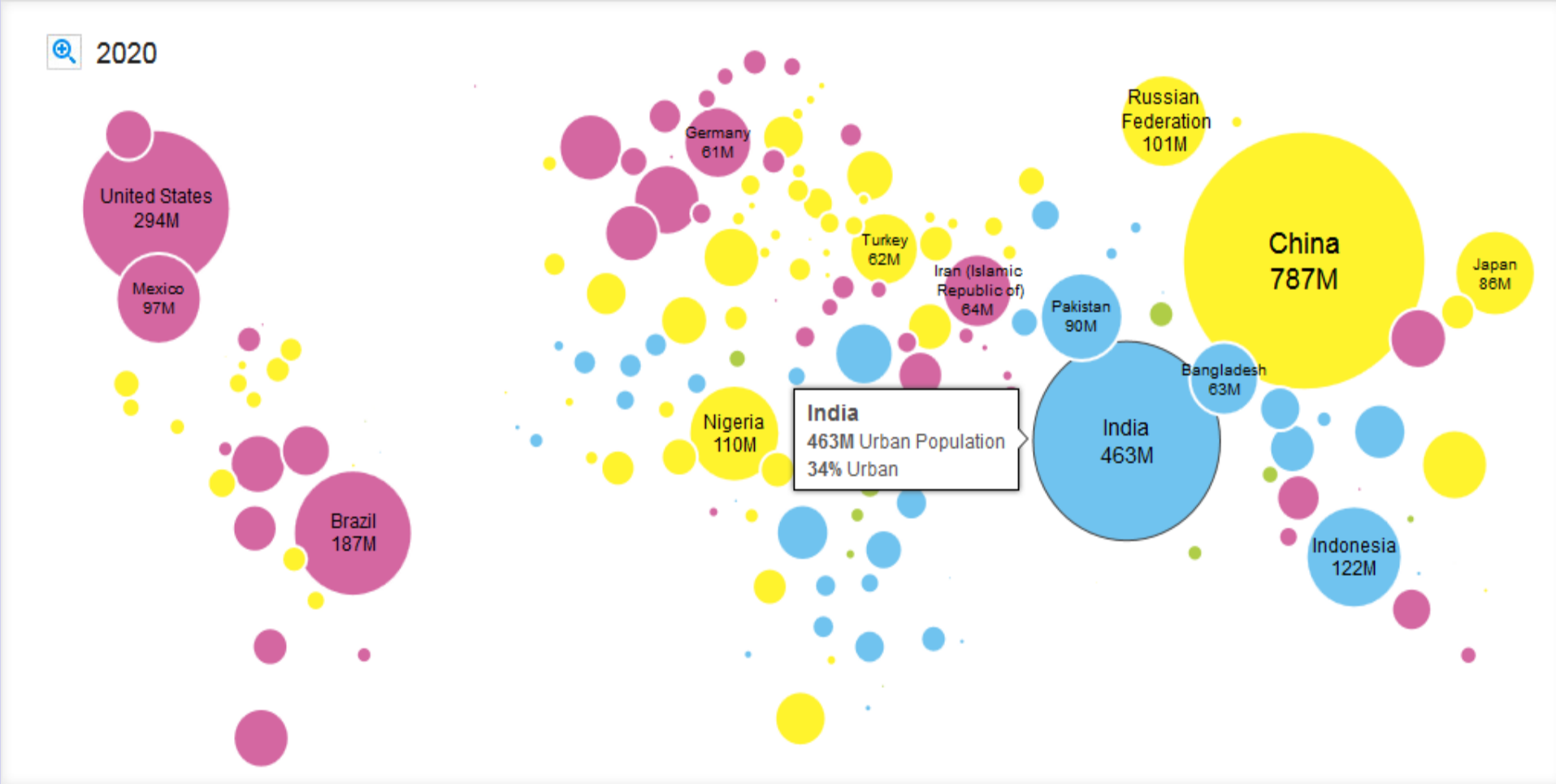

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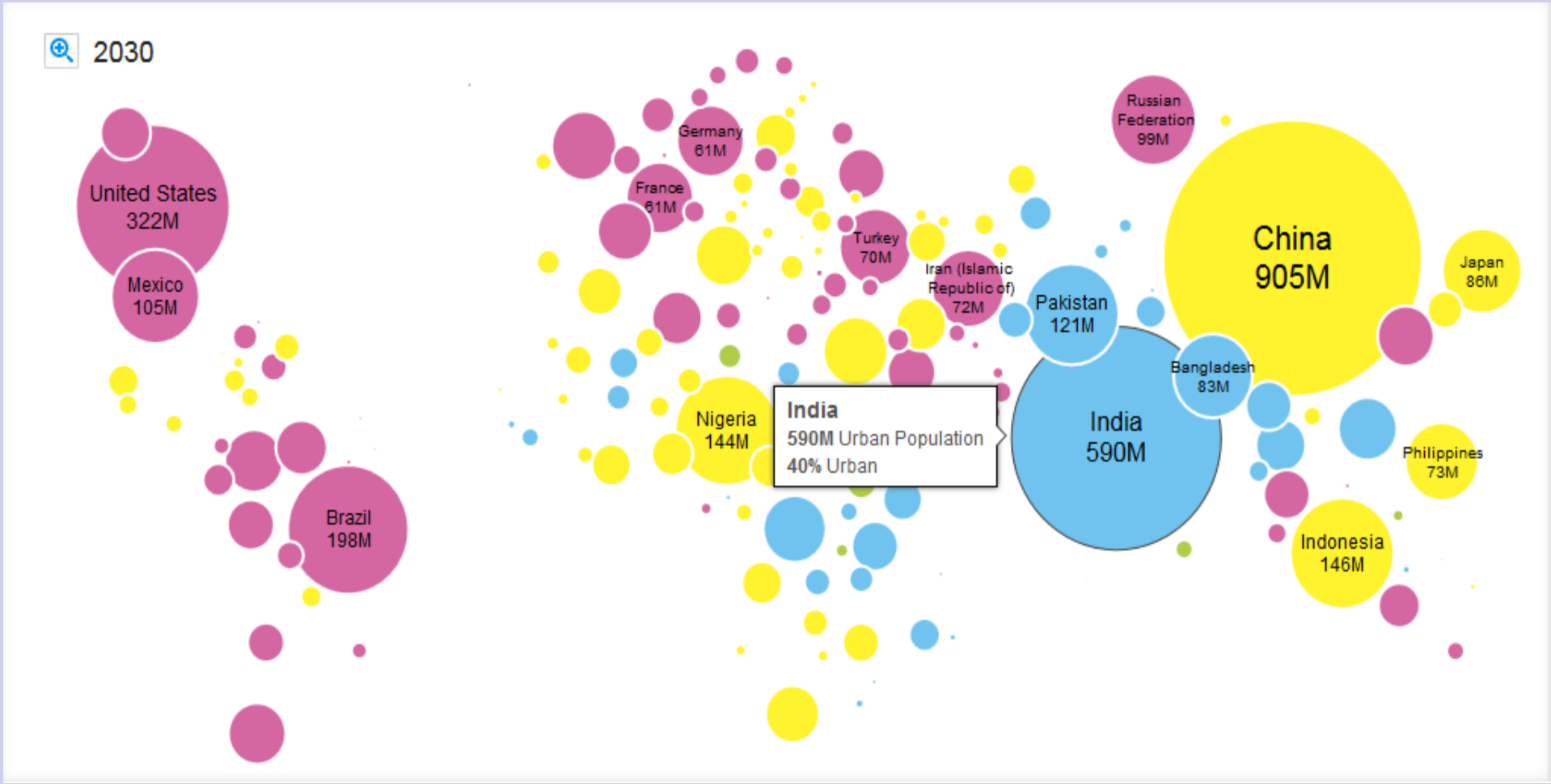

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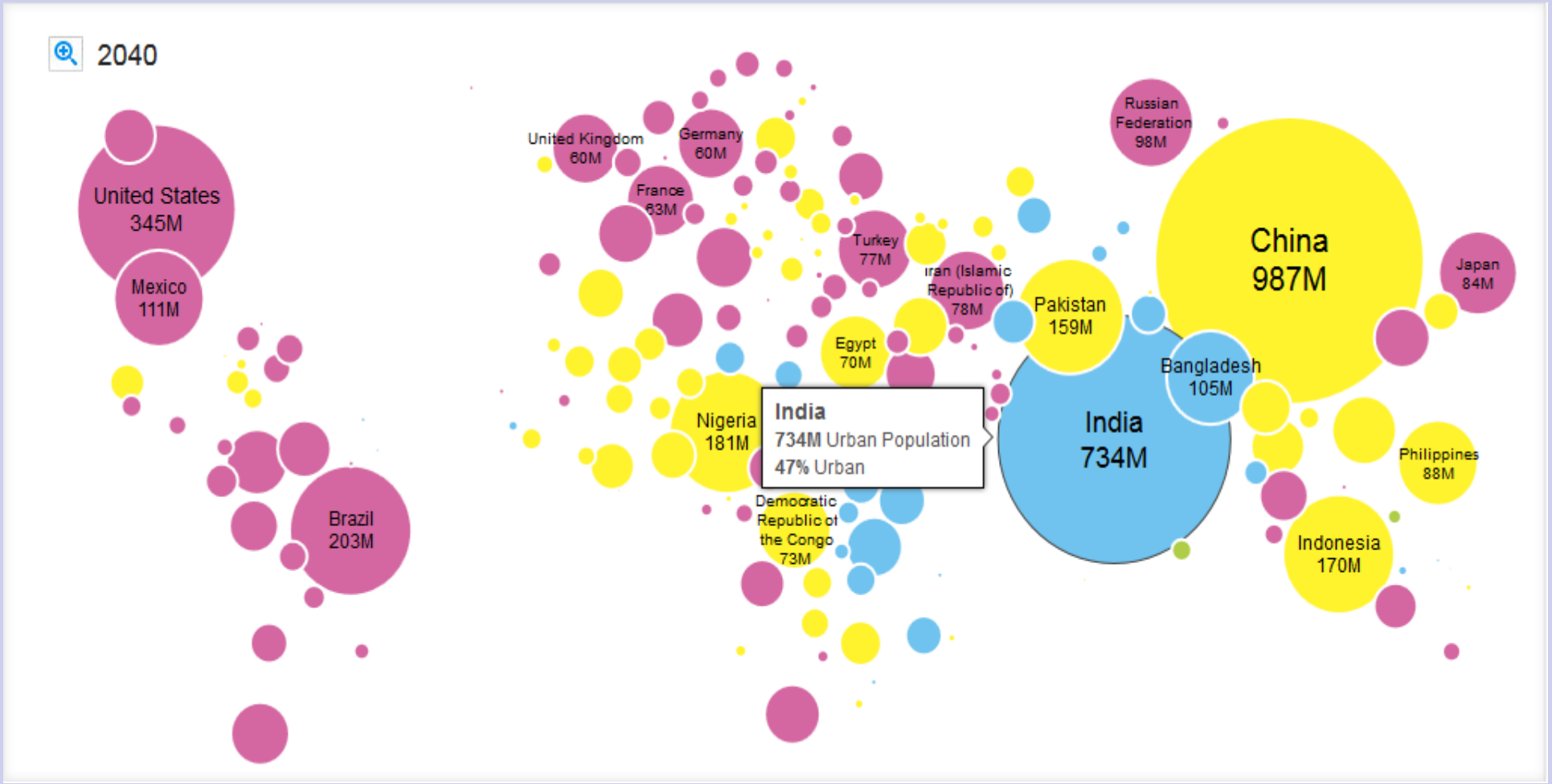

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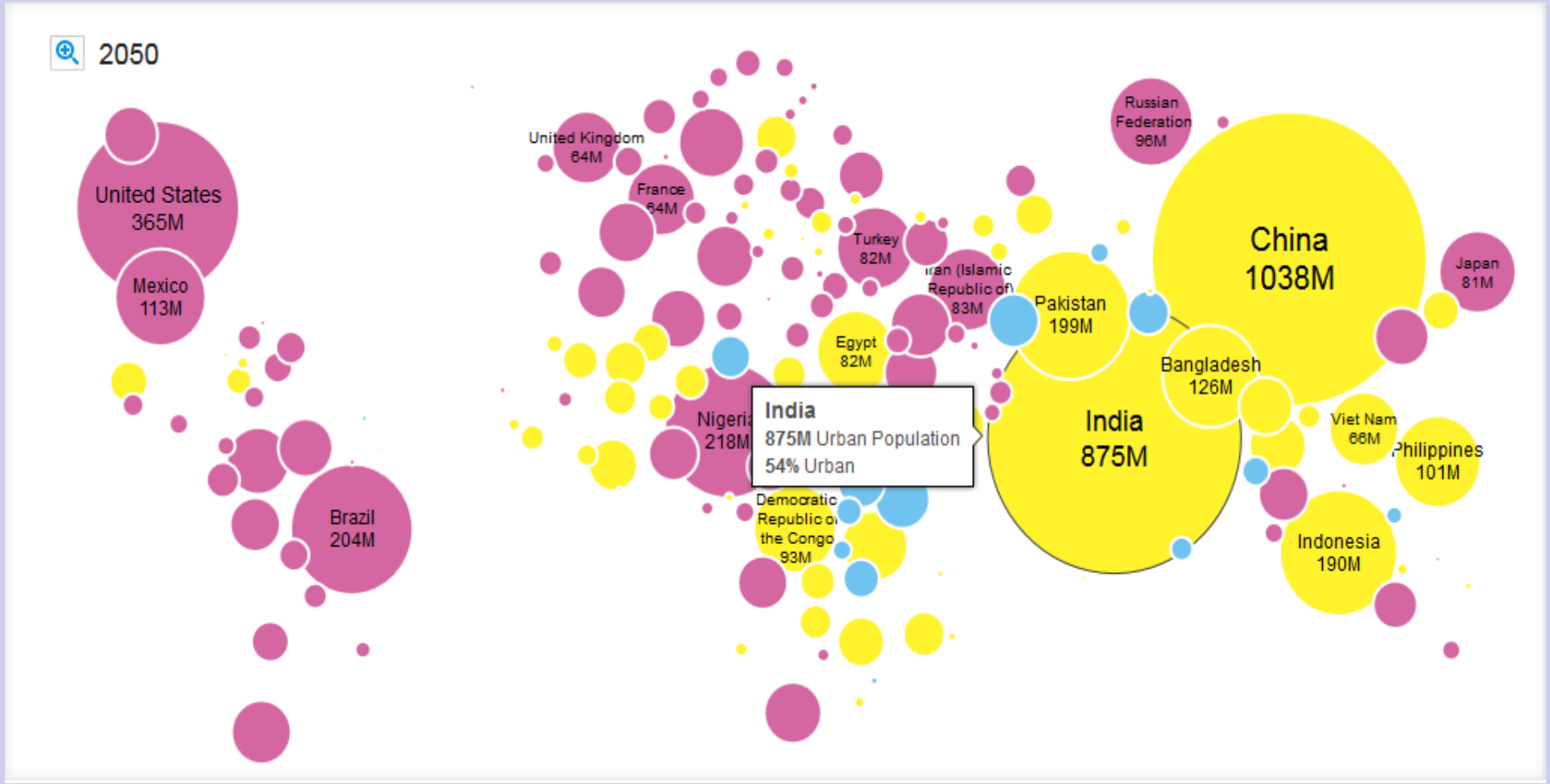

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Sustaining Growth in India through Better Urban Planning

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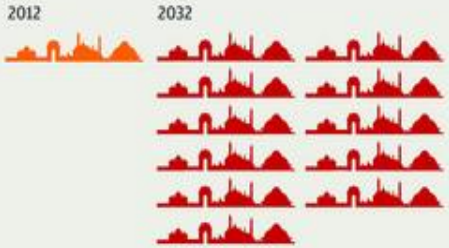


Electricity

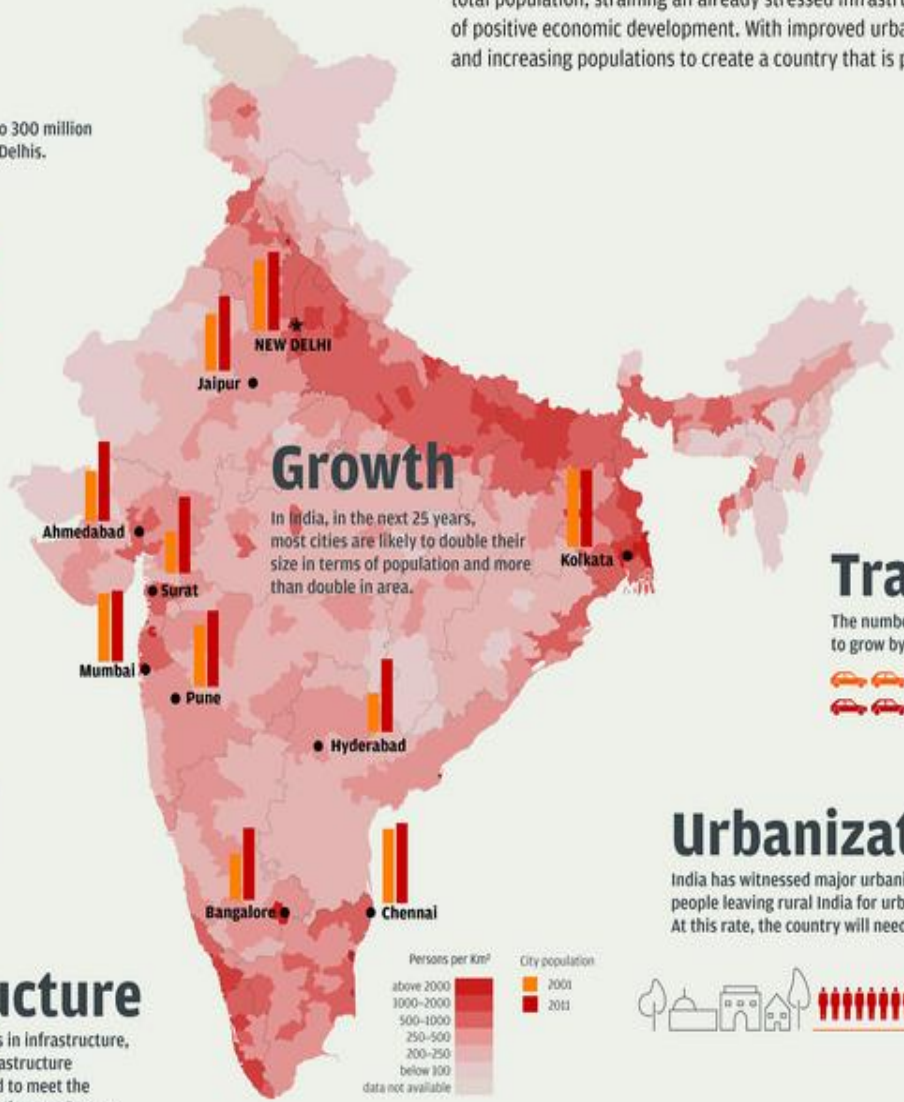
Of the 1.4 billion people of the world who have no access to electricity in the world, India accounts for over 300 million.

Water

Only 74% of urban households in India are served by piped water supply. No Indian city has piped water 24 hours a day, seven days a week—4 to 5 hours of supply per day is the average.

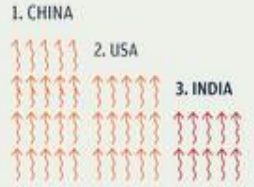
Infrastructure

Despite increased investments in infrastructure, an estimated $1 trillion in infrastructure improvements will be required to meet the country's resource needs over the next 5 years.



Growth

In India, in the next 25 years, most cities are likely to double their size in terms of population and more than double in area.



Pollution

By 2015, India is expected to become the world's third largest emitter of carbon dioxide—it ranked fifth in 2005.

Transportation

The number of private vehicles in India is expected to grow by more than 3 times by 2021.

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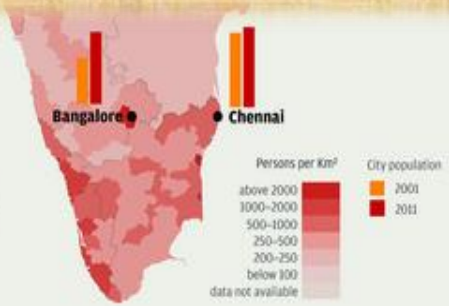

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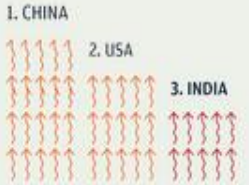

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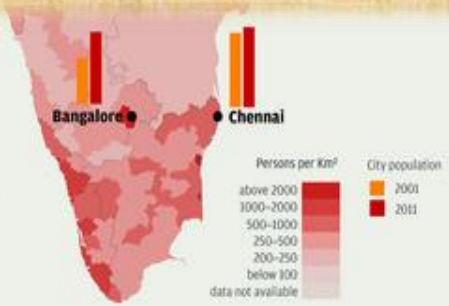

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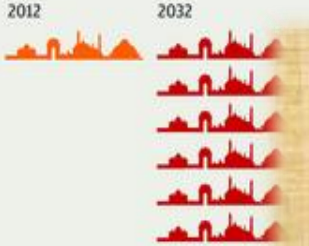

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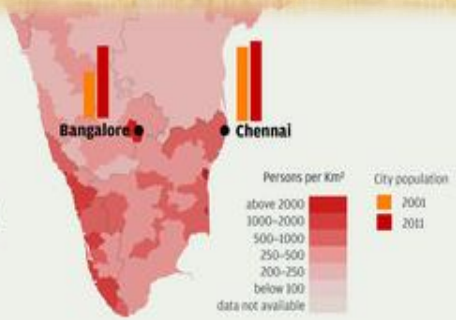

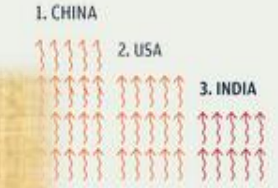

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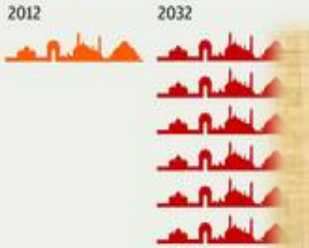

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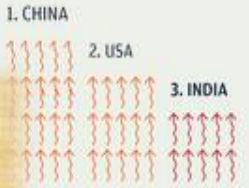

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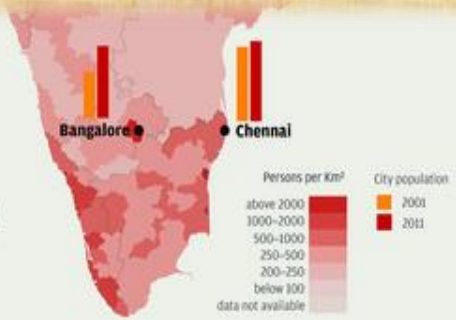

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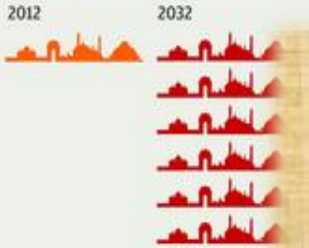

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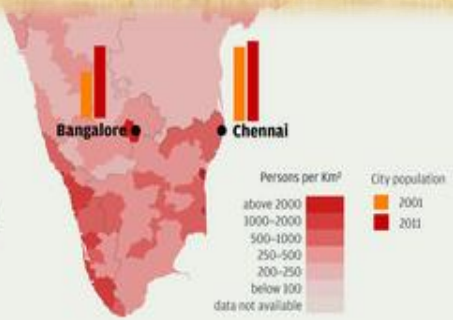

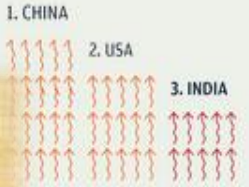

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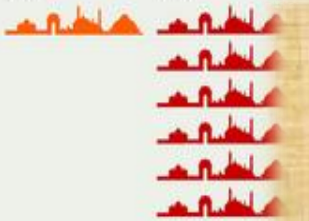

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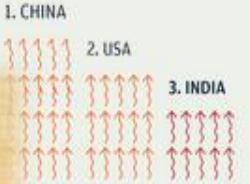

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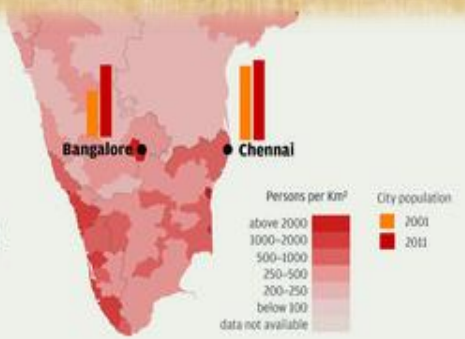

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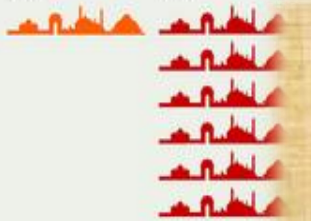

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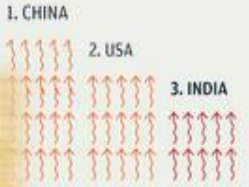

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Urbanization

- **Consequence**
  - High density
  - Greater mobility ?
- **Motorization**
  - Shift to private modes
  - Congestion and delays
  - Fuel consumption and Emissions

Urbanization

- **Urban Transportation**
  - Cities consume three quarters of energy generated and are responsible for 80% of CO2 emissions worldwide

Urbanization

Public vs Private

Urbanization

Intelligent Transportation Systems

Intelligent Transportation

Definition:

Application of computer, electronics, and communication technologies and management strategies in an integrated manner to provide information to traveller and to increase the safety and efficiency of the road transportation systems

Intelligent Transportation

- **Goal**
  - Involve vehicles, drivers, passengers, road operators, and managers all interacting with each other and the environment, and linking with the complex infrastructure systems to improve the safety and capacity of road systems
  - application of technology to better manage traffic and maximize the utilization of our existing transportation infrastructure

Intelligent Transportation

- **Efficiency**
  - Use of technology
    - Optimal performance
    - Informed decision
- **Safety**
  - Zero accidents
  - Safer to vulnerable uses
- **Sustainable**
  - Less burden on environment

Intelligent Transportation

- **Benefits**
  - To the User
    - Improves driving experience
    - Improves the safety of the system
    - Reduces risks in transportation
  - To the Planner
    - Enhances capacity of road systems
    - Relieves traffic congestion
    - Improves transportation efficiency
    - Reduces pollution

Intelligent Transportation

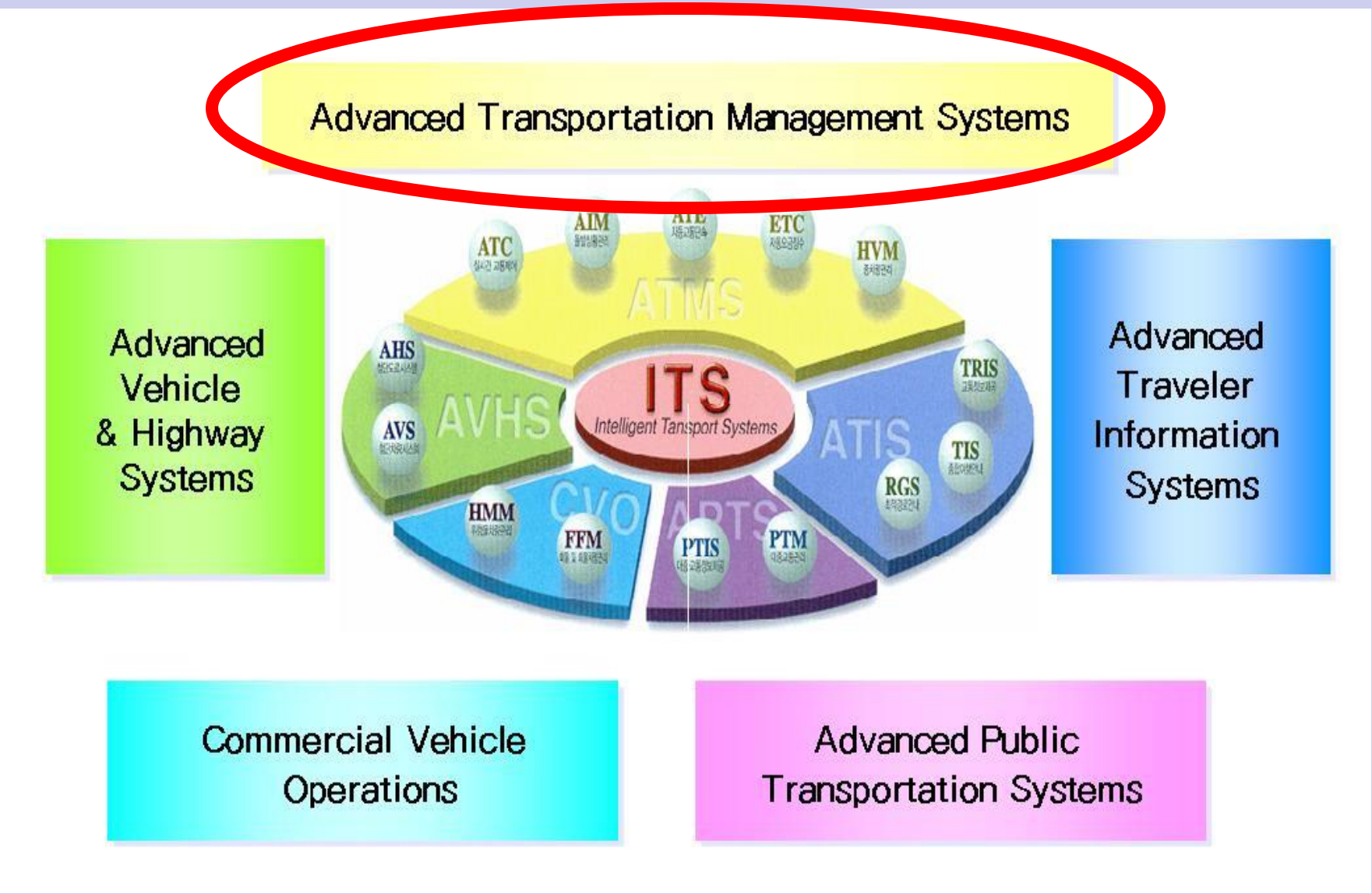
- **Topics**
  - User services
  - Architecture
  - Standards
  - Planning
  - Evaluation
- **Applications**
  - Adaptive Signal Control
  - Traffic Simulation

User Services

Intelligent Transportation

- **User Services**
  1. Travel and traffic management
  2. Public transportation operations
  3. Electronic payment
  4. Commercial vehicle operations
  5. Advanced vehicle control and safety systems
  6. Emergency management
  7. Information management
  8. Maintenance and construction management

User Services

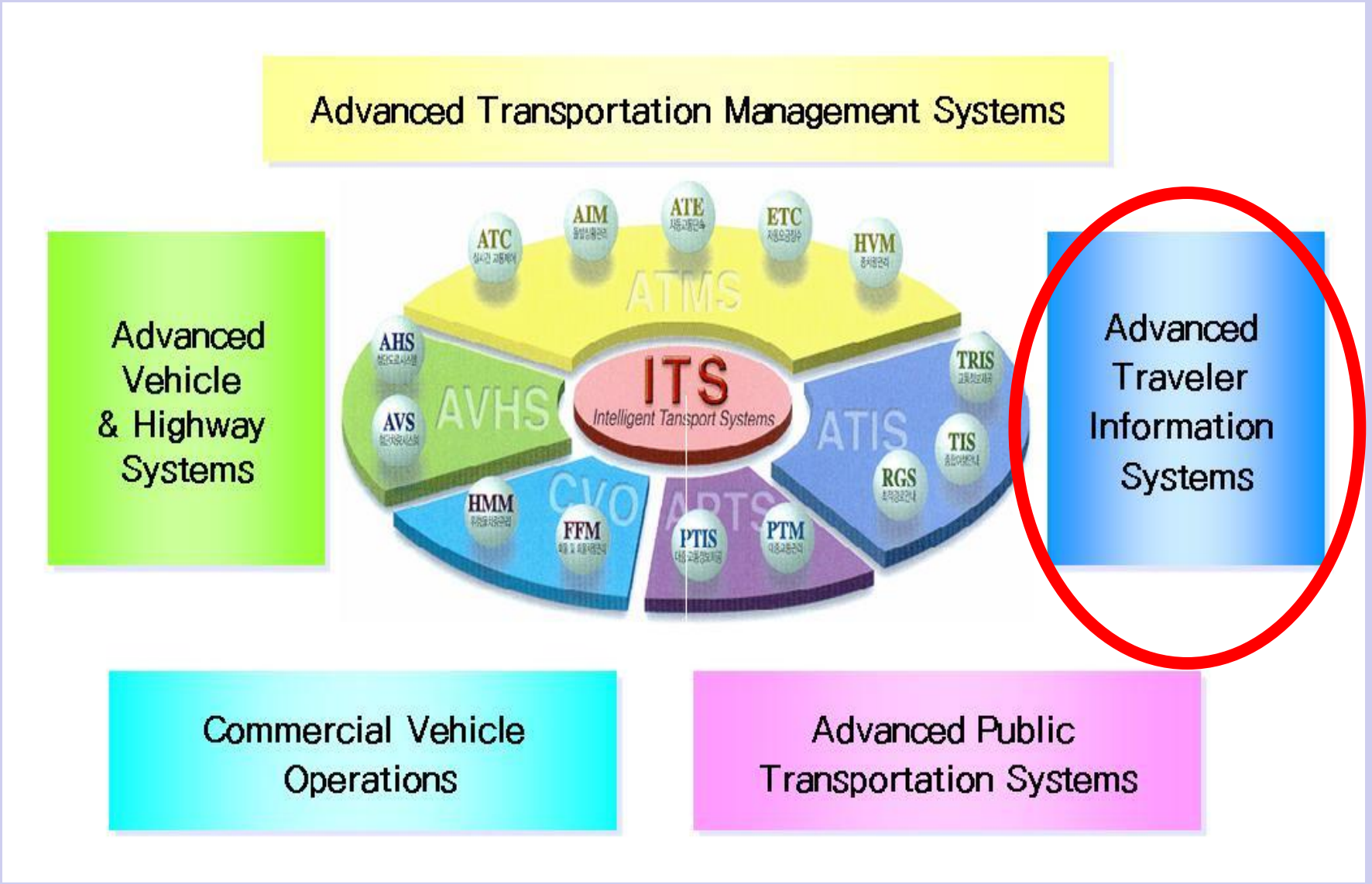


ATMS

- **Detection system**
  - Vehicle
- **Decision**
  - Optimal
- **Control system**
  - Intersection control
  - System optimal


Autonomous Intersection Management
Traffic Control for the Future
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
© 2012 Cnes/Spot Image
Image © 2012 TerraMetrics
Google earth

Components


Advanced Transportation Management Systems
Advanced Vehicle & Highway Systems
ATC
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FFM
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Advanced Public Transportation Systems

ATIS

- **Traveler information systems**
  - Pre-trip
  - En-route
- **Components**
  - Data collection
  - Processing
  - Dissemination
    - www/mobile

ATIS

RTrAC

Real-time Traffic Analyser and Classifier

HOME ABOUT GALLERY HOW IT WORKS RESOURCES FEEDBACK

Authorized Login

Snapshot at this IIT Powai at 2012-07-12 11:55:00

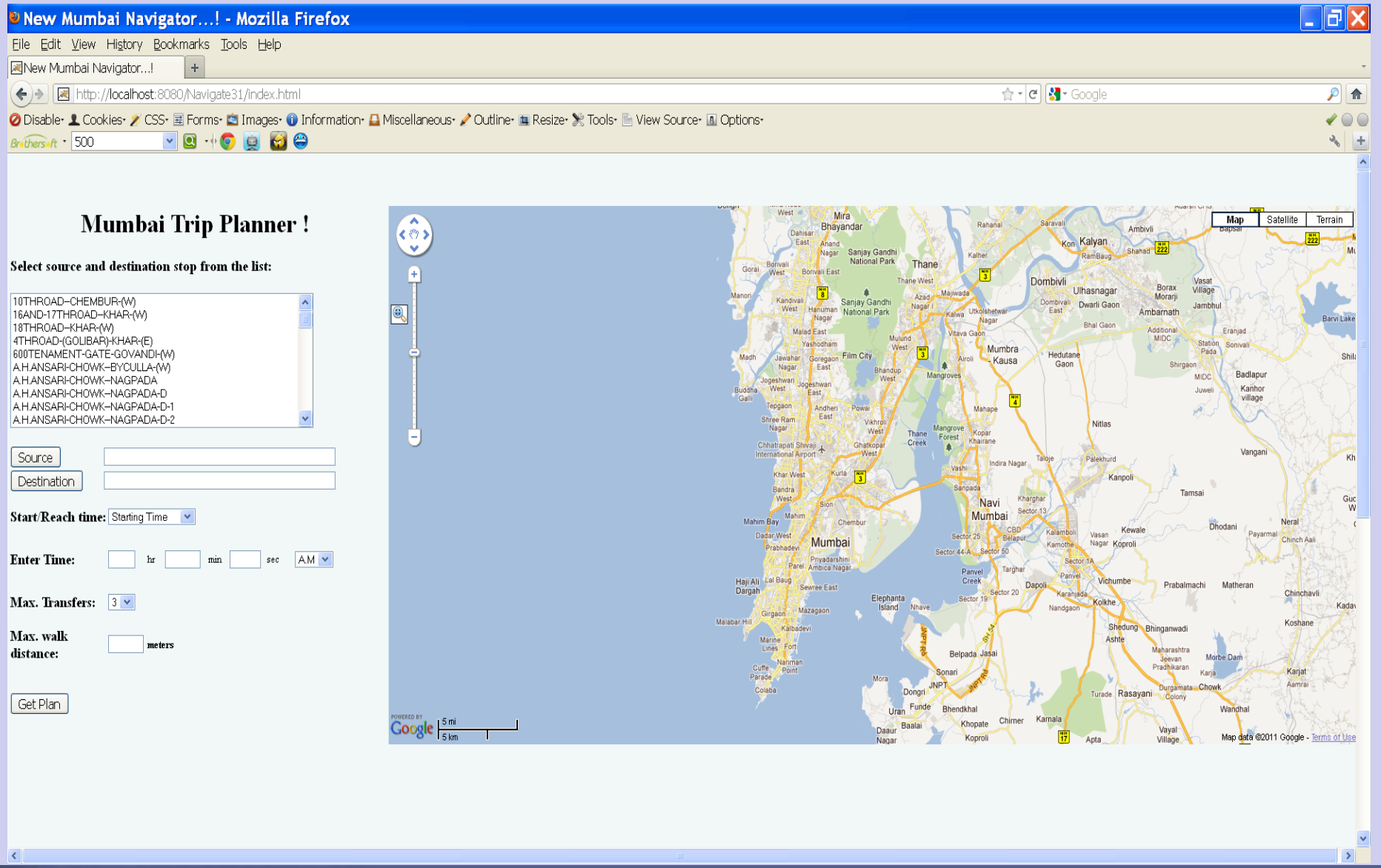
Legend

Criteria	Category	Colour
Count < 675 (Low Traffic)	A	Dark green
675 < Count < 900 (Normal Traffic)	B	Light Gold
900 < Count < 1125 (Medium Traffic)	C	Yellow
1125 < Count < 1250 (High Traffic)	D	Red
1250 Count < 1500 (Very High Traffic)	E	Dark red
Count > 1500 (Stop and Go Traffic)	F	Maroon

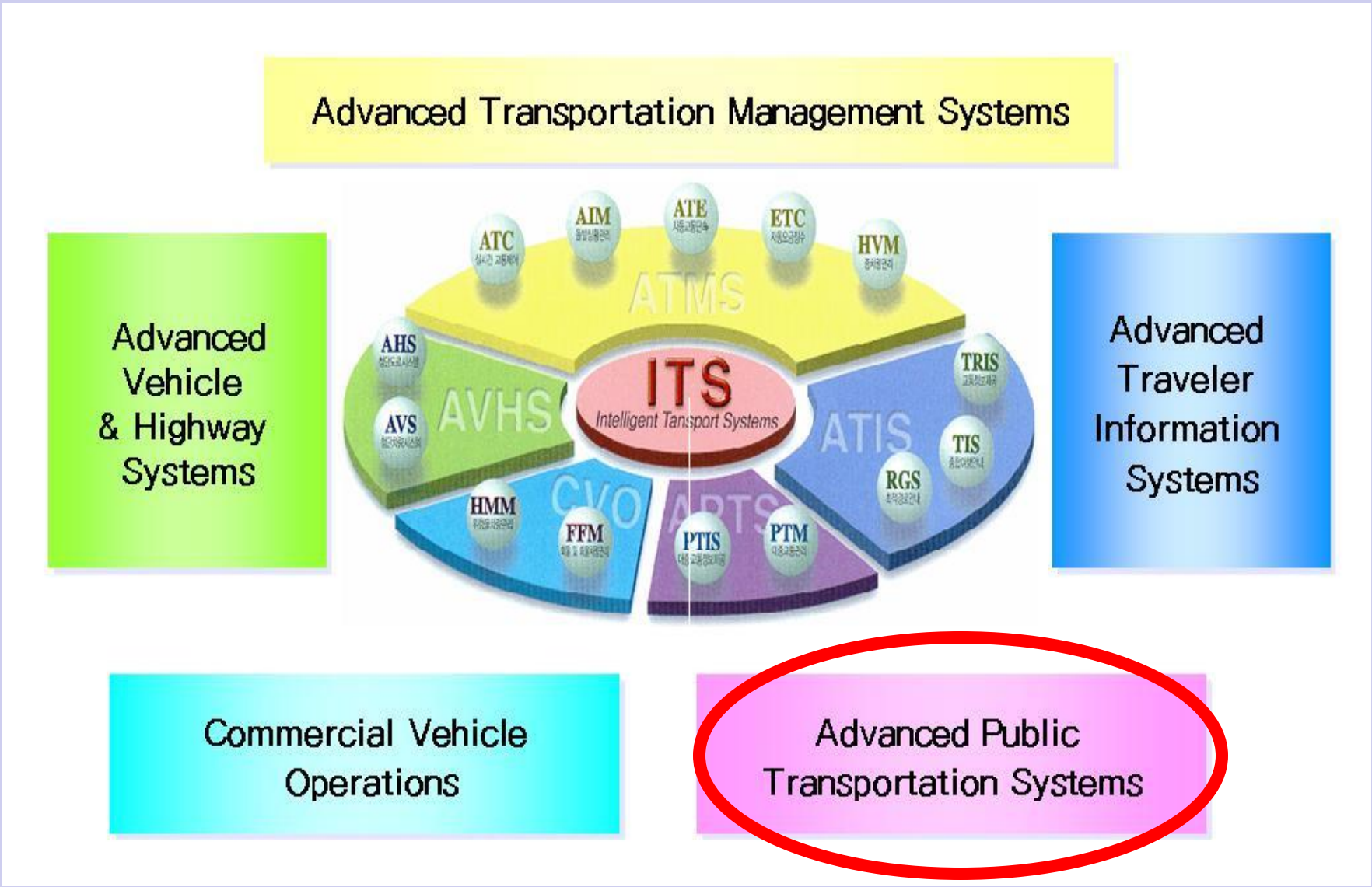
Timestamp	Vehicle Count (for 5 min)	Two Wheeler	Three Wheeler	Light Vehicles	Heavy Vehicles	Average Velocity (km/h)	Congestion State
2012-07-12 11:50:07	254	62	62	100	60	24.00	B
2012-07-12 11:45:16	290	50	60	116	64	25.15	B
2012-07-12 11:40:01	225	54	42	90	39	27.01	B
2012-07-12 11:35:16	297	42	61	144	50	29.00	B
2012-07-12 11:30:19	220	42	20	101	40	20.02	B
2012-07-12 11:25:02	240	40	51	94	46	24.69	B
2012-07-12 11:20:00	217	60	54	79	51	27.60	B
2012-07-12 11:15:09	266	44	46	107	39	26.24	B
2012-07-12 11:10:14	276	61	67	107	61	29.29	B
2012-07-12 11:05:02	321	59	50	140	55	26.50	D
2012-07-12 11:00:12	401	60	69	222	92	24.40	D
2012-07-12 10:55:02	392	66	61	171	74	24.10	D

*Disclaimer: RTrAC produces accurate results from

ATIS


New Mumbai Navigator...! - Mozilla Firefox
File Edit View History Bookmarks Tools Help
New Mumbai Navigator...!
http://localhost:8080/Navigate31/index.html
Disable Cookies CSS Forms Images Information Miscellaneous Outline Resize Tools View Source Options
Mumbai Trip Planner !
Select source and destination stop from the list:
10THROAD–CHEMBUR-(W)
16AND-17THROAD–KHAR-(W)
18THROAD–KHAR-(W)
4THROAD-(GOLIBAR)-KHAR-(E)
600TENAMENT-GATE-GOVANDI-(W)
A.H.ANSARI-CHOWK–BYCULLA-(W)
A.H.ANSARI-CHOWK–NAGPADA
A.H.ANSARI-CHOWK–NAGPADA-D
A.H.ANSARI-CHOWK–NAGPADA-D-1
A.H.ANSARI-CHOWK–NAGPADA-D-2
Source
Destination
Start/Reach time: Starting Time
Enter Time: hr min sec A.M
Max. Transfers: 3
Max. walk distance: meters
Get Plan
Map Satellite Terrain
Mumbai
Navi Mumbai
Thane
Kalyan
Dombivli
Ulhasnagar
Ambarnath
Mumbra Kausa
Nitlas
Vangani
Tamsai
Kanpoli
Dhodani
Kewale
Koproli
Vichumbe
Prabalmachi
Matheran
Chinchavli
Koshane
Shedung
Bhinganwadi
Rasayani
Wandhal
Vayal Village
Apta
Karnala
Chirner
Khopate
Koproli
Uran
Dongri
JNPT
Belpada
Jasai
Sonari
Elephanta Island
Haji Ali Dargah
Malabar Hill
Girgaon
Kalbadevi
Cuffe Parade
Colaba
Nariman Point
Marine Lines
Fort
Mahim Bay
Dadar West
Prabhadevi
Parel
Sewree East
Chembur
Sion
Kurla
Bandra West
Khar West
Santacruz
Vile Parle
Andheri East
Jogeshwari East
Goregaon East
Film City
Malad East
Kandivali West
Borivali West
Borivali East
Dahisar East
Mira Bhayandar
Sanjay Gandhi National Park
Yashodham
Mulund West
Bhandup West
Mangroves
Airoli
Vitava Gaon
Kalwa
Majiwada
Thane West
Kalher
Ambivli
Shahad
RamBaug
Dombivli East
Dwarli Gaon
Bhal Gaon
Additional MIDC
Shirgaon
Badlapur
Kanhor village
Juwel
Barvi Lake
Hedutane Gaon
Palekhurd
Taloje
Kharghar
Sector 13
Sector 25
Sector 50
Sector 44-A
Sector 19
Sector 20
Sector 1A
Panvel Creek
Targhar
Kalamboli
Kamothe
Vasan Nagar
Nandgaon
Karanjada
Kolkhe
Ashte
Maharashtra Jeevan Pradhikaran
Morbe Dam
Karja
Karjat
Aamrai
Durgamata Colony
Chowk
Turade
Belapur CBD
Indira Nagar
Vashi
Sanpada
Mangrove Forest
Kopar Kharane
Ghatkopar West
Thane Creek
Chhatrapati Shivaji International Airport
Powai
Vikhroli West
Mahape
Shree Ram Nagar
Tepgaon
Buddha Gali
Jogeshwari West
Jawahar Nagar
Mash
Manori
Gorai
Dahisar East
Anand Nagar
Hanuman Nagar
Azad Nagar
Utkolshetwar Nagar
Powered by Google
5 mi
5 km
Map data ©2011 Google - Terms of Use

Components


Advanced Transportation Management Systems
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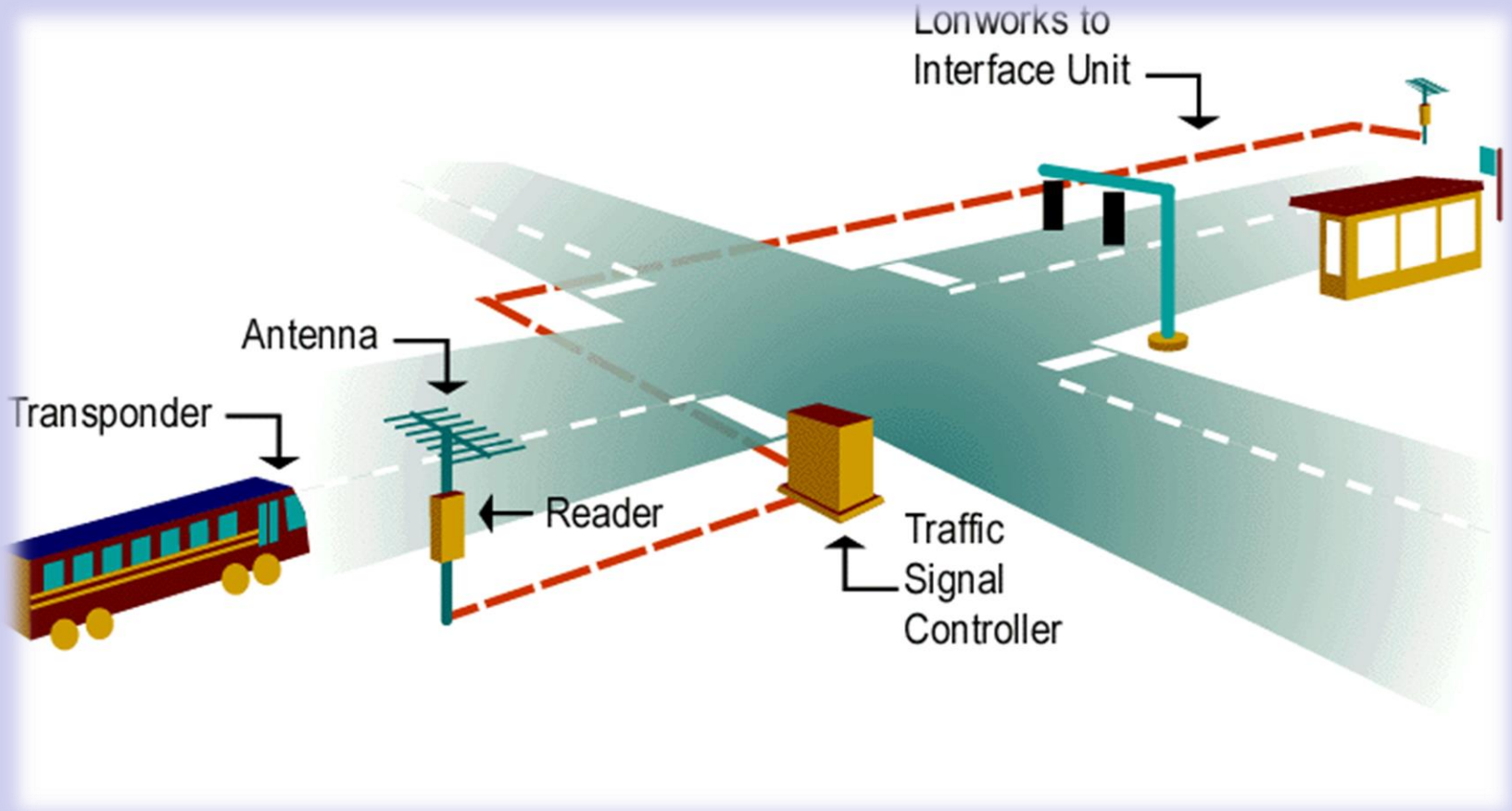
FFM
PTIS
PTM

APTS

- **Transit priority**



Advanced public transportation systems

- **Goal**
  - To improve the operations of public transportation systems and thereby to encourage their use
- **Four methods**
  - Public transportation management
  - Enroute transit information
  - Personalized public transit
  - Public travel security

Advanced public transportation systems

- **Public Transportation Management**
  - Automation to improve operations
    - Monitors the location of transit vehicles
    - Identifies deviations from the schedule
    - Offers potential solutions to operators
  - Quick response to service delays
    - Assure transfer connections from vehicle to vehicle and between modes to facilitate
    - To enhance security of transit personnel by providing access management of transit vehicles

Advanced public transportation systems

- **En Route Transit Information**
  - Provide real-time, accurate, information to travelers after they begin their trips using public transportation
    - On-board the vehicle
    - At transit stations
    - At bus stops
      - assist travelers in making decisions
      - modify their trips underway

Advanced public transportation systems

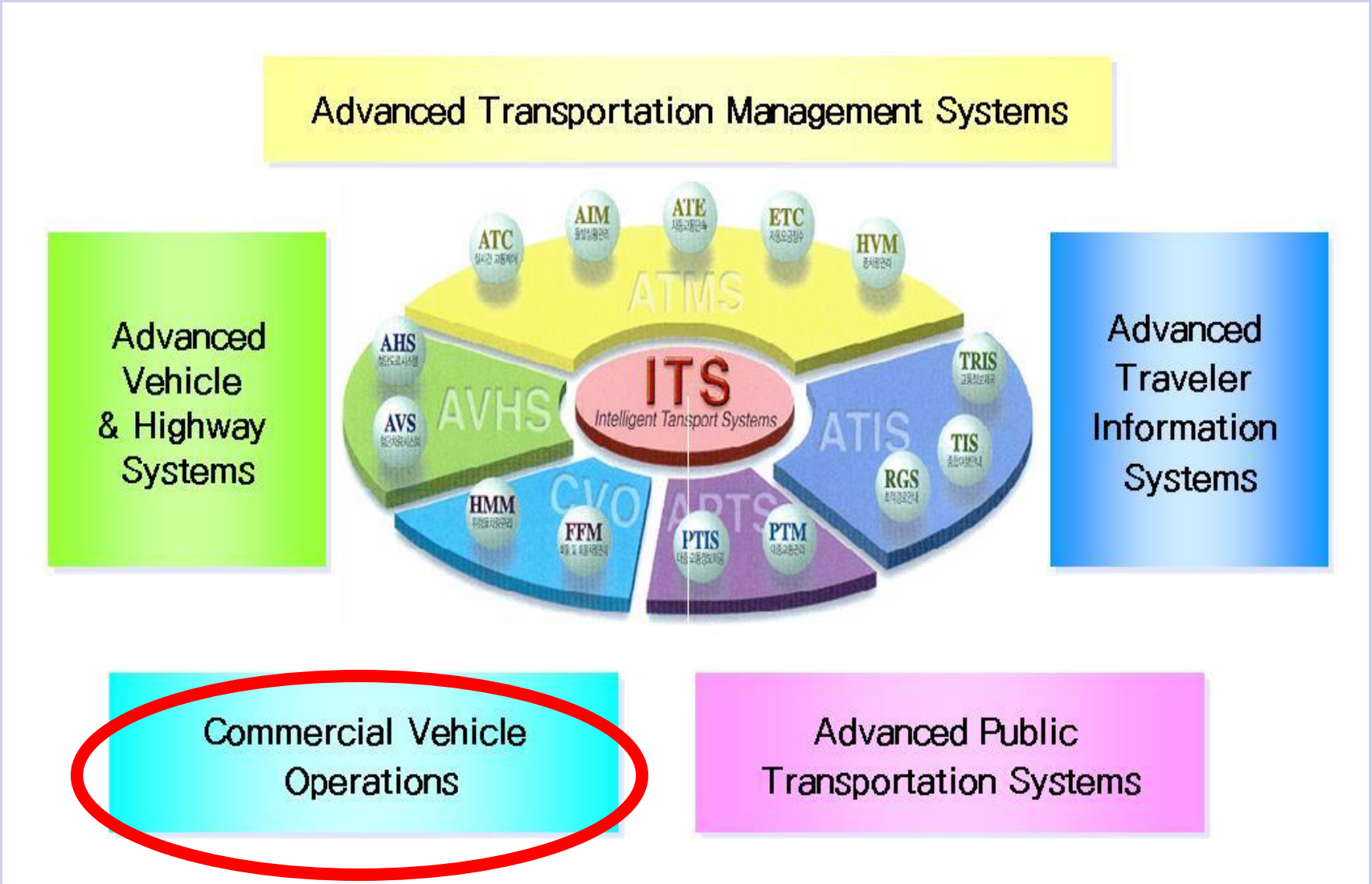
- **En Route Transit Information**
  - Provide real-time, accurate, information to travelers after they begin their trips using public transportation
    - On-board the vehicle
    - At transit stations
    - At bus stops
      - assist travelers in making decisions
      - modify their trips underway

Personal Transit System

- **Advantages**
  - Flexibility
    - of private vehicles
  - Efficiency
    - of public transit systems

Video

Components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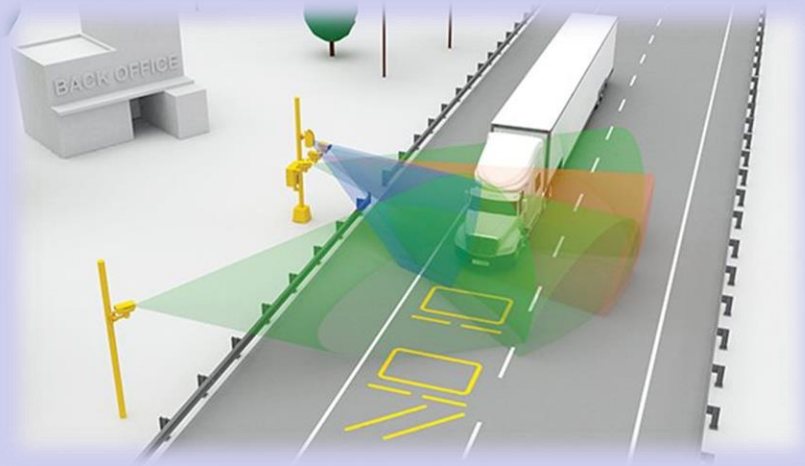
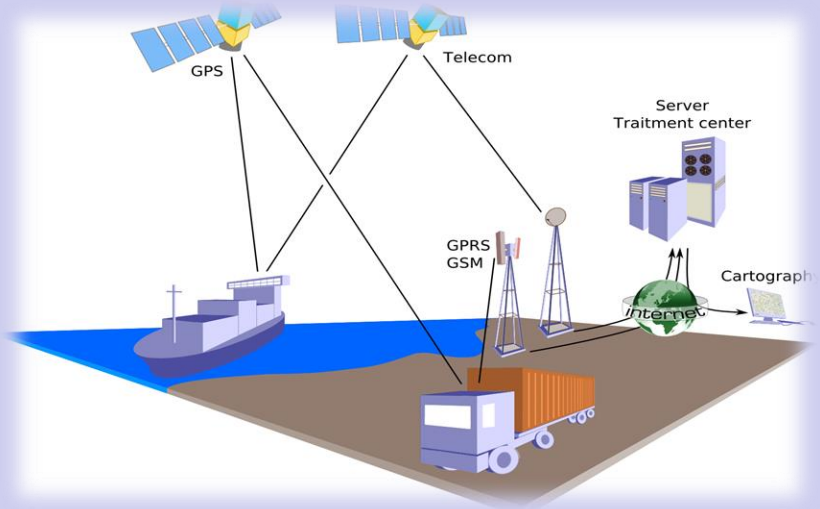
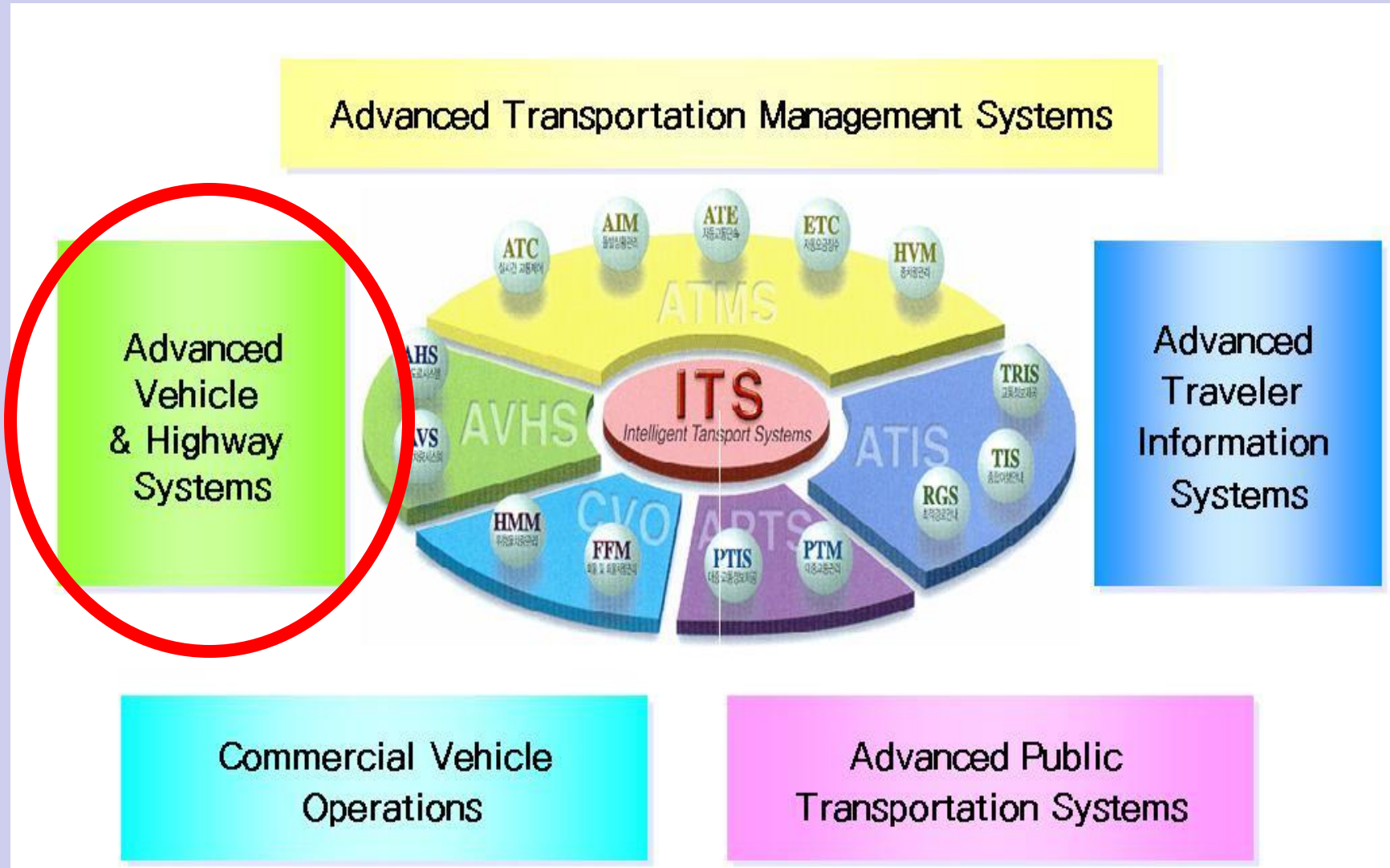
CVO

- Fleet Administration
- Freight Administration
- Electronic Clearance
- International Border Crossing
- Weigh-In-Motion (WIM)
- On-Board Safety Monitoring
- Freight In-Transit Monitoring
- Freight Terminal Management





Components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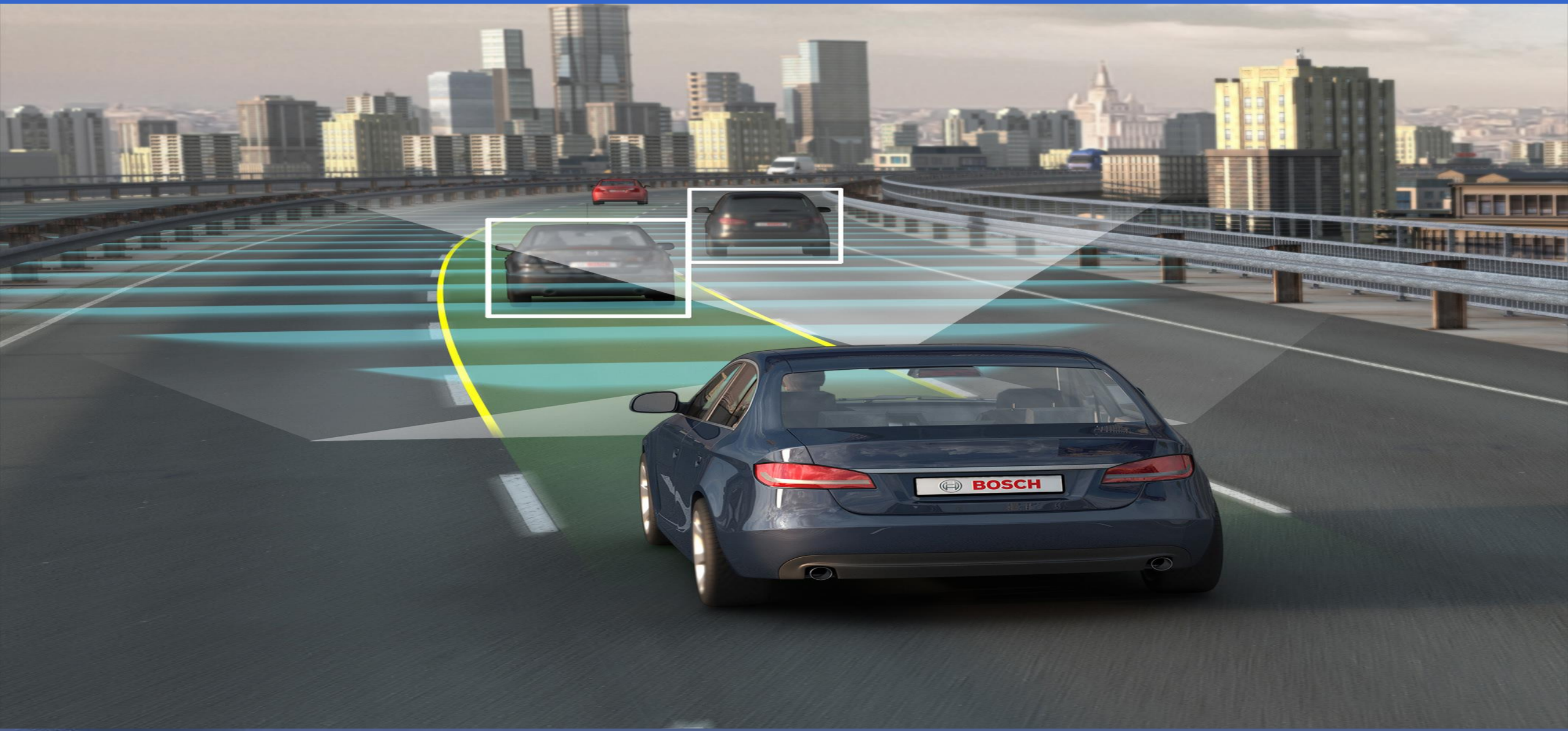
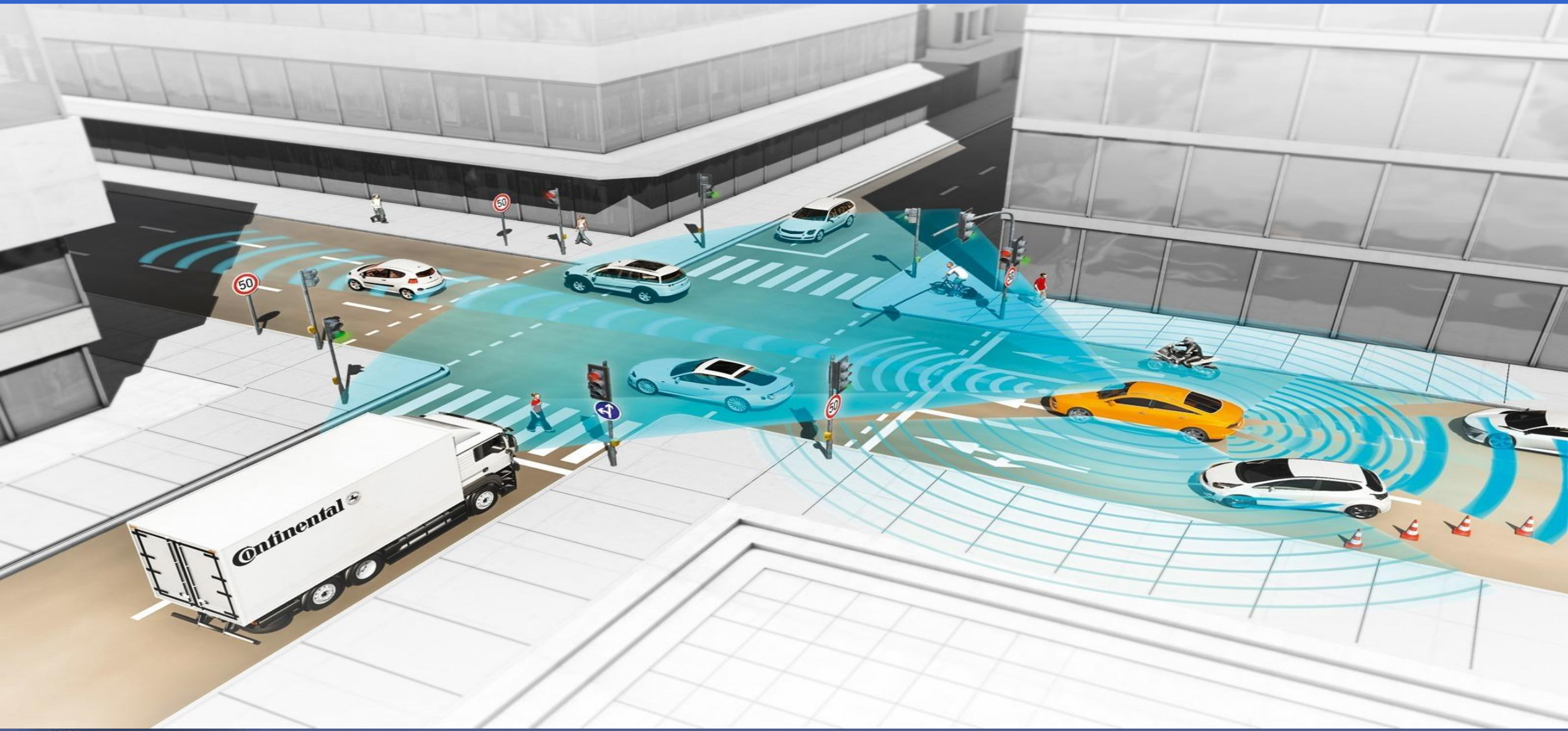
AVHS

- **Goal**
  - Improve the safety of the transportation system by supplementing drivers' abilities to maintain vigilance and control of the vehicle by enhancing the crash avoidance capabilities
  - User services
    - Collision avoidance
    - Vision enhancement for collision avoidance
    - Pre crash restraint deployment
    - Automated highway system

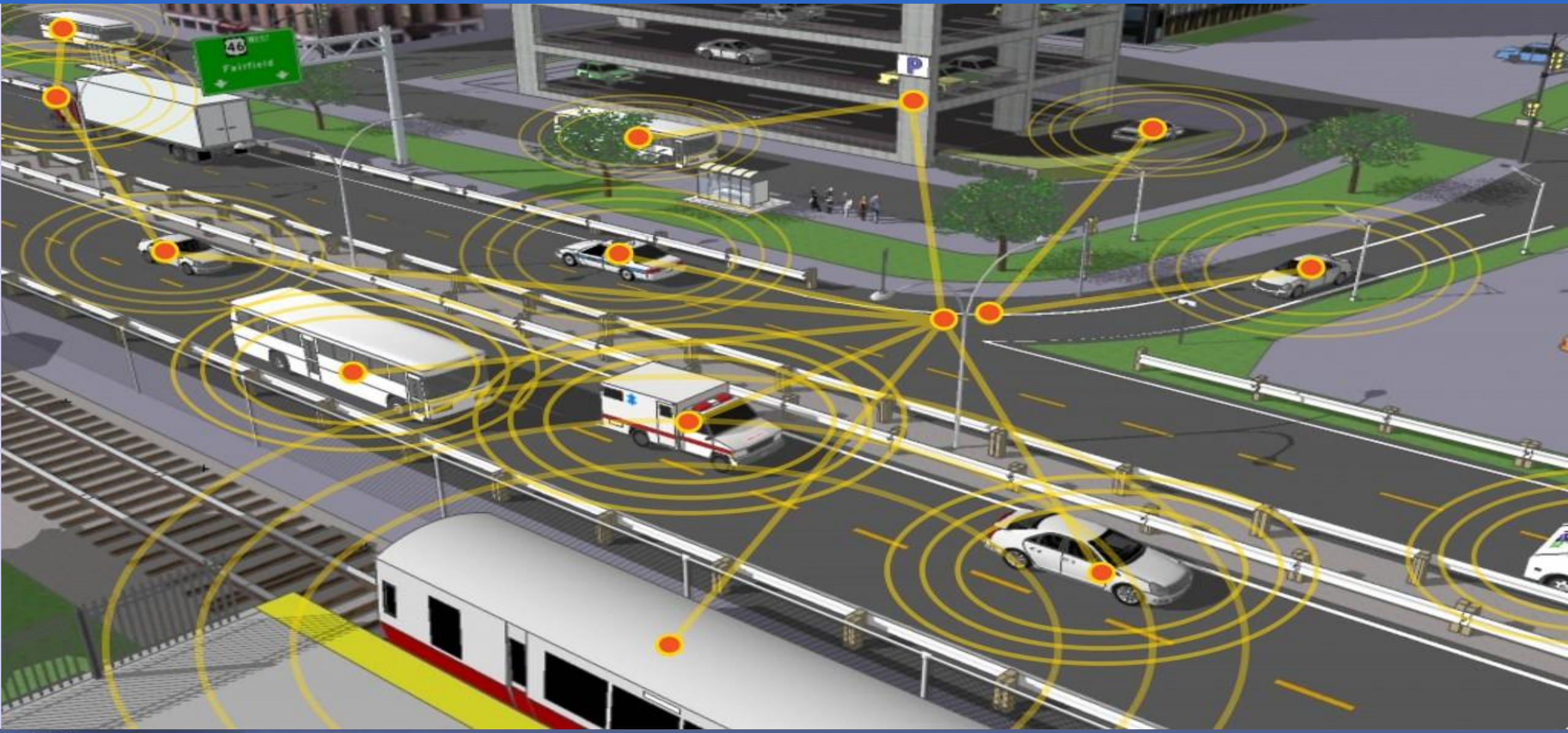
AVHS



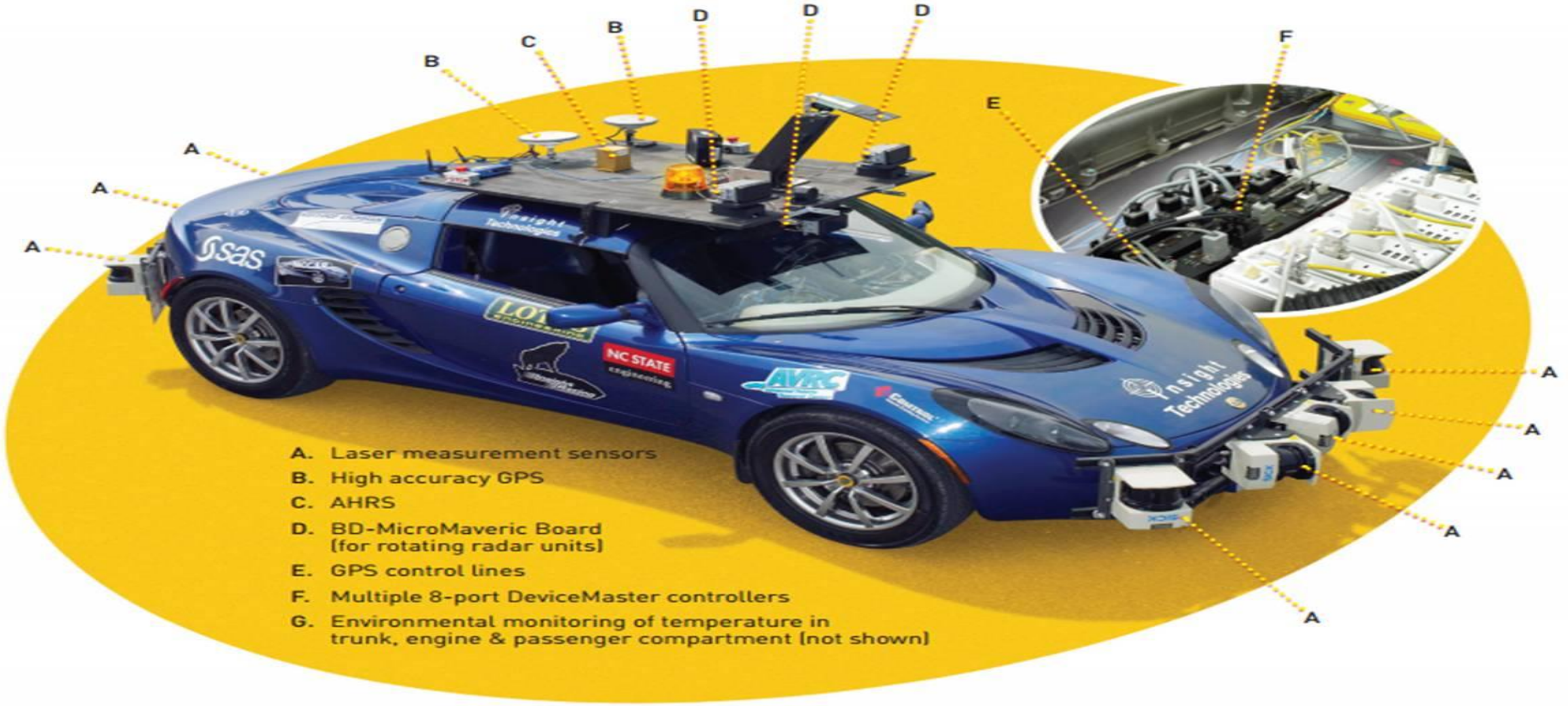
AVHS



AVHS



AVHS


A. Laser measurement sensors
B. High accuracy GPS
C. AHRS
D. BD-MicroMaveric Board (for rotating radar units)
E. GPS control lines
F. Multiple 8-port DeviceMaster controllers
G. Environmental monitoring of temperature in trunk, engine & passenger compartment (not shown)

AVHS

Google Driverless Car Video

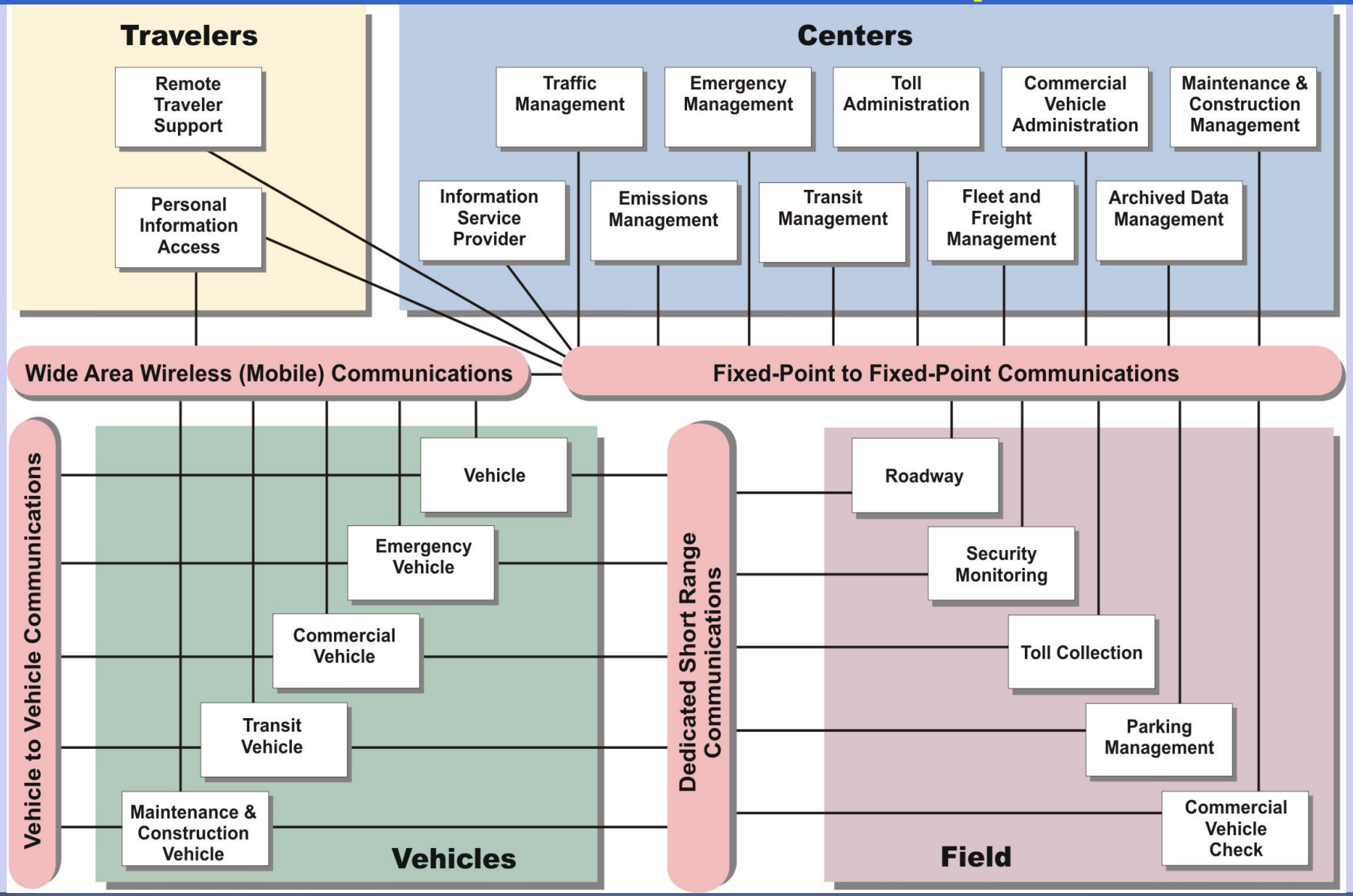
First Drive Video

ITS Architecture

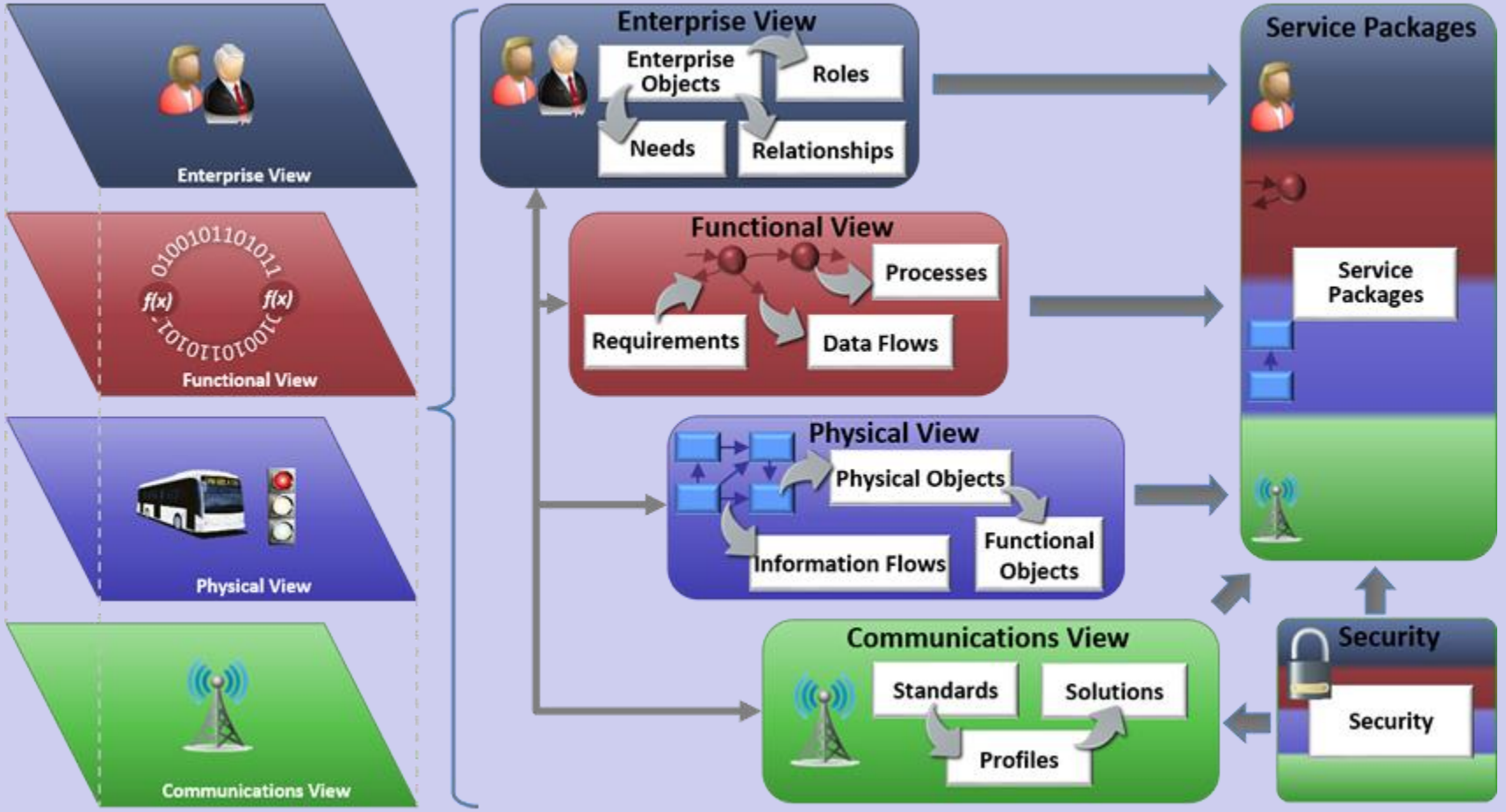
ITS Architecture

- **Definition**
  - a common framework for planning, defining, and integrating intelligent transportation systems
  - common basis for planners and engineers with differing disciplines to conceive, design and implement systems using a common language as a basis for delivering ITS, but does not mandate any particular implementation

ITS Architecture - Components

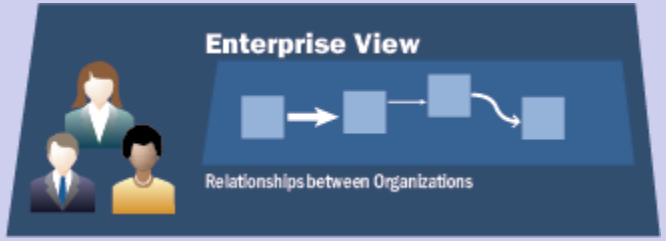


ITS Architecture - Overview



ITS Architecture - Overview

- **Enterprise**



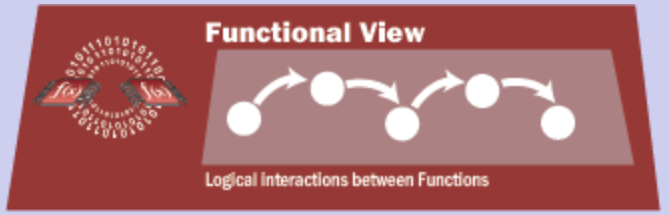
  - addresses the relationships between organizations and users, and the roles those entities play in the delivery and consumption of ITS services

ITS Architecture - Overview

- **Enterprise**
  - Questions
    - Who is responsible for providing transportation-related user services?
    - Who is responsible for installation, operations and maintenance of ITS services, applications and devices?
    - What relationships need to exist between various stakeholders?
      - Agreements, contracts, funding, expectations

ITS Architecture - Overview

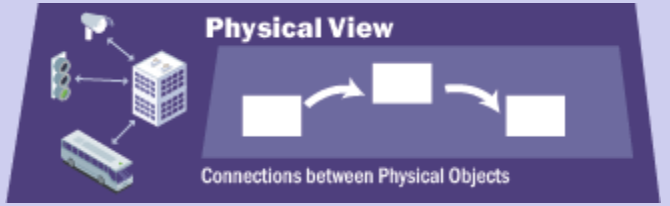
- **Functional**



  - addresses the analysis of abstract functional elements and their logical interactions
  - Questions
    - What kinds of data are required to implement a given service?
    - What functionality is required to implement a given service?

ITS Architecture - Overview

- **Physical**



  - describes the transportation systems and the information exchanges that support ITS
  - Questions
    - What physical entities are involved?
    - What interfaces are required?
    - What are the data security considerations?
    - What are the physical devices security issues?

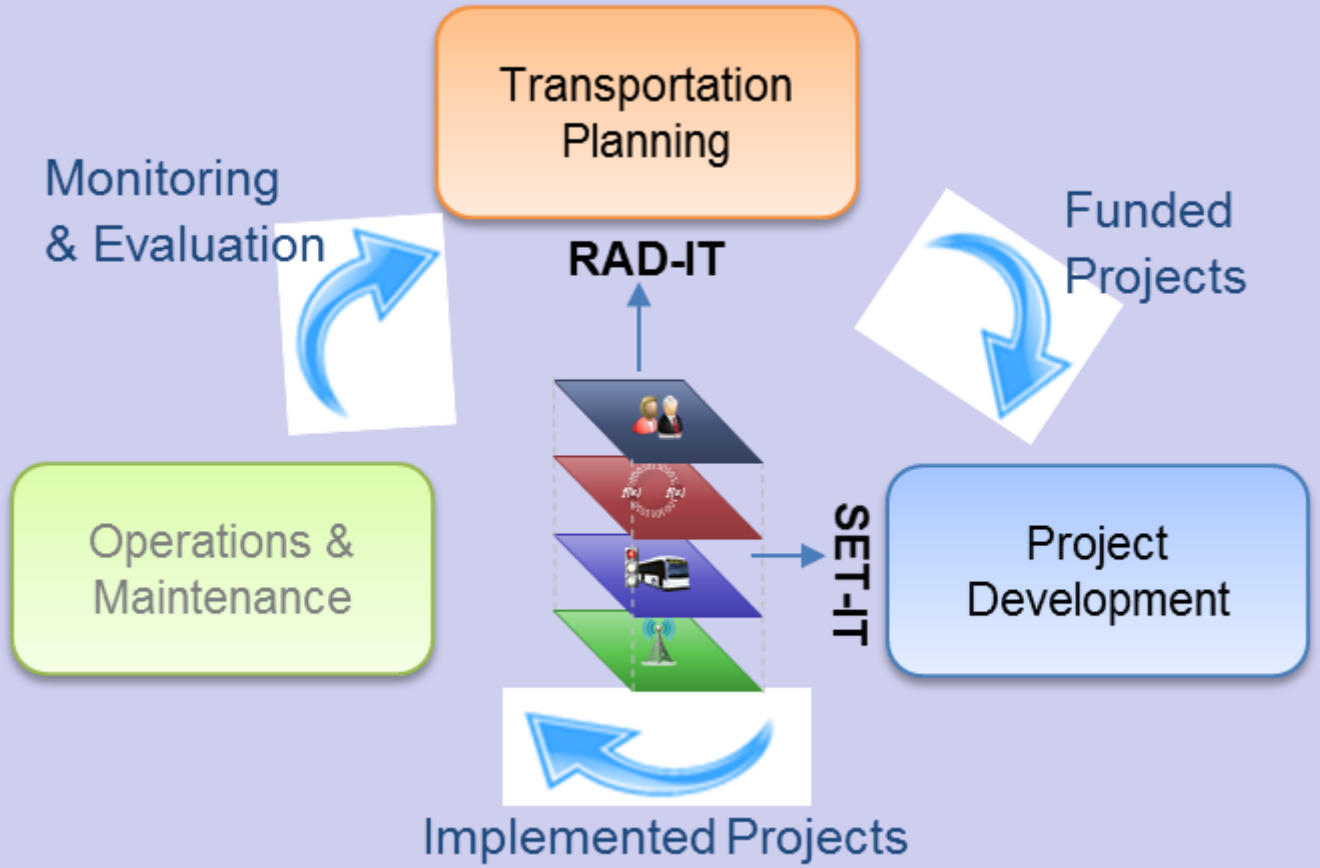
ITS Architecture - Overview

- **Communications**

  - identifies the protocols needed to implement an information flow between sub-systems
  - Questions
    - What is the set of communications protocols?
    - What protocols address critical system-wide security issues - data confidentiality?
    - What organizations are responsible for the maintenance of data, communications, security and management standards and specifications?

ITS Architecture - Overview

- **Architecture Use**



ITS Standards

Standards

- **Purpose**
  - Provide norms and regulations to be followed
  - Help in generalizing any system
  - Brings homogeneity in the design

Standards

- **Need - Enforce Product Behaviour**
  - Prescribe ways the product should behave
  - Uniform product responses
  - Helps in easy understanding of a device
  - Consistency in the output
  - Avoids confusion to the users

Standards

- **Interface**
  - Components of the system must be universal
  - More ‘plug and play’ type devices
    - Eg. Traffic signal controller
  - Note
    - If universal interface is not there, then many devices will not work everywhere

Standards

- **Co-ordination and Interaction**
  - Data transfer from one agency/device to other
  - Data must be in standard format
  - Data sharing must be possible
  - Standard data dictionary is required
    - e.g., bus, traffic, etc.

Standards

- **Case-Study**

Standards

- **Case-Study: FASTag**
  - interoperable nationwide toll payment solution
    - encompasses a common set of processes, business rules and technical specifications which enable a customer to use their FASTag as payment mode on any of the toll plazas irrespective of who has acquired the toll plaza

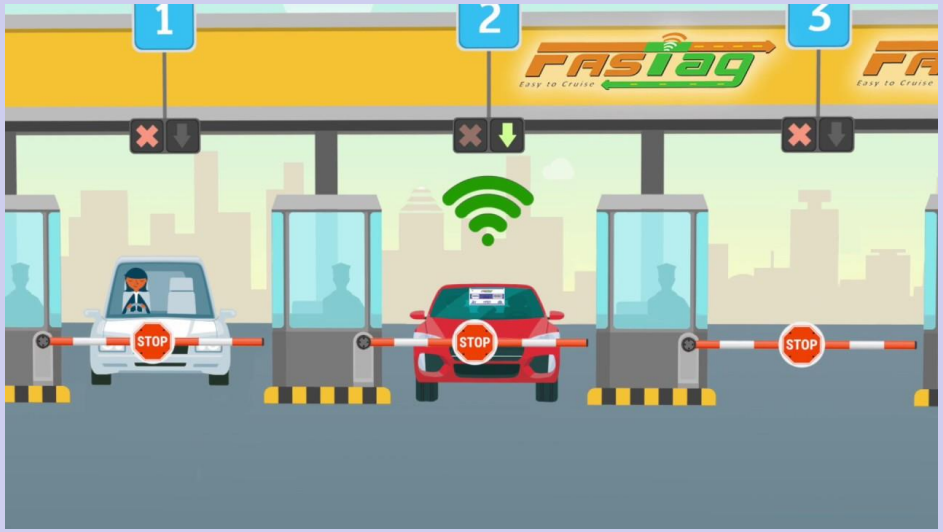
Standards

- **Case-Study: FASTag**
  - FASTag is a device that employs Radio Frequency Identification (RFID) technology for making toll payments directly while the vehicle is in motion
  - FASTag (RFID Tag) is affixed on the windscreen of the vehicle and enables a customer to make the toll payments directly from the account which is linked to FASTag

Standards


FASTag Trademark
QR Code
Colour Code
Antenna
Tag Class
TID
E200 34120138 FC00 0CCC F6E8
4


4
1800110018
NPCI
IHMCL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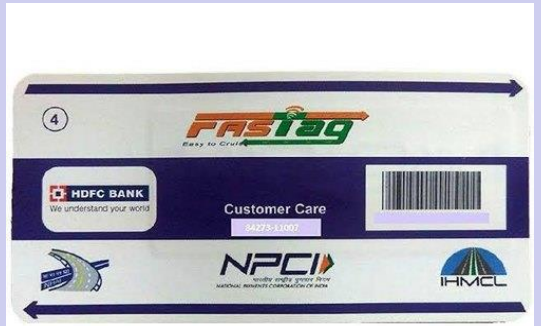
STOP


4
HDFC BANK
We understand your world
Customer Care
NPCI
IHMCL


4
Paytm
Payments
Bank
Customer Care
1800 102 6480
NPCI
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ITS Evaluation

Evaluation

- **Objective**
  - Minimizes the risk of project failure
  - Identification of current performance
- **Types of evaluation**
  - Planning level evaluation
  - Deployment tracking
  - Impact assessment
  - User perception

Evaluation

- **Planning level**
  - Done at the planning stage using prior data
    - Benefit cost analysis
      - Ratio of the benefit to cost
    - Relative ranking
      - Weight based ranking to select alternatives

Evaluation

- **Deployment Tracking**
  - Evaluates the gap between goals and actual
  - Evaluates the current progress rate
  - Identifies future actions to achieve goals

Evaluation

- **Impact Assessment**

Performance Criteria	Measure Of Effectiveness
Safety	Crashes, Injuries, Fatalities
Travel time	Travel time/delays for selected O-D or mode, or Network travel time
Throughput	Vehicles/persons using the facility
Customer satisfaction	Ratings of travel experience
Air quality	CO, NO2, VOC, HC, Ozone
Fuel consumption	Reduction or not

Evaluation

- **User Perspective**
  - Using Revealed Preference (RP) survey
    - Existing service of a facility/service
    - Whether the service is really effective or not
  - Using Stated Preference (SP)survey
    - Future requirements of a system
    - Help in judging whether implementation of a service will benefit the user or not

Evaluation

- **Tools**
  - Directly compute cost and benefit
    - IDAS model of US DOT is an example
  - Or use parameters like travel time, speed, delay to compute cost and benefit
    - Traffic Simulation tools - VISSIM

Summary

- **Benefits**
  1. Safety
  2. Productivity
  3. Environmental
  4. Equity

- **Challenges**
  1. Technology
  2. Complexity
  3. Security


Thank You, Questions ?
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tvm@civil.iitb.ac.in