An Approach to GIS-T Database Design & Application for Public Transit Planning

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Objectives

- Review and analysis of existing GIS Transportation data model, especially the ESRI'S Arc GIS Unified Network Transportation (UNETRANS) Model.
- Design a GIS-T database and implement it for public transport planning and operational analysis in Visakhapatnam city.
- Apply the design through prototyping.

GIS-T Introduction

- Now a days, tremendous increase in vehicular flow and managing the public transit has become a major problem.
- GIS-T is specifically designed for Transportation and has been defined as "*principles and applications of applying geographic information technologies to transport problems*".

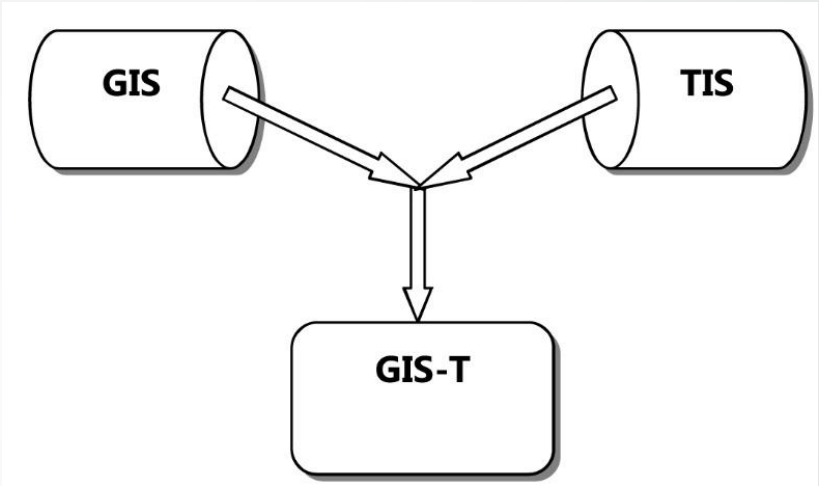


Figure 2: GIS-T as an integrated GIS and Transportation Information System (TIS) (Vonderohe, 1993)

GIS-T Study Categorization:

- **Data representation**: How can various components of transport systems be represented in GIS-T?
- **Analysis and modeling**: How can transport methodologies be used in a GIS-T?
- **Applications**: What types of applications are particularly suitable for GIS-T?

GIS-T Data model:

- Data model is a construction plan for the implementation and design of a database.
- GIS-T data model is a conceptual design representing transportation data having both spatial and non spatial characteristics.
- It is a way of presenting both spatial and non spatial characteristics of transportation data in the form of objects and processes in a geographic database.

Various GIS-T data models:

- ArcInfo route system structure.
- Transportation Feature Identification (TFIS).
- Geographic Data File format (GDF).
- Enterprise GIS-T.
- Unified Network Transportation model (UNETRANS).

UNETRANS Data model:

- UNETRANS is a ESRI-centric data model intended to provide framework for transportation-specific applications.
- This data model was a result of collaboration between software developers and provider, ESRI and the National Centre for Geographic Information Analysis (NCGIA), University of California, Santa Barbara.
- The developed UNETRANS is a unified or universal as well as industry standard GIS-T data model which is an ESRI's Arc GIS standard transportation data model.

Two-Ways of Presenting UNETRANS Data model

- **Layer View-**

✓ For viewing objects sharing similarity in functions

✓ Aids in managing the objects by organizing them into layers

- **Analysis Diagram View-**

✓ It is a layout of all the data objects that comprise the data model.

✓ These diagrams contain set of packages that contains subsets of these feature classes and tables.

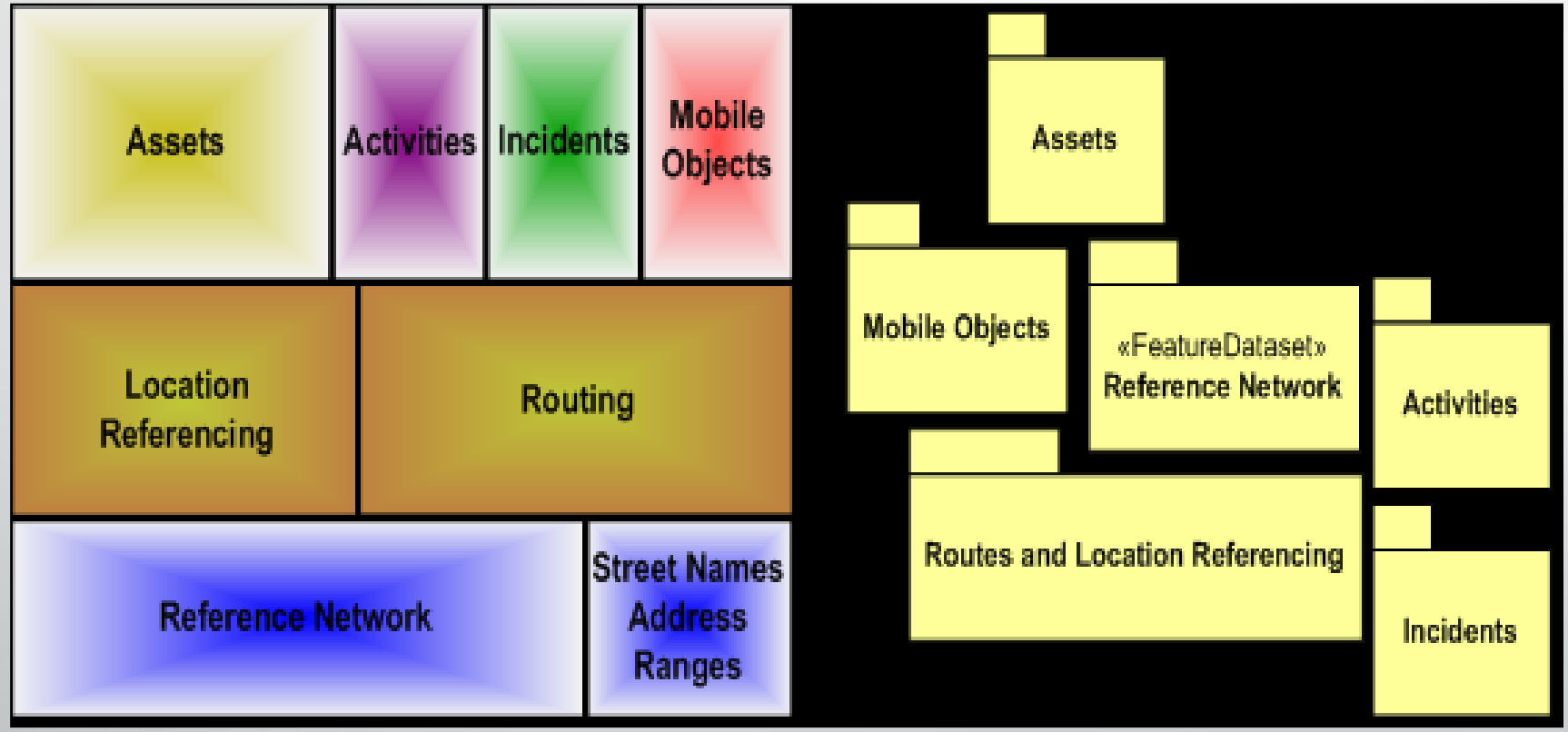
✓ Each feature class represents a table of information in the database that is represented by a single class box in the diagram.

✓ The analysis diagram uses the UML notations.

The layer view descriptions of the UNETRANS data model

Layer	Descriptions
Reference Network	The transportation network consists of several sets of data that represents the roads, railroads, waterways and other pathways along which transportation activities take place in a linear spatial representation
Route Feature	Route feature layer that are built from the links in the Reference Network Layer.
Events	Transportation-related objects that are related to the Reference Network or Route Feature but are not part of the network itself. However, these events are integral to the operation of the transportation system.

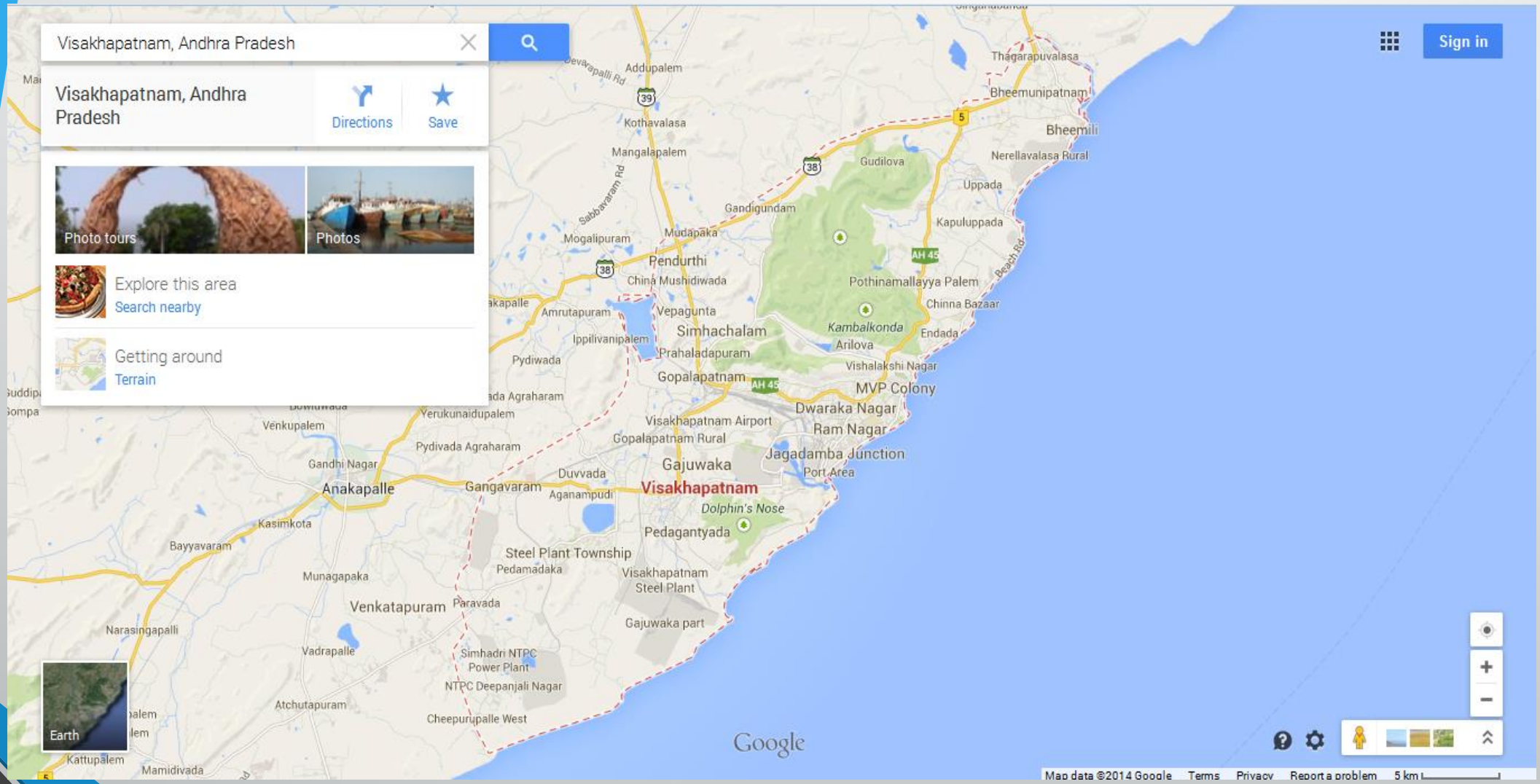
Analysis diagram of the UNETRANS data model



Analysis view descriptions of the UNETRANS data model

Package	Definition
Reference Network	A representation of physical, semi-permanent infrastructure features intended to facilitate a channeling or control of traffic
Street Names and Address Ranges	Attribute objects associated with one or many objects from the Reference Network
Location Referencing	Objects and procedures for associating transportation related
Routing	Primarily tabular related data needed to support transportation planning processes
Assets, Activities, Incidents	A representation of physical features, planned projects, and unplanned occurrences which are located in reference to Reference Network, but are not part of the network itself
Mobile Objects	An object representing any type of medium through which people or commodities are transported along the Reference Network.

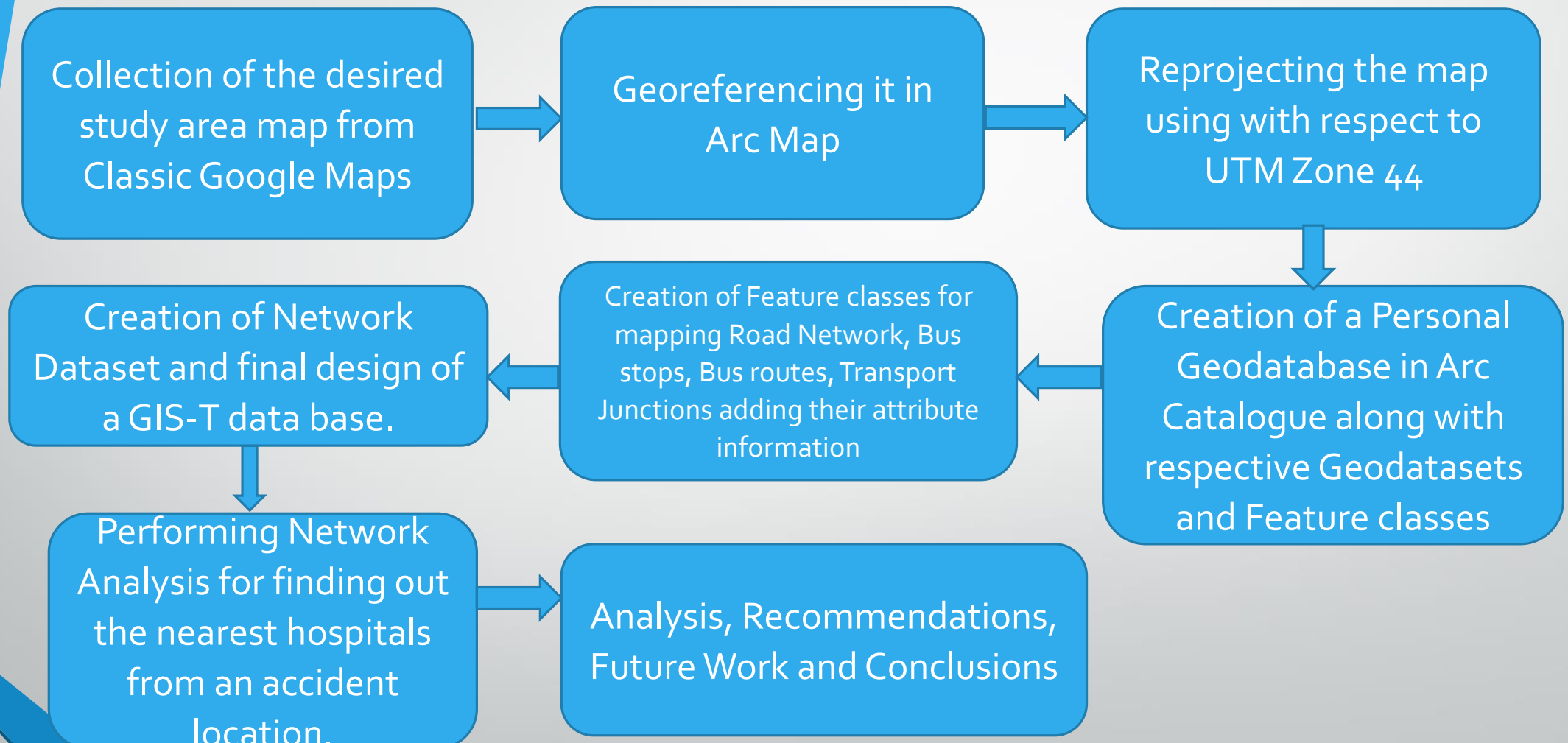
Study Area:


Visakhapatnam, Andhra Pradesh
Visakhapatnam, Andhra Pradesh
Directions
Save
Photo tours
Photos
Explore this area
Search nearby
Getting around
Terrain
Sign in
Addupalem
Kothavalasa
Mangalapalem
Thagarapuvalasa
Bheemunipatnam
Bheemili
Nerellavalasa Rural
Gudilova
Uppada
Kapuluppada
Gandigundam
Mudapaka
Mogalipuram
Pendurthi
China Mushidiwada
Pothinamallayya Palem
Chinna Bazaar
Amrutapuram
Vepagunta
Simhachalam
Kambalkonda
Endada
Arilova
Ippilivanipalem
Prahaladapuram
Pydiwada
Vishalakshi Nagar
Gopalapatnam
MVP Colony
Dwaraka Nagar
Ram Nagar
Visakhapatnam Airport
Gopalapatnam Rural
Jagadamba Junction
Port Area
Venkupalem
Yerukunaidupalem
Pydivada Agraharam
Gandhi Nagar
Anakapalle
Gangavaram
Duvvada
Aganampudi
Gajuwaka
Visakhapatnam
Dolphin's Nose
Pedagantyada
Kasimkota
Bayyavaram
Steel Plant Township
Pedamadaka
Visakhapatnam Steel Plant
Munagapaka
Venkatapuram
Paravada
Gajuwaka part
Narasingapalli
Vadrapalle
Simhadri NTPC Power Plant
NTPC Deepanjali Nagar
Atchutapuram
Cheepurupalle West
Earth
Kattupalem
Mamidivada
Google
Map data ©2014 Google
Terms
Privacy
Report a problem
5 km

Problem Statement :

- A lack of efficient public transport system makes the city of Visakhapatnam to experience major transportation problems.
- A dynamic increase in vehicular population led us for implementing a geodatabase for public operations within the city.
- This way of design of a geographic data base majorly helps in the management of the traffic during the peak hours in a day, thereby leading to the minimization of accidents and traffic jams.

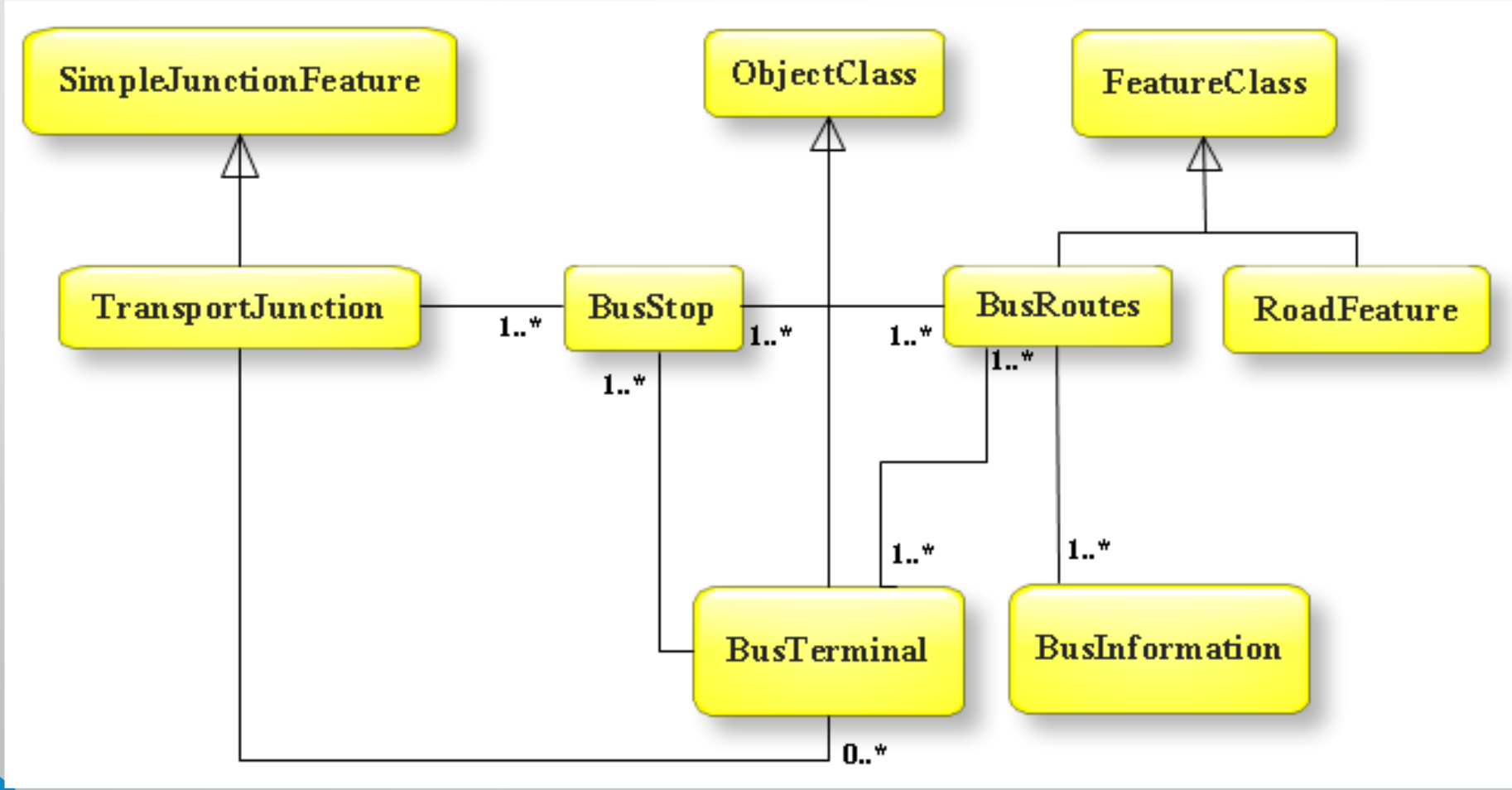
Flowchart depicting Methodology



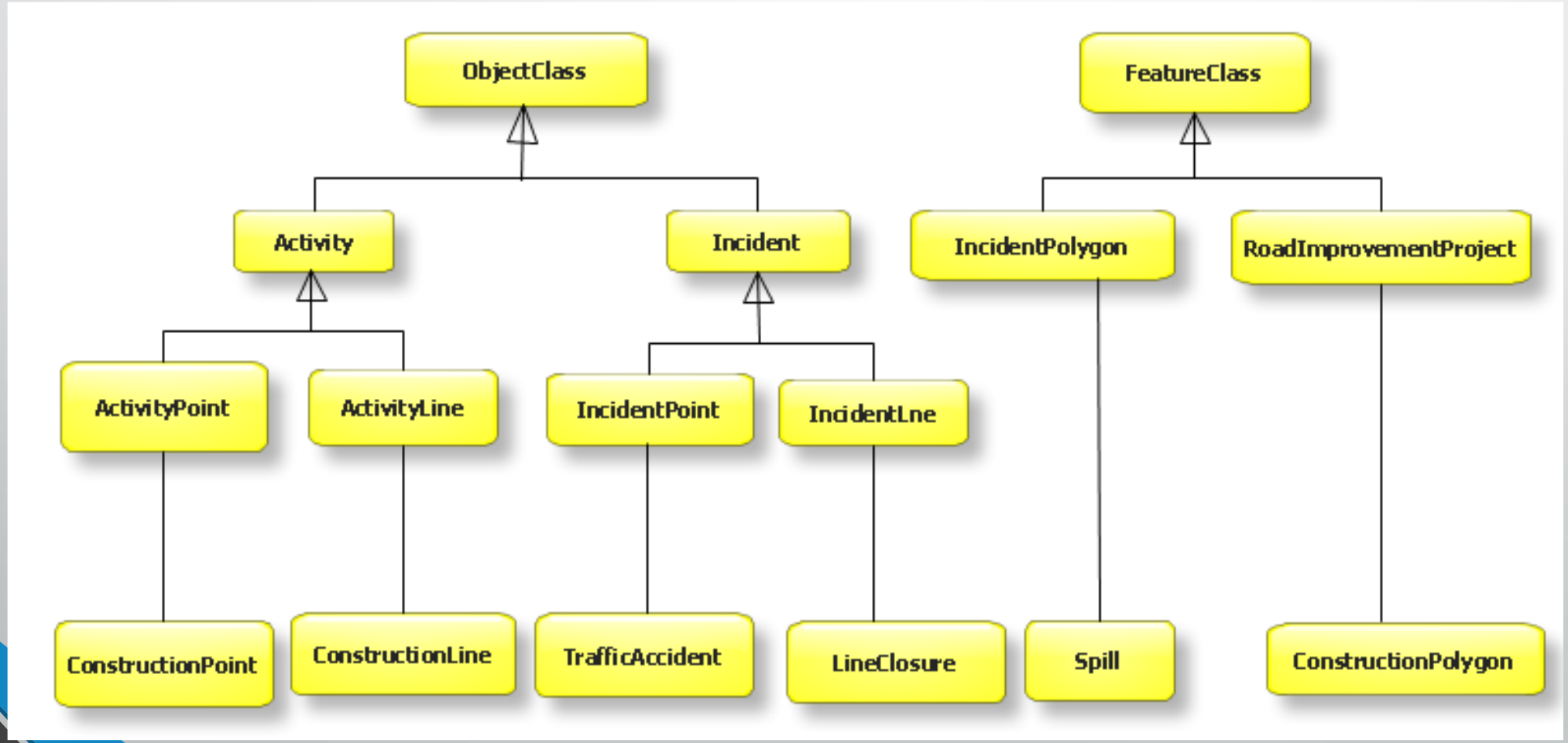
Conceptual Model Design

- A Conceptual Model is a model made of the composition of the concepts that exists in the mind.
- The conceptual model design for the Visakhapatnam city is a simplified model that follows the path of the ESRI's UNETRANS data model
- The conceptual model adapts two packages namely the *Network Package and Events package* as shown in figure below

Conceptual Design of Network Package



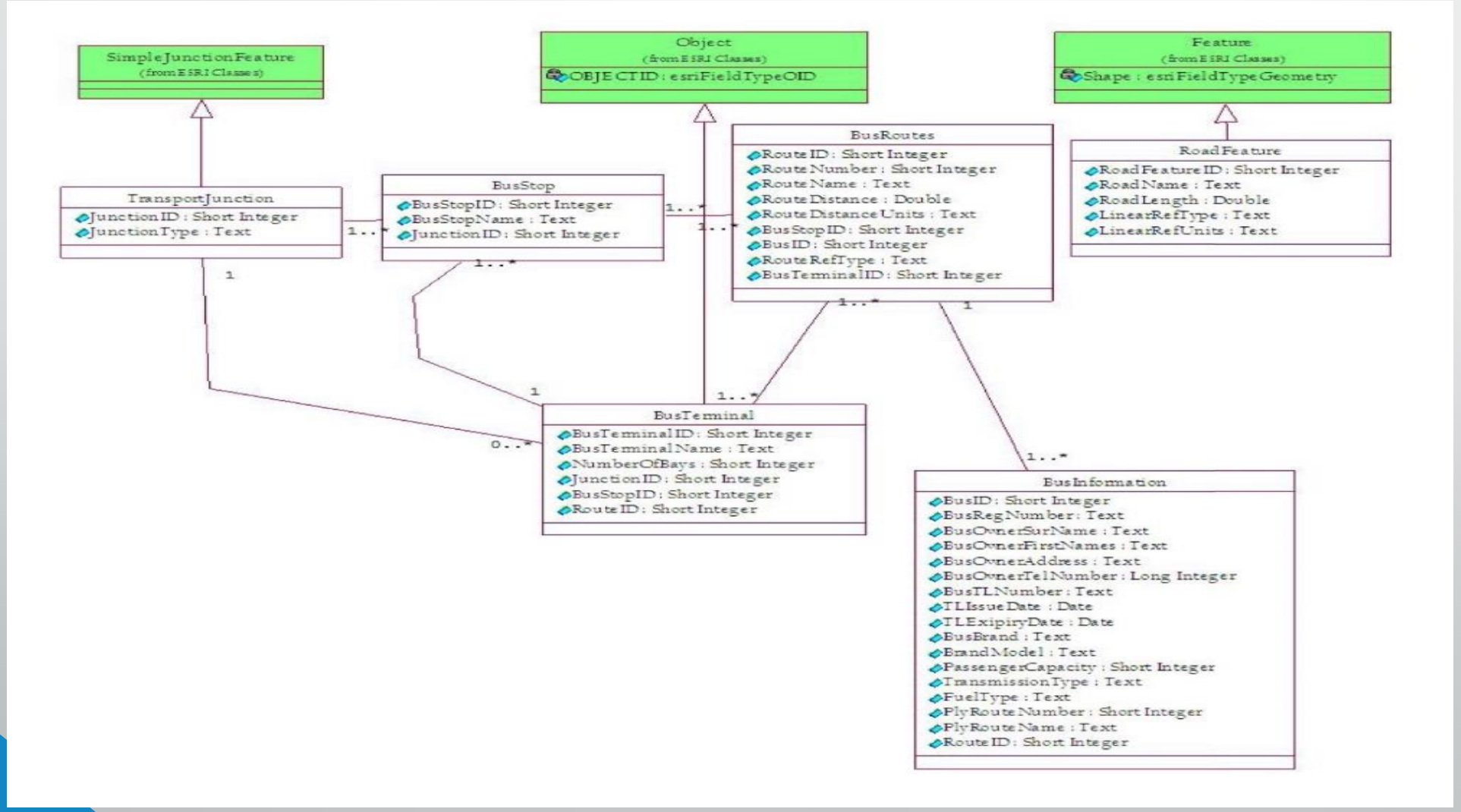
Conceptual design of Events Package: Feature and Object Classes



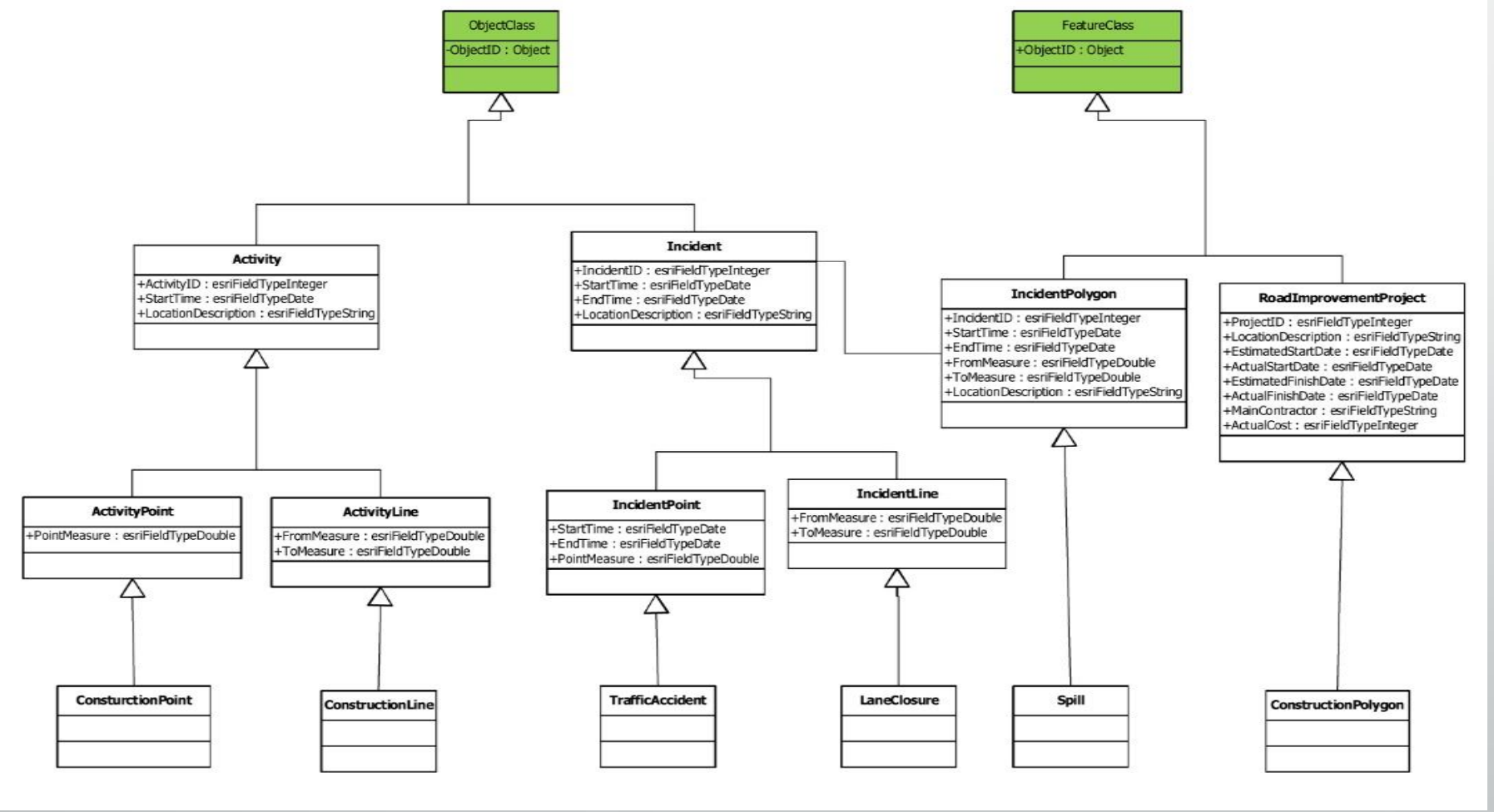
Logical Model Design

- A logical data model is a typical type of model which shows the detailed representation of the organization's data which is independent of data management technology and described in business language.
- It is typically represented as a diagram, organized in terms of entities, relationships with underlying definitions.
- The purpose of logical design is to translate the conceptual schema design into a logical schema customized to the specified database's management system

Logical design of the Network package developed for the Visakhapatnam city



Logical design of the Events package developed for the Visakhapatnam city



Concept of Geodatabase

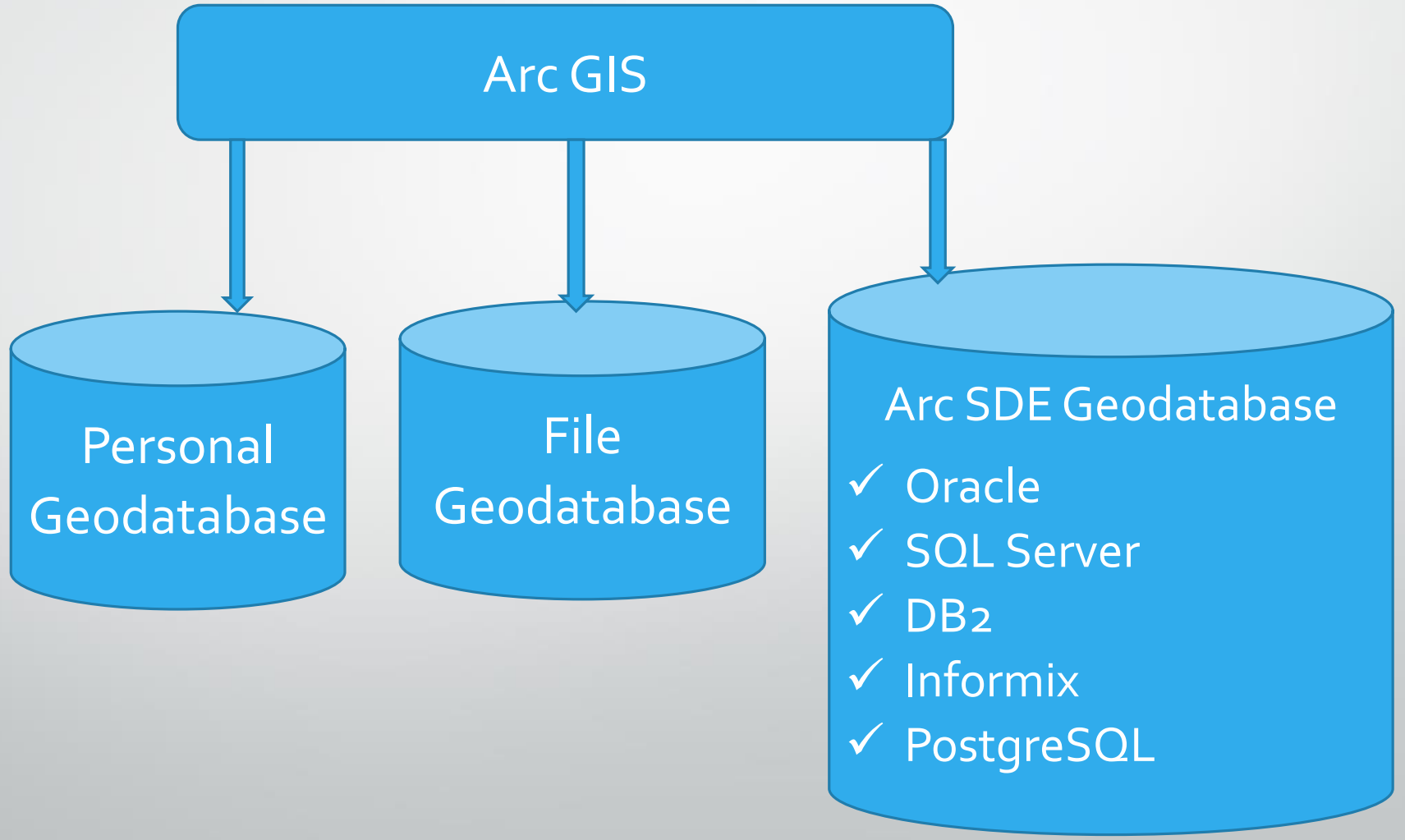
- It is a collection of geographic datasets like Feature classes, Raster data, Attribute tables.
- It is the native data structure for Arc GIS.
- A geodatabase provides the ability to

  -Leverage data relationships

  - Enforce Data Integrity

  - Create Intelligent features

Geodatabase Types



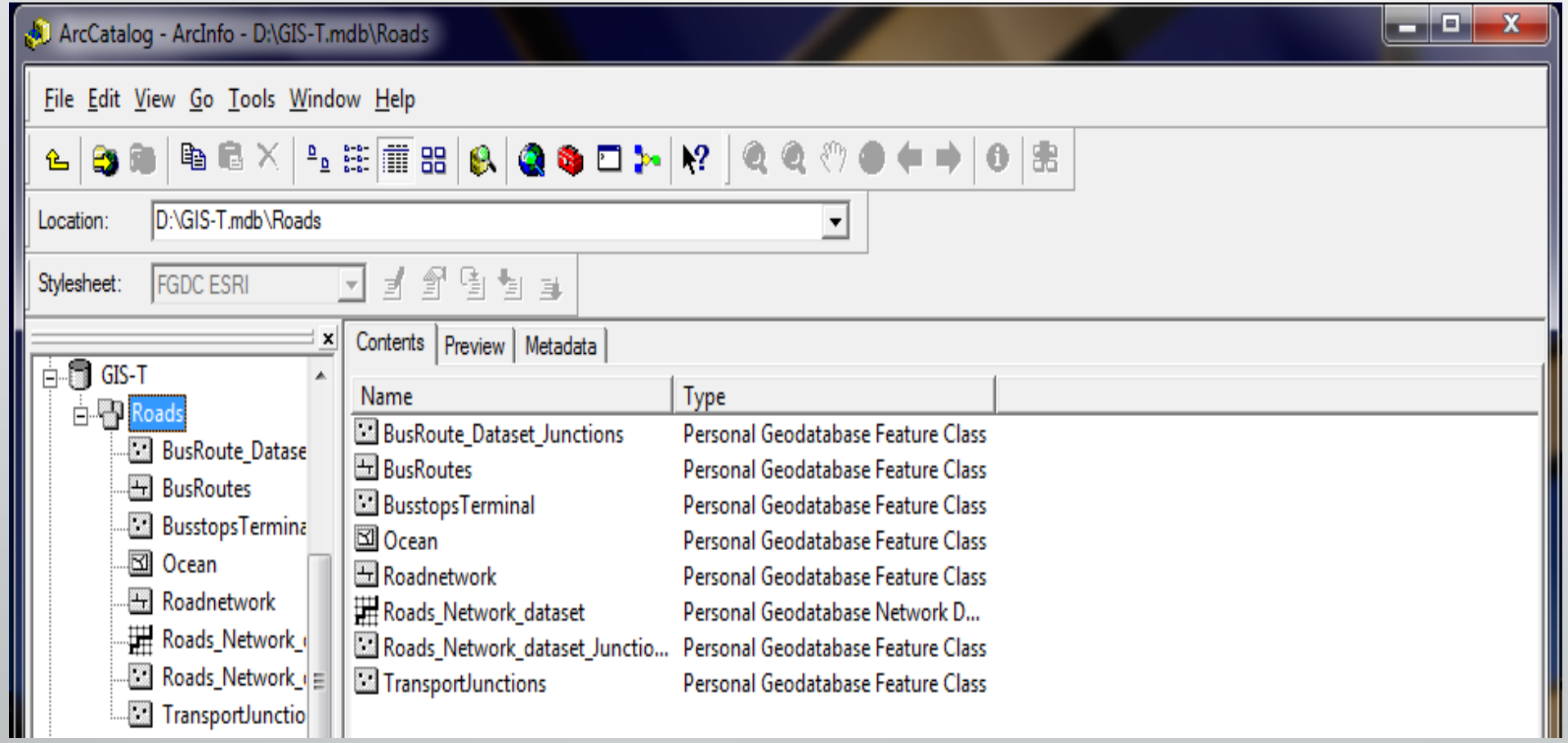
Geodatabase Parametrical Categorization

3 Types of Geodatabases…

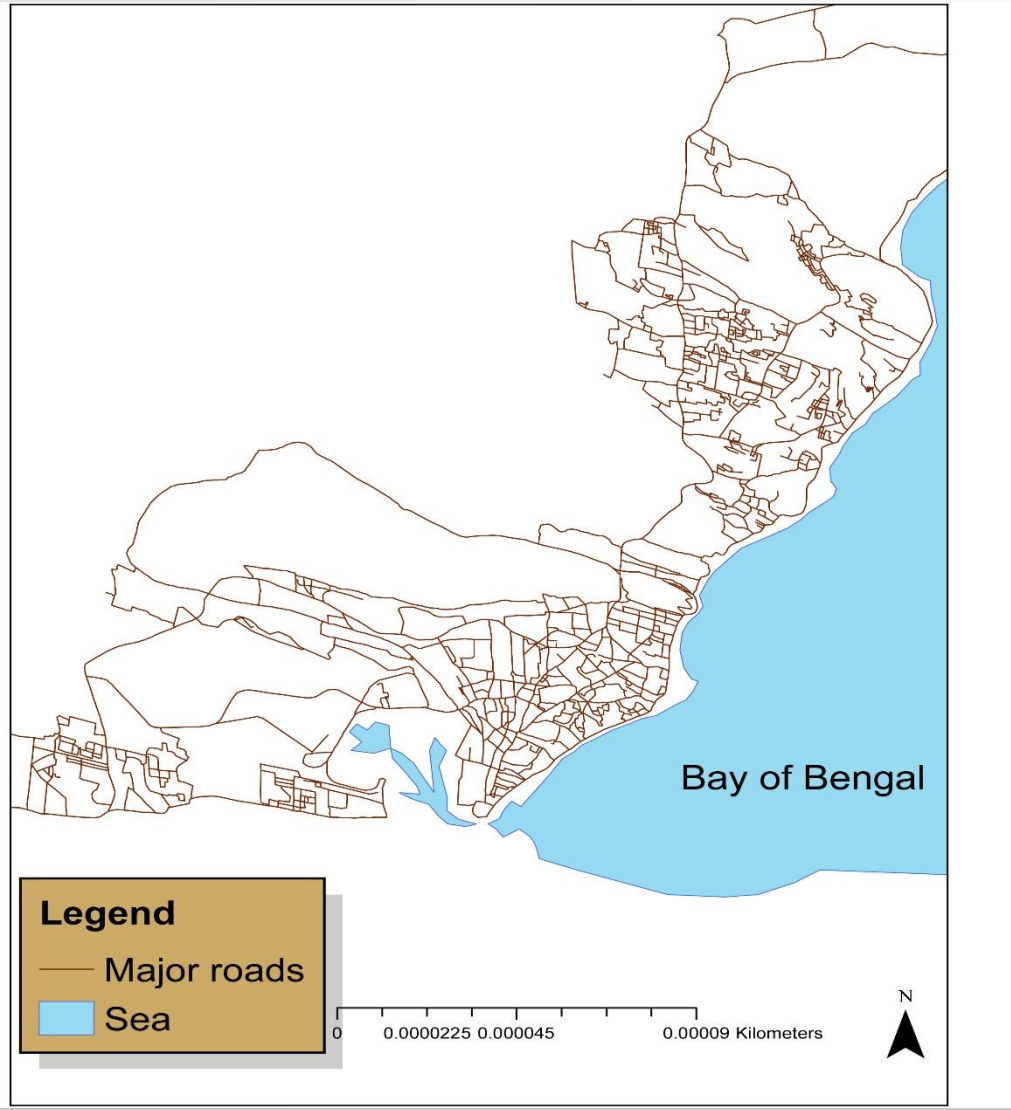
	Personal GDB 	File GDB 	SDE GDB (3 editions) 
Storage format	Microsoft Access	Folder of binary files	DBMS
Storage capacity	2 GB	1 TB per table*	Depends on edition
Supported O/S platform	Windows	Any platform	Depends on edition
Number of users	Single editor Multiple readers	Single editor Multiple readers	Multiple editors & readers
Distributed GDB functionality	Check out/check in replication	Check out/check in replication	Replication (all types) & versioning

* By default; option to have 256 TB per table

Geodatabase Creation in Arc Catalog



Part of Digitized Major Road Features



Part of Digitized Major Bus routes

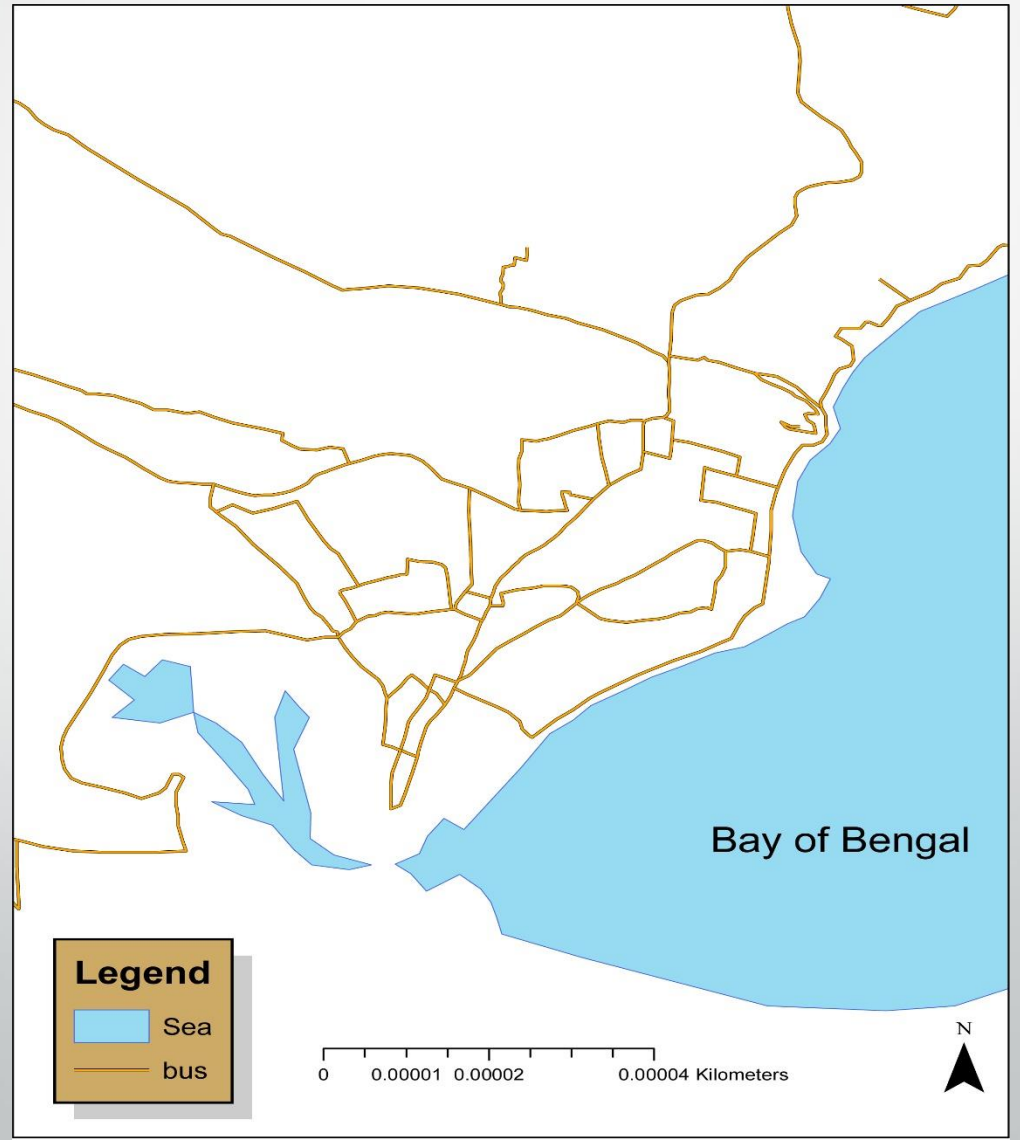
Table

bus

OBJECTID *	SHAPE *	SHAPE_Length	bus_no	bus_code	bus_owner
2	Polyline	0.021555	900	<Null>	APSRTC
3	Polyline	0.102825	900	<Null>	APSRTC
4	Polyline	0.016735	69900	<Null>	APSRTC
5	Polyline	0.041965	6960	C	APSRTC
6	Polyline	0.019269	25222	P,D/V,K,G,J,M	APSRTC
7	Polyline	0.038563	255260	P,D/V,K,G,M	APSRTC
8	Polyline	0.033553	20	A	APSRTC
9	Polyline	0.006074	69	<Null>	APSRTC
10	Polyline	0.047965	2069	A	APSRTC
11	Polyline	0.009597	540541500	H	APSRTC
12	Polyline	0.039848	54054138	A,B,C,D	<Null>

1 (0 out of 52 Selected)

bus



Part of Digitized Transportation Junctions

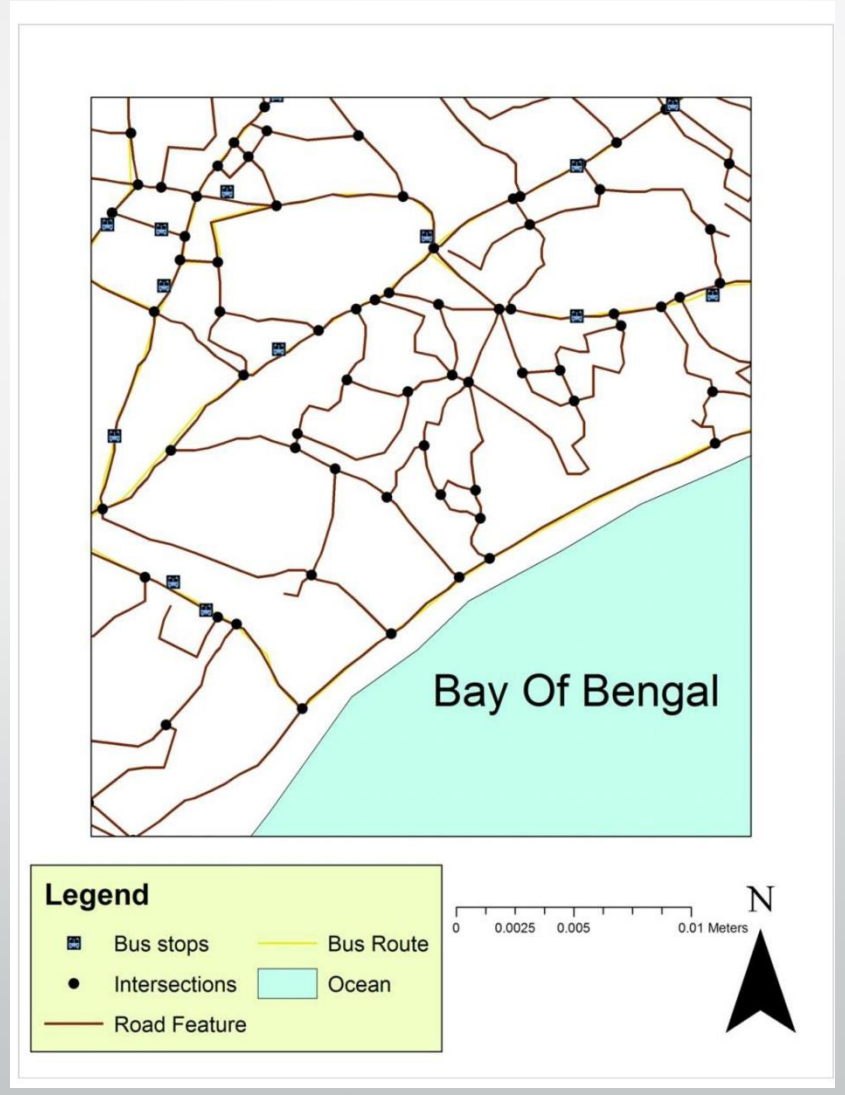
Table

terminal

OBJECTID *	SHAPE *	Bustop_name
29	Point	Boyapalem
30	Point	Paradesipalem
31	Point	Boravanipalem
32	Point	Marikavalasa
33	Point	Pmpalem
34	Point	Lawcolz
35	Point	Yendada
36	Point	Zoopark
37	Point	Sundarnagar
38	Point	Adarshnagar
39	Point	Hanumanthavaka
40	Point	Hanumanthavaka
41	Point	Visalakshinagar
42	Point	Dayalnagarcolony
43	Point	Dyalnagartwo
44	Point	Isakathota
45	Point	Maddilapalem
46	Point	Maddilapalem

0 (0 out of 131 Selected)

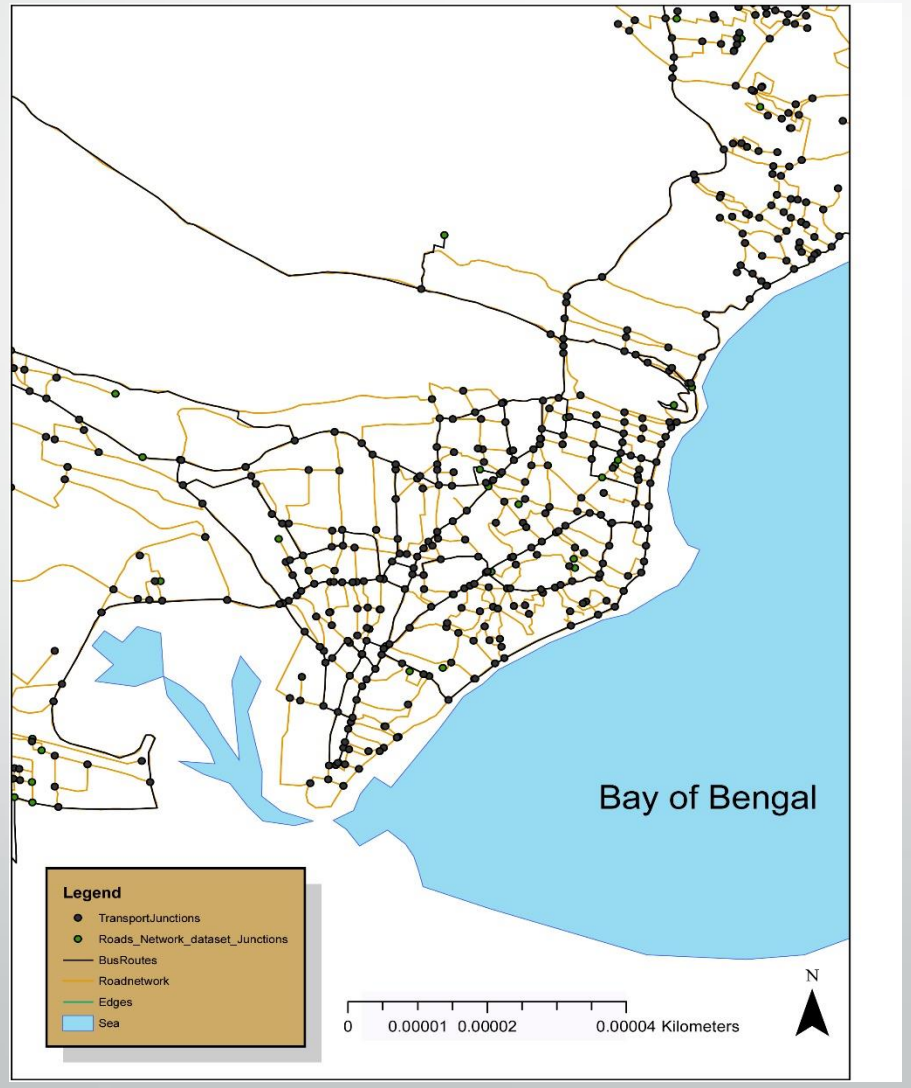
terminal



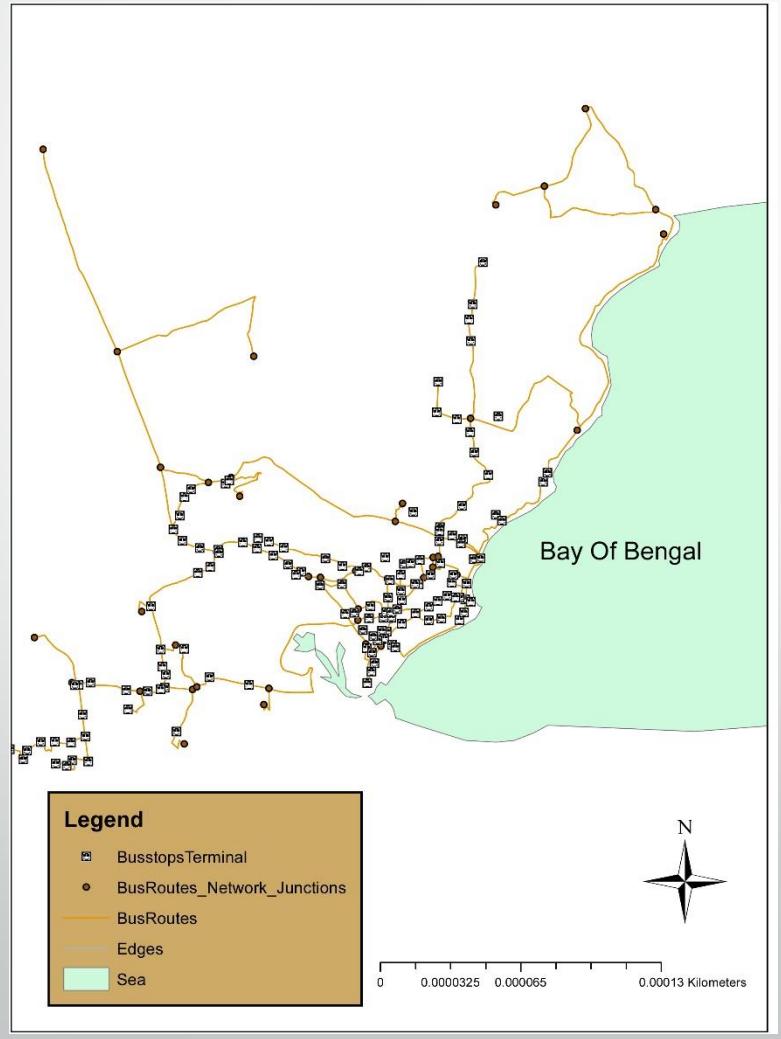
Network Dataset & Creation

- Network datasets are well suited to model transportation networks.
- They are created from source features, which can include simple features (lines and points) and turns, and store the connectivity of the source features.
- When you perform an analysis using ArcGIS Network Analyst, the analysis always happens on a network dataset.
- It is created by navigating through a right click on the feature dataset in the created geodatabase, where the feature classes can be added.

Created Road Network Dataset



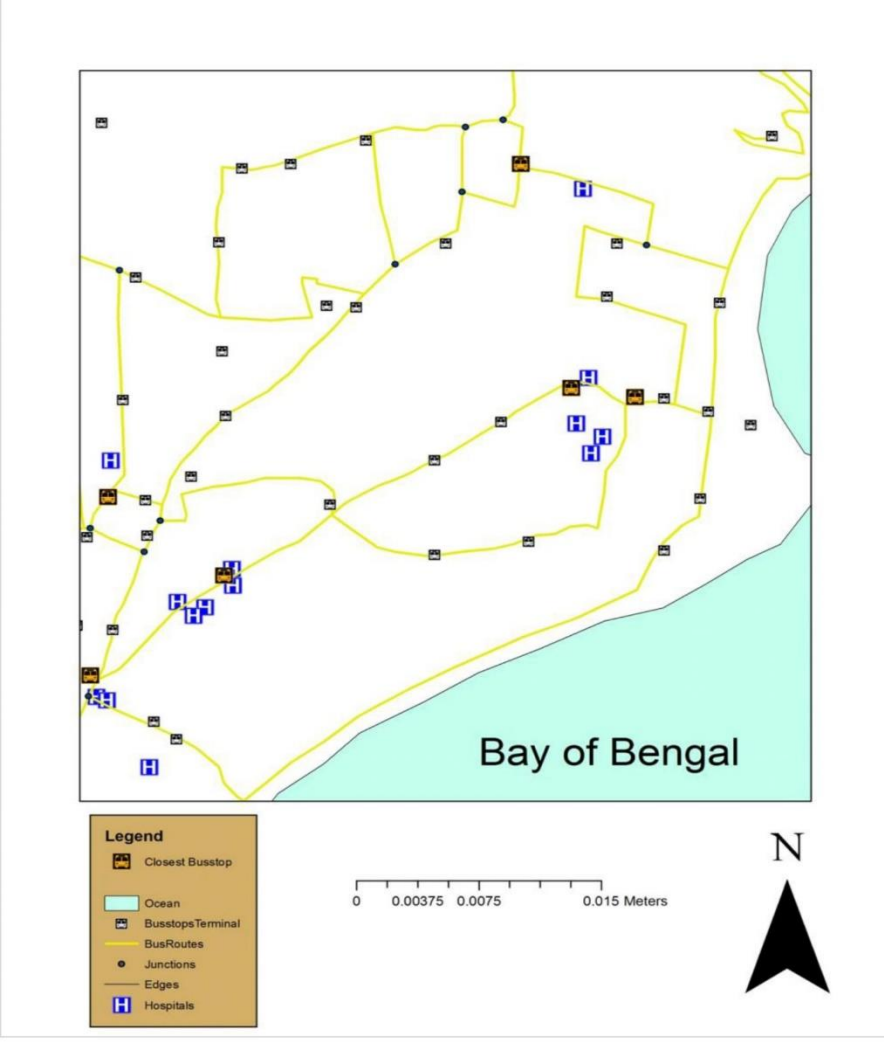
Created Bus route Network Dataset



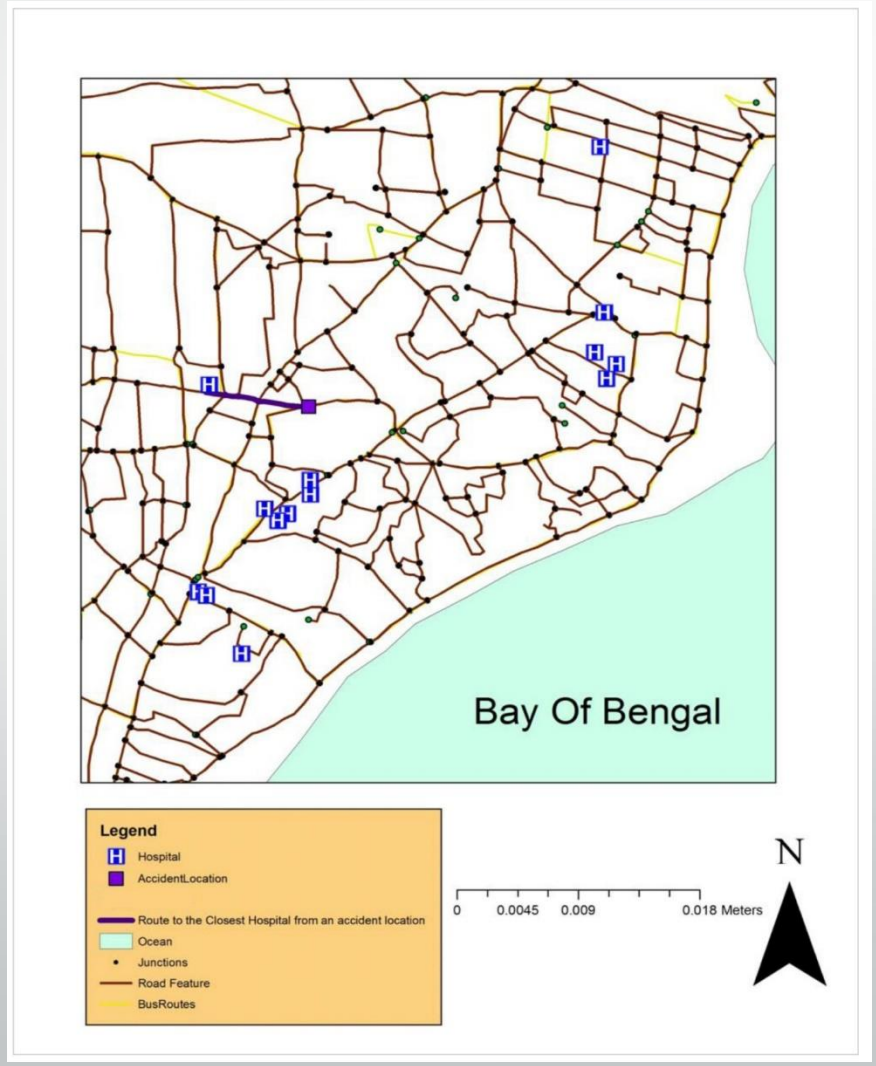
Concept of Network Analysis

- Network data structures were one of the earliest representations in geographic information systems (GIS), and network analysis remains one of the most significant and persistent research areas in geographic information science (GI Science).
- Network analysis is a way to solve network problems such as finding the best route, finding the closest facility, and identifying a service area around a location, OD cost matrix analysis, Vehicle routing problem, location-allocation.
- We have carried out two network analysis applications namely finding the closest facility (Closest Bus Stop to hospitals), finding the closest route from an incident location to hospital.

Example of Closest Bus stops to Hospitals



Closest route to a hospital from an accident location



Conclusions

- A Customized GIS-T data model is designed for Visakhapatnam city.
- The designed and implemented database is not full and comprehensive system, but a mere prototype, which can be further, improved, and expanded.
- A network analysis on selected application was done to find the routes to existing hospital facilities within the city.

Limitations

- Due to non-availability of enough spatial and non-spatial data, there may exist in the prototype many null values in the geodatabase attribute tables; all these need to be collected, documented, and implemented.
- The development and design of the GIS-T for Visakhapatnam city was based on the limited available spatial and non-spatial data.
- Thus, the developed GIS-T database is not comprehensive.

Recommendations

- In order to have well collected and organized spatial data related to the transportation sector, there is a need to have a spatial data infrastructure for Visakhapatnam city, which can make available all spatial data for the city. This will facilitates and make easy use of standardized data for various activities including development of GIS-T for the city;
- Therefore, decision makers need to be aware of the importance of the GIS-T for decision-making process, in addition, should be aware of the benefit of having such a geodatabase in support of urban transport planning systems.


Thank You!