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Itinerary

Counterpart Training Program

Stage 1 – Knowledge Building Stage

Day 2 - Session 1

1

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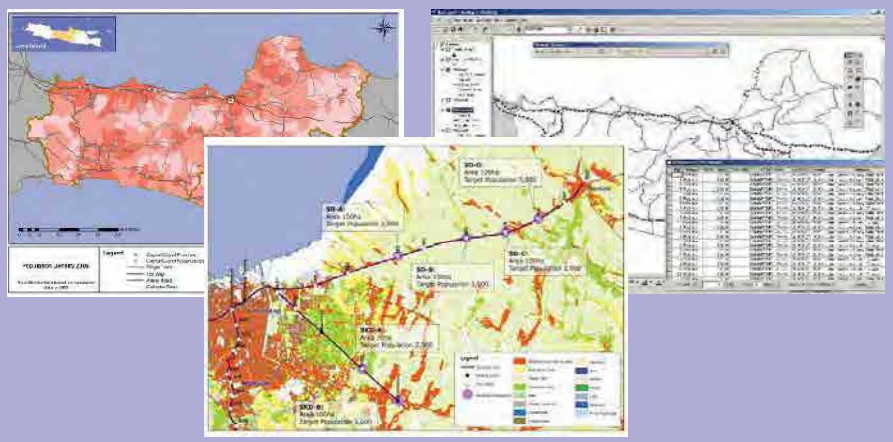
What's GIS?

- **Geographic Information System (GIS) is "a computer application used to store, view, and analyze geographical information, especially maps".**



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(Source: American Heritage Dictionary)

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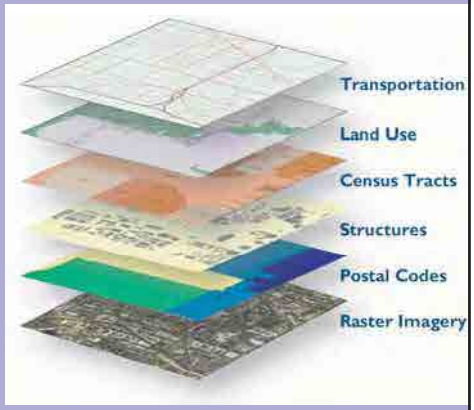
Layer and Dataset

- There are various geographic features such as administrative boundary, transportation, land use, census result, structures and so force.
- Data types are also various including numerical results of mapping survey, photo image, address and zip code.
- GIS relate all these data and enable cross-layer analysis on computer.



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Advantages of GIS compared with Paper Map

GIS is …

- **Multiscale**
  - Zoom in and out freely
- **Interactive**
  - **Overlay function ease interactive analyses**
- **Software with Many Applications**
  - **Tools such as map editing, geographical analyses, routing, geocoding etc**
- **Multiple Source**
  - **Many kind of source of information can be**
- **Flexible**
  - **A variety of GIS map applications and frameworks support a wide range of deployment options such as original software or website**

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3 functions and views of GIS

- **Geodatabase**
  - A GIS is a spatial database containing datasets such as features, rasters, attributes, topologies, networks, and so forth.
- **Geoprocessing**
  - A GIS is a set of intelligent maps and other views that show features and feature relationships on the earth's surface.
- **Geovisualization**
  - A GIS is a set of information transformation tools that derive new information from existing datasets.

5

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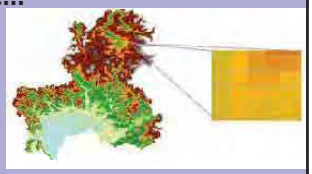
Type of GIS dataset

- **Vector data**
  - ex. Points, Lines, Polygons
- **Raster data**
  - ex. Digital Elevation Model, Satellite Image…
- **Data tables**
  - ex. Customer Information, boarding passenger at railway station…



6

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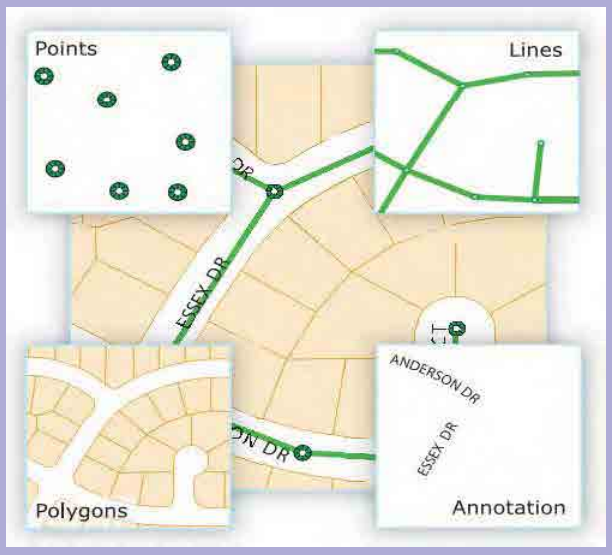
Vector-based features

- Points
- Lines
- Polygons



7

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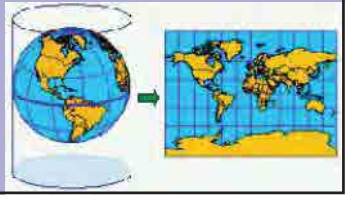
Coordinate System

- **Geographic Coordinate System**
  - ❑ Identifying location on earth by longitude and latitude. Although longitude and latitude is identical to location on earth, there are several geocoding systems because of difference or anchoring point.

- **Projected Coordinate System**
  - ❑ Since the earth is a deformed sphere, some rules, projection, are required for describing it in flat display or paper.
  - ❑ Projected coordinate system is based on projections, hence coordinate unit is distance measure such as meter.



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Coordinate System in Central Java

- **Geographic Coordinate System**
  - Most type of coordinate system can be applied.
  - Example of coordinate by Longitude and Latitude at Yogyakarta Tugu station is (110° 21'58"E, 7° 47'22"S).
- **Projected Coordinate System**
  - Universal Mercator Method (UTM), which divide area by 6 degree longitude, is widely used. Central Java regions are close to the are called "49S".
  - "WGS_1984_UTM_Zone_49S" is typical project coordination file for Central Java.
  - Example of coordinate by UTM 49S at Yogyakarta Tugu station is(430113m, 9138917m)

9

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Major GIS software

GIS	Company	Main features
ArcGIS	ESRI	The most popular GIS in the world.
MapInfo	Pitney Bowes	One of Major GIS software
SIS	CadCrop	User friendly interface and cost competitive
TransCAD	Caliper	Transportation Planning software with GIS function
Google Earth? ?	Google	Google Earth could be GIS in a broad sense

10

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What's ArcGIS

- ArcGIS contains various packages for Desktop PC, Server, Developer and Mobile machines and now CUBE

11

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ArcGIS Desktop Series

- ArcView
  - focuses on comprehensive data use, mapping, and analysis.
- ArcEditor
  - adds advanced geographic editing and data creation.
- ArcInfo
  - is a complete, professional GIS desktop containing comprehensive GIS functionality, including rich geoprocessing tools.

12

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Applications included in ArcView

Applications	Features
ArcMap	The main application in ArcGIS is ArcMap, which is used for all mapping and editing tasks as well as for map-based query and analysis. It's the primary application for all map based tasks including cartography, map analysis, and editing.
ArcCatalog, tool box	The Arc Catalog application helps users organize and manage all geographic information, such as maps, globes, data files, geodatabases, geo processing toolboxes, metadata, and GIS services.
Model Builder	The Model Builder interface provides a graphical modeling framework for designing and implementing geo processing models that can include tools, scripts, and data.

13

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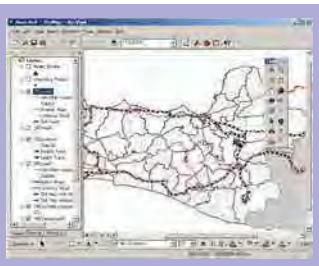
ArcMap

- ArcMap is main application of ArcGIS consisting of many controls, toolbars and object libraries.
- User can show and edit map with powerful GUI (graphical user interface).



14

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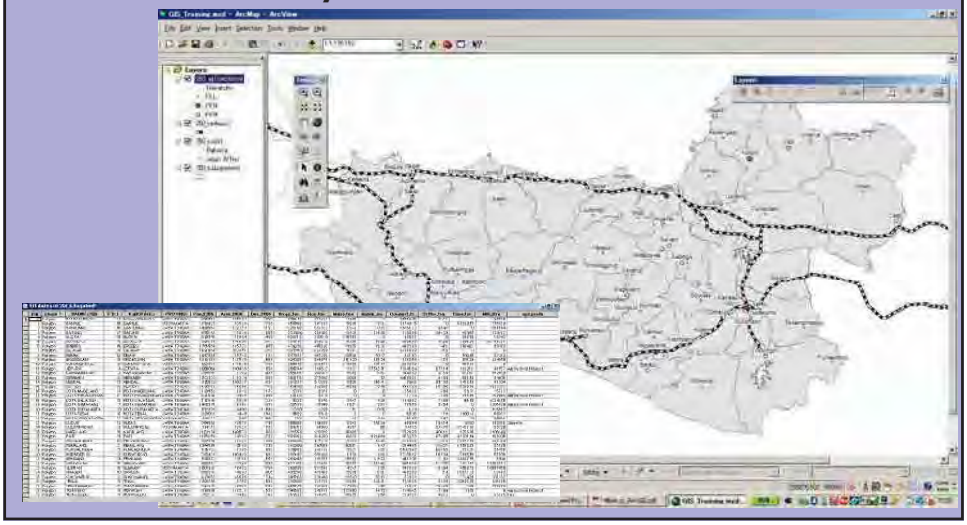
ArcMap: Data View and Attribute Table

- Data view is used for editing map and attribute table makes us easy to view details of data.



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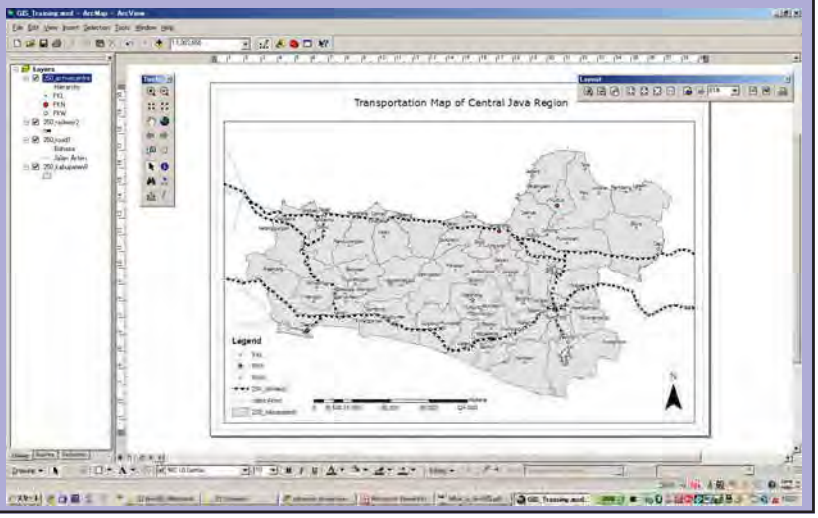
ArcMap: Layout View

» Layout view is useful for printing.



16

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ArcCatalog

- ArcCatalog is powerful application, especially for processing geographic data, "geo processing" with explorer like GUI and tool box.

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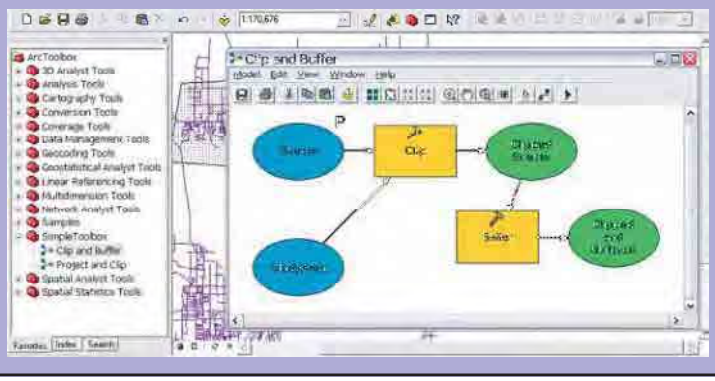
Model Builder

- In case user requires complicated geographic data processing, "geo processing", model builder play important role visualizing flow of process.
- Users who only conduct simple processing, model builder is not essential.



18

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File Types for ArcGIS

- Layer (Shape) files
  - Files containing shape of geographical features such as longitude and latitude, projected coordinate, shape of objects.
  - Example: shp file, lyr file, jpg file
- Data files
  - Files containing numerical or text database such as name of town, population
  - Example: dbf file, gdb file
- Project (Map) files
  - Files containing information on how to relate layer files and data files. Coordinate system of layer, symbol, label definition is also included. User have to note that object's location and database is not included here.
  - Example: mxd file

19

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Let's try!

- Points to be learned
  - How to visualize map data?
  - How to label by it's attributes?
  - How to change coordinate system and what's the difference?
  - How to change color and width by classification of city or road?
  - How to see attribute data?
  - How to show data table of each shp files?
  - What's data view and layout view?
  - What's mxd file and shp file?

20

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Let's try! (1) Labeling and Symbolizing

- Visualize kabupaten, city, road and railway in one map using the following data.

File type	File Name	Data Type
Kabupaten	kabupaten.shp	Area
Road	road.shp	Line
Railway	railway.shp	Line
City	activecenter.shp	Point

21

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Let's try! (1) Labeling and Symbolizing

- **How to symbolize and label features**
  - **Open ArcGIS by clicking Start -> Program -> ArcGIS -> ArcMap**
  - **Choose "A new empty map".**
  - **Right click "Layers" in the table of contents**
  - **Choose "Add data" and browse the geographic shape file which you want to open.**
  - **Change symbol by double clicking and choosing "Symbology" tab.**
  - **Adding label by double clicking and choosing "Labels" tab.**
  - **After labeling and symbolizing, please save mxd file**

22

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Let's try! (1) Labeling and Symbolizing

- How to remove unnecessary symbol
  - Choose layer of "road".
  - Double click and choose "Symbology" tab.
  - From left box, choose "Categoly" and "Unique Value".
  - From "Value field" pull down menu, choose "Bahasa".
  - Push "Add All Values" bottun.
  - Choose symbol except "Jalan Arteri" using shift key.
  - Right click and choose "Remove Value(s)".
  - Only Arterial Road will be shown in the map.
  - Please try to make a map like example answers

23

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Let's try! (1) Example Answers

24

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Let's try! (3) Using Layout view

- Add legend, north arrow and scale bar using layout view
  - Push "Layout View" button in the left bottom corner.
  - In the top tool bar, push "Insert" -> "Legend" to show legend of map.
  - Text, North arrow and Scale bar is also added selecting each menu from "Insert" menu.
  - Please try to make a map like example answer

25

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Stage 1 – Knowledge Building Stage

Day 2 - Session 2

1

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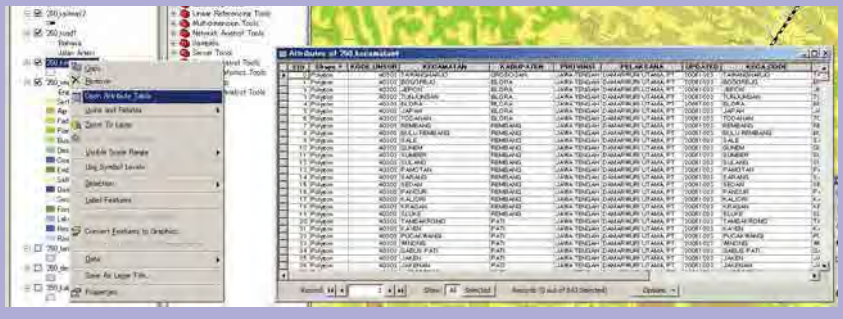
Joining and Relating map with database - 1

- One of the key function of GIS is to join and relate variety of data and analyses them easily.
- Usually shp file and it's corresponding dbf file contain attributes data.
- You can find the attribute data by right clicking layer and choose "Open Attribute Table".



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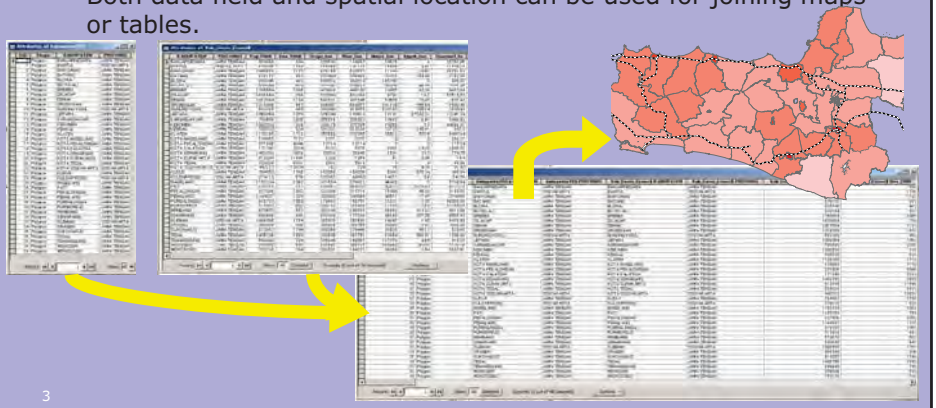
Joining and Relating map with database - 2

- Joining map with tables / maps
  - The joined attributes will be saved in the dataset's attributes table.
  - The joined attributes can be labeled and calculated.
  - Both data field and spatial location can be used for joining maps or tables.



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Joining and Relating map with database - 3

- Relating map with tables / maps
  - Relating do NOT append attributes.
  - Relating only stores the relationship between tables.
  - The related records are accessed on demand, when you select a feature or record in the original table or map.

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Joining and Relating map with database - 4

- Data Consistency is sometimes crucial…
  - Data have to be identical. Neither difference of expression nor space is allowed. Description have to be same to join or relate data.
  - Example: "Surakarta", "Solo", "Kota Solo", "Kdy.Solo", "Kdy Solo", "KdySolo"?
  - Numerical ID is recommended to join data.

5

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(1) Joining and Relating map with database

- One(many)-to-one(many) relationship
  - Joining: One-to-one and Many-to-one only
  - Relating: One-to-one, Many-to-one, One-to-many, Many-to Many can be used.

Kota	Population
Semarang	1,468,292
Solo	512,898
Yogyakarta	443,112

Kota	Station
Semarang	Tawang
Semarang	Poncol
Solo	Purwosari
Solo	Balapan
Solo	Jebres
Yogyakarta	Tugu
Yogyakarta	Lempuyangan

Kota	Population	Station
Semarang	1,468,292	Tawang? Poncol?
Solo	512,898	Purwosari? Balapan? Jebres?
Yogyakarta	443,112	Tugu? Lempuyangan?

Example of one-to-many relationship

6

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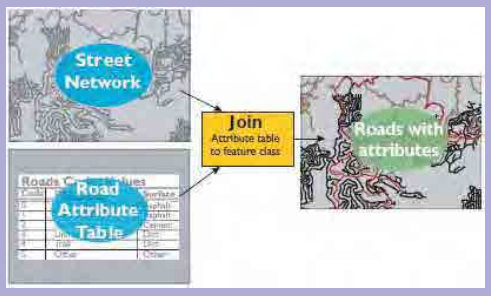
Geoprocessing

- Geoprocessing is one of the unique feature of GIS which edit data by geographical conditions.
- Geoprocessing is the methodical execution of a sequence of operations on geographic data to create new information. The process you perform may be routine, for example, to help you convert a number of files from one format to another.



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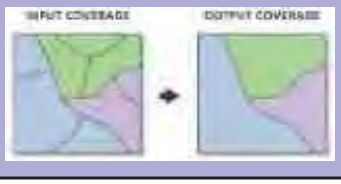
Geoprocessing

The following are typical types of Geoprocessings:

- Intersect
  - Computes the geometric intersection of two coverages, where only those features in the area common to both coverages will be preserved.

- Dissolve
  - Merges adjacent polygons, lines, or regions that have the same value for a specified item.



8

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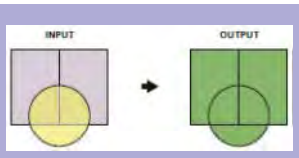
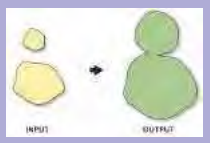
Geoprocessing – Typical Types

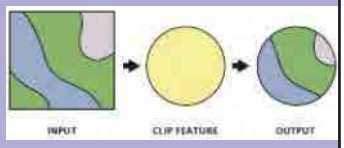
- **Union**
  - Creates an output feature class containing all features from both inputs.



- **Buffer**
  - Creates buffer polygons to a specified distance around the input features.



- **Clip**
  - Extracts, using a cookie-cutter method, those features or portions of features from an input coverage that overlap with a clip coverage polygon.



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Trying Buffer

- Buffer is simple and often used Geoprocessing.
  - Please find the "ArcToolbox" Button in the upper menu bar.
  - Open ArcToolbox and browse "Analysis tools" -> "Proximity" -> "Buffer" and please double click "Buffer" tool.
  - The right is the example of buffer window.
  - Please select station shp file "Stations_UTM" for "Input features".
  - Output file will be automatically selected.
  - Input buffer distance from stations. Let's say, 1,000m.
  - Press "OK"!

10

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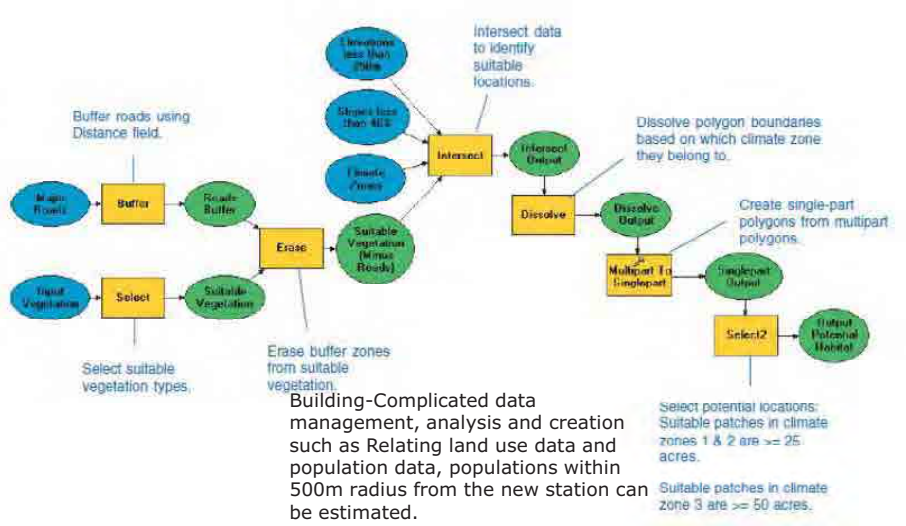
Further Step: Model Building



Building-Complicated data management, analysis and creation such as Relating land use data and population data, populations within 500m radius from the new station can be estimated.

11

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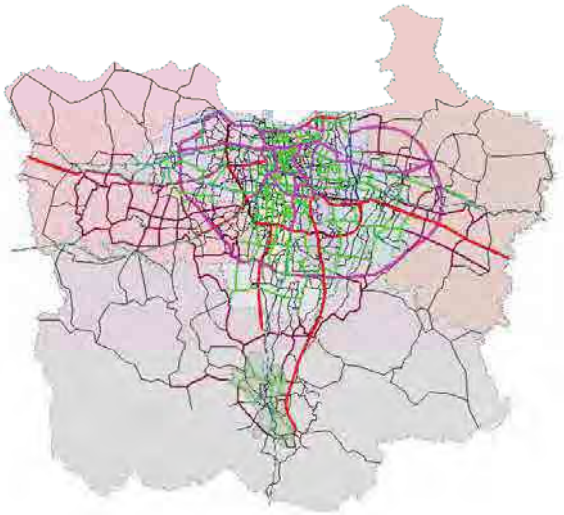
Future Transport Map of Region



12

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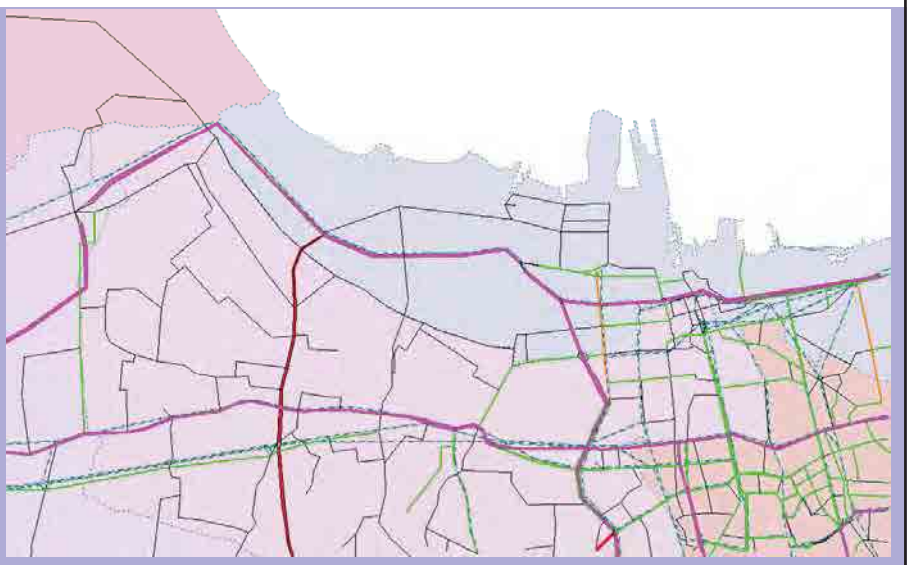
Zoom in on Northern Jakarta



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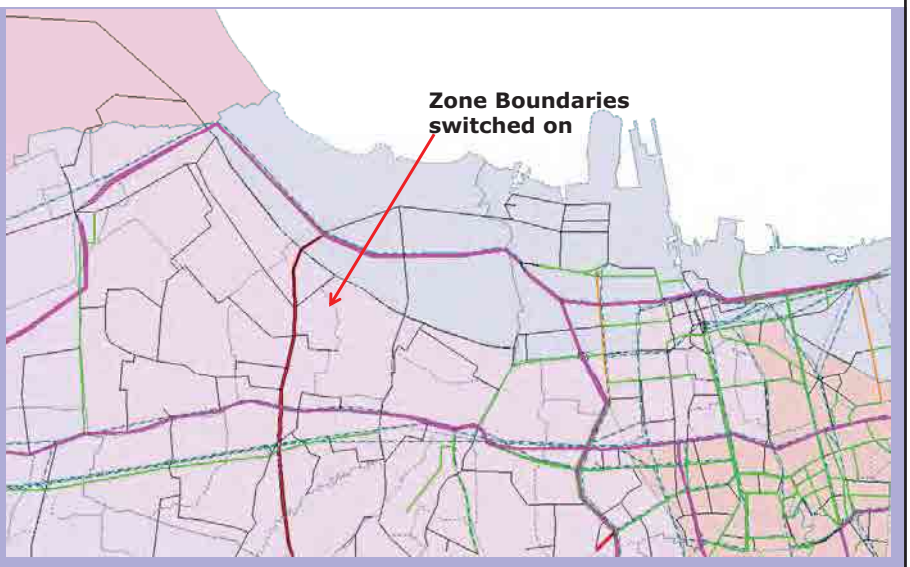
Zoom in on a Particular Zone



14

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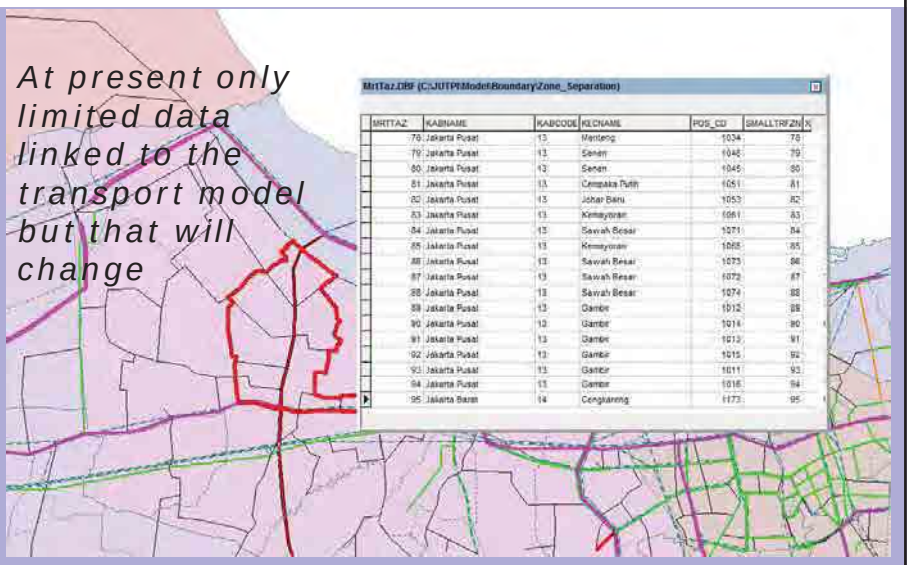
Highlight the Zone



15

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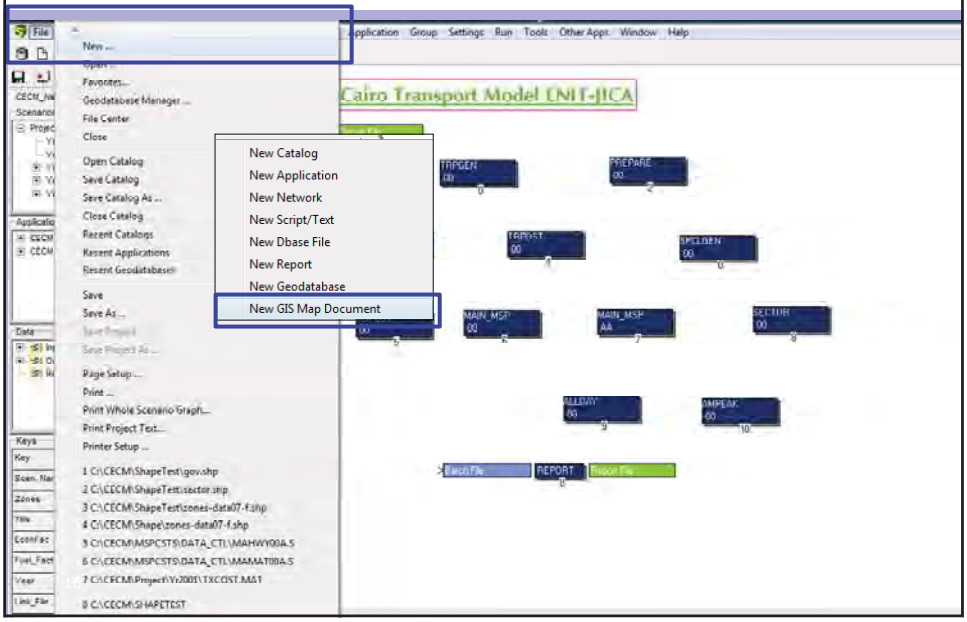
Geoprocessing Union Using CUBE



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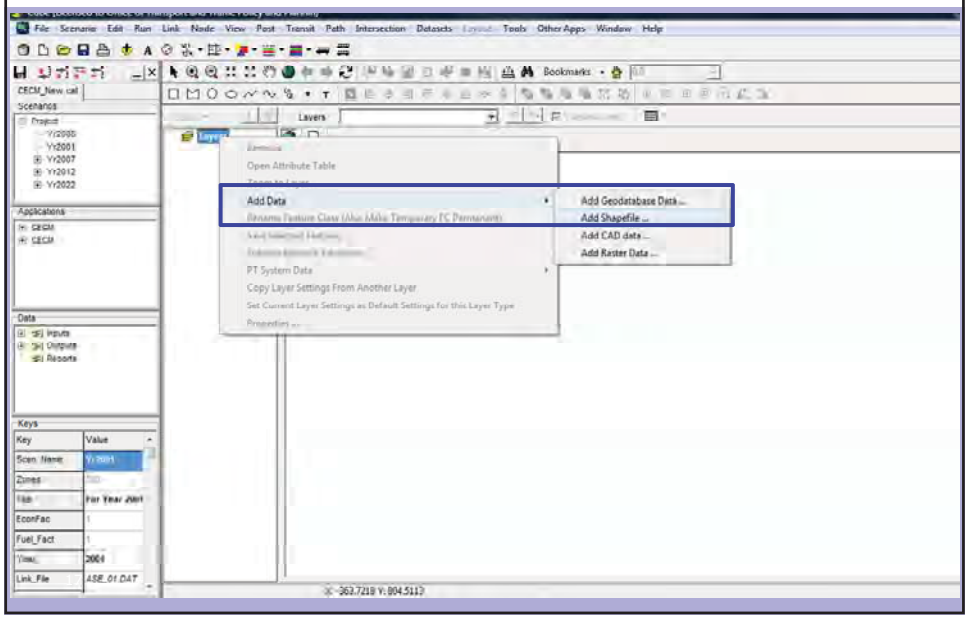
Specify Geoprocessing



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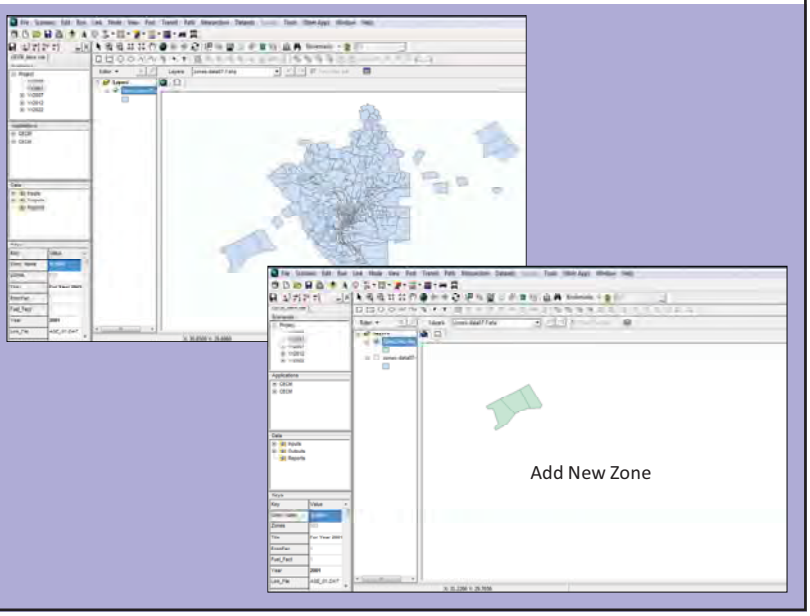
Add new Zone Data for Cairo



18

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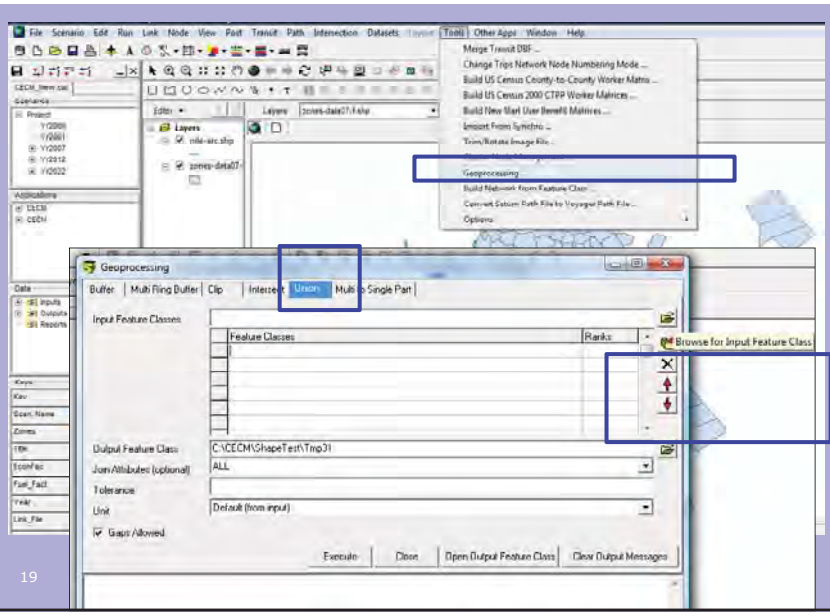
Open Geoprocessing Menu



19

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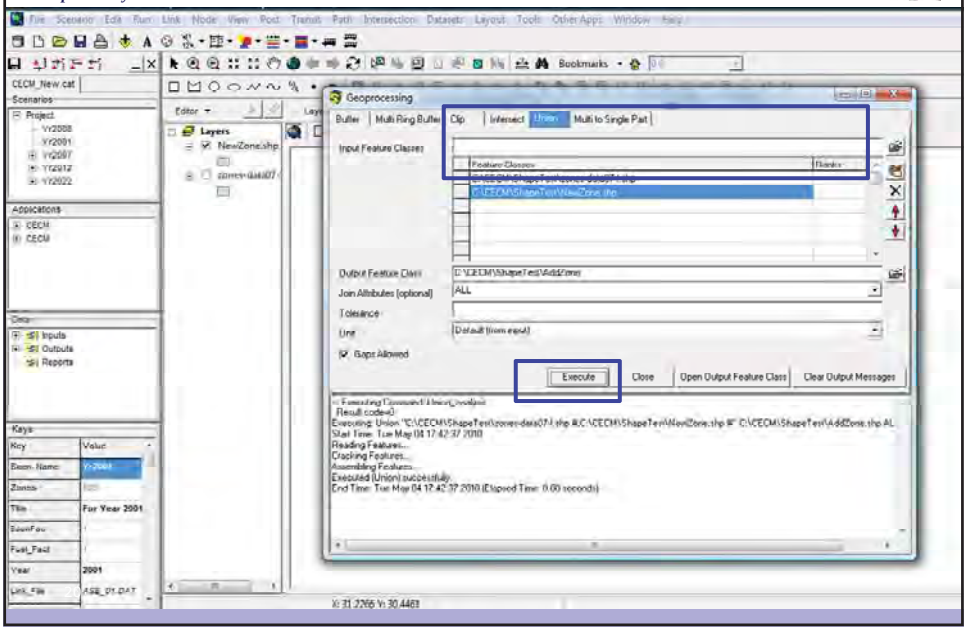
Execute Geoprocessing



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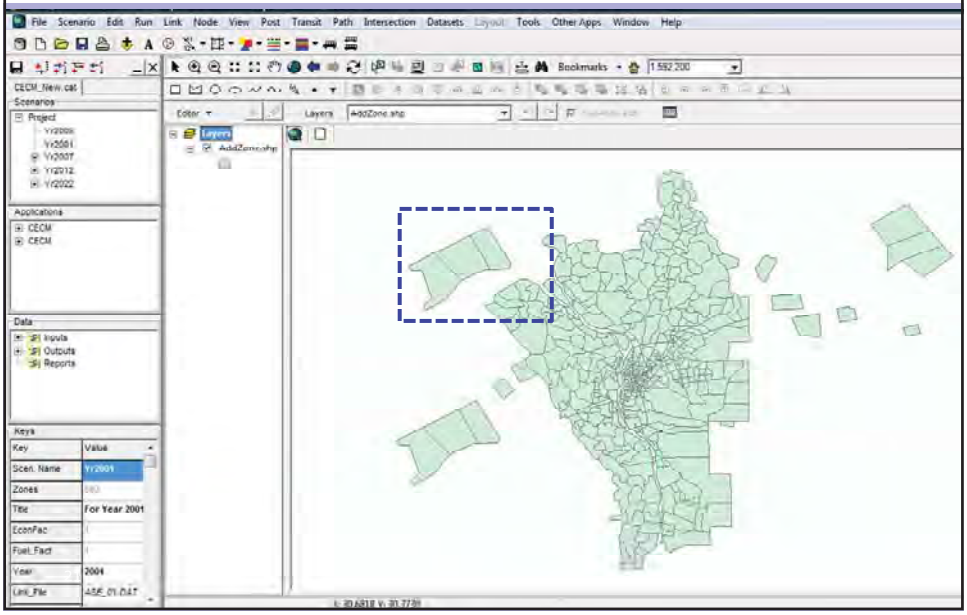
New Zone Added to Map



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Itinerary

Counterpart Training Program

Stage 1 – Knowledge Building Stage

Day 2 - Session 3

1

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CUBE--Citilabs

- **Citilabs was created several years ago via a merger of UAG and the software division of an English Consulting Company**
- **2200 sites in more than 70 countries use its products for transportation planning**
- **Citilabs is an Authorized ESRI Business Partner, utilizing ArcGIS Engine and other ESRI products.**

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Clients

Major Metropolitan Areas:

- San Francisco
- Sacramento
- Los Angeles
- Salt Lake City
- Tucson
- Minneapolis
- St Louis
- Cincinnati
- Cleveland
- Atlanta
- Washington
- Baltimore
- Philadelphia
- Pittsburg
- Cairo
- Bangkok
- Edinburgh
- London
- Copenhagen
- Amsterdam
- Brussels
- Paris
- Lyon
- Milan
- Beijing
- Dublin
- Hong Kong
- Sydney
- Melbourne
- Jakarta

Cube Base

Cube Dynasim

3

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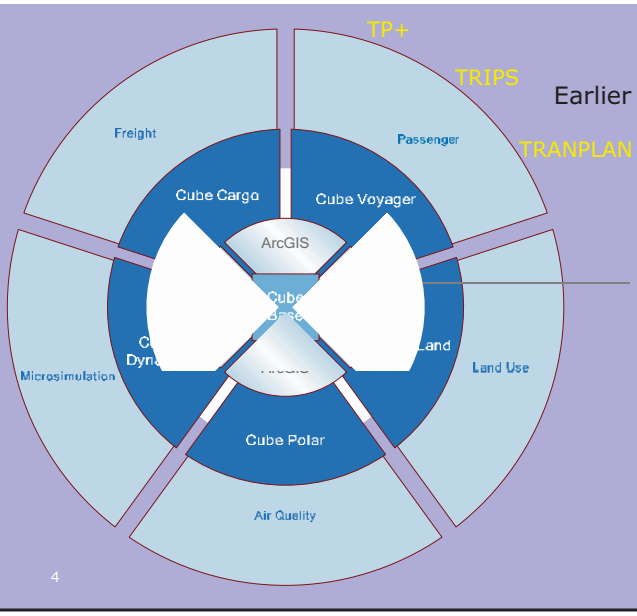
The Cube System



Earlier Products

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Is CUBE the only Transport Planning Software ?

- No, other software is used in the World such as
  - **TRANPLAN**
    A legacy software of Citilabs. Matrices and Networks can be read directly into CUBE. VIPER was a forerunner of CUBE Voyager
  - **EMME2**
    Matrix files can be read and written to an EMME databank
  - **SATURN**
    Conversion programs are available
  - **VISUM**
    Currently used elsewhere in the Middle East
  - **Network Data**
    is normally stored in GIS today, CUBE will directly read an ESRI Shape file.

5

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Demand Modeling

- Objective:
  - To develop a model capable of testing changes in:
    Transport Network Supply (road, rail, waterway, etc.)
    Movements of People (personnel, population, etc)
    Movements of Supplies (goods, trucks, trains, etc)
    Policy (e.g., avoid certain areas, minimize costs, etc)
- A travel forecasting model
  - represents travel supply (roads, buses..) and demand (travel/trips), the interactions between these, and the demand responses to changes in supply and policy.

6

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Elements of a Demand Model

1. The Model:
   - Various equations reflecting travel behavior
     - How frequently one travels
     - Where one travels
     - What mode..
2. The Software:
   - Applies 'The Model' Equations
3. The Data:
   - Describes the supply and the demand
     - Socio-Demographics
     - Land Use
     - Networks…

Some of this we have discussed already but we are now looking at the material in the context of a transport model.

7

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Methodological Approaches

Cube Voyager easily applies to <u>ANY</u> form of Transport Model :

- The 'Four-Step' model
- Modified 'Four-Step' models
- Tour-Based Models
- Activity Based Models
- Urban Models
- Regional Models
- National Models

8

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The 'Four-Step' Model

1. **Trip Generation:**
   - Estimate how many trips (Productions) are made by each household for each trip purpose (commuting, shopping…)
   - Estimate how many trips (Attractions) are attracted to each location (shopping centers, work places..)
   - Results in Production/Attraction Vectors
2. **Trip Distribution:**
   - Estimate how many trips go from a location to all other locations
   - Results in Production/Attraction Matrices
3. **Modal Choice:**
   - Given that someone will travel from one location to another, compare the travel options and select a mode
   - Results in Origin/Destination Trip Matrices by Mode
4. **Assignment:**
   - Route the travel onto public transport services and roadways

9

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Transport Modeling Terminology

- LINK
- NODE
- ZONE/TAZ
- CENTRIOD
- NETWORK
- ZONAL DATA
- PRODUCTIONS
- ATTRACTIONS
- TRIP TABLE
- MATRIX
- GRAVITY MODEL
- COST
- PATH BUILDING
- SKIM/SKIMMING
- LOS
- VC RATIO

Now for some important CUBE Terminology.

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CUBE Terminology – the Catalogs

- **The Catalog**
  - The Catalog File is the only file which you must remember its name and location.
  - The Catalog is the 'root' of a model. Everything else is linked to it.
  - The Catalog tracks all the components of a model
    - Applications (Model Processes)
    - Model Keys (User Input Data)
    - Scenario Data (Unique Sets of Keys)

11

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Applications

Applications

- The Applications are the Model Processes.
- A single Catalog may have many Applications
  - Passenger Forecasting
  - Freight Forecasting
  - Land-Use Forecasting
  - Sub-Area Analysis
  - Impact Studies
- The Application file is a single page which tracks data flows and organizes modeling functions. These functions may be either from Cube Libraries or User Defined.
- Application files may be nested to provide model structure.

12

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Starting Cube

The 'Welcome to Cube' Screen
- Used to Access a Catalog
- Easy access to the most recent Catalog

1. Double-Click the Cube Icon to Access the Welcome Screen
2. Click 'Cancel' to open Cube without opening a Catalog

13

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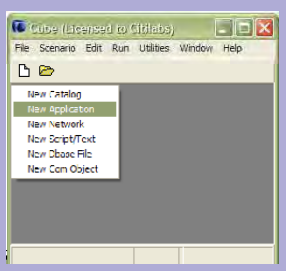
Create a Catalog

1. Select File > New
2. Choose 'New Catalog'
3. Save the new Catalog to: ???
4. Scenario-Manager opens for the new Catalog along the left-side of the window.



14

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Back to the CUBE Programs ?

Today	• Base • Voyager
Today Next Session	• Analysis • Avenue • Land • The Geodatabase • The Cairo Model, including a GIS example
Tomorrow- Scripting	• Scripting • An Example

15

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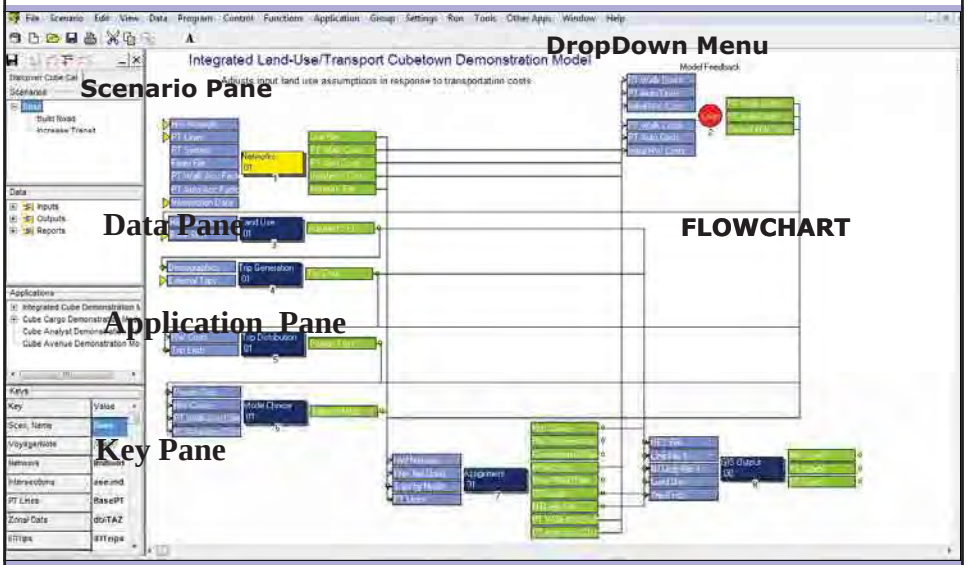
CUBE Base



16

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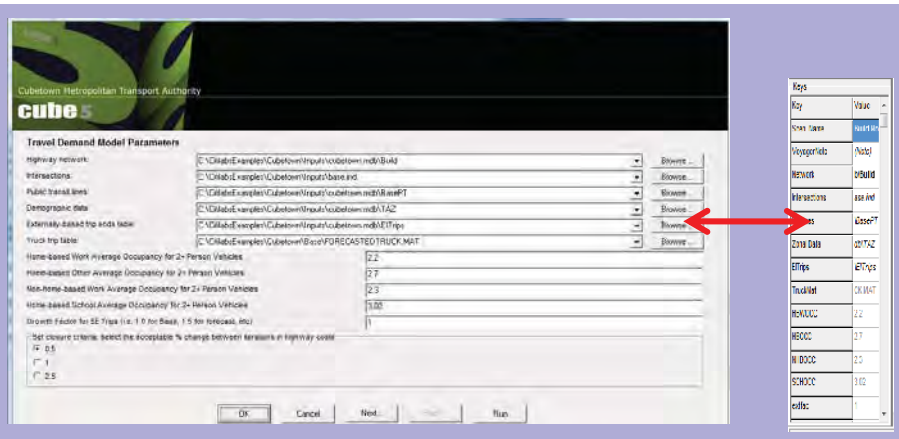
Catalogue Keys



17

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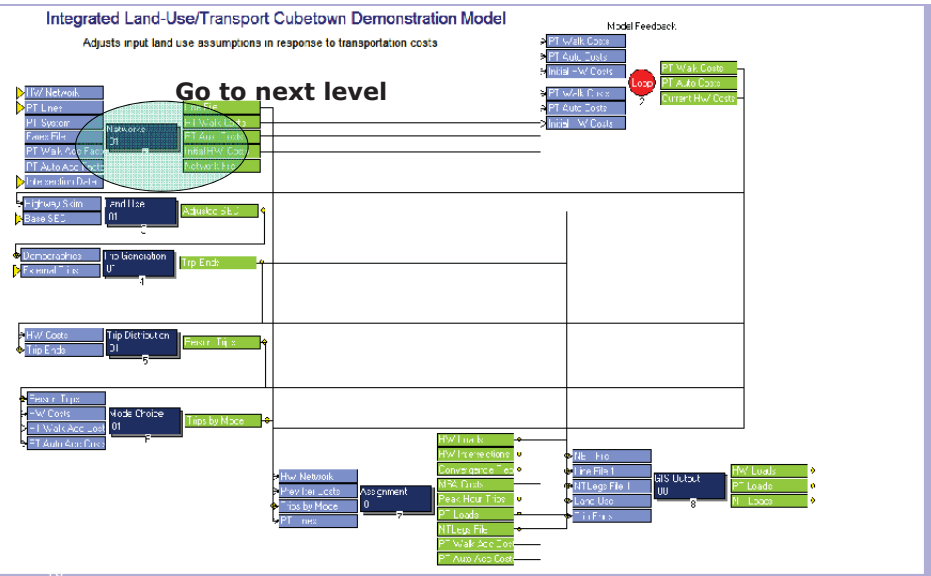
CUBE MODEL LEVELS



18

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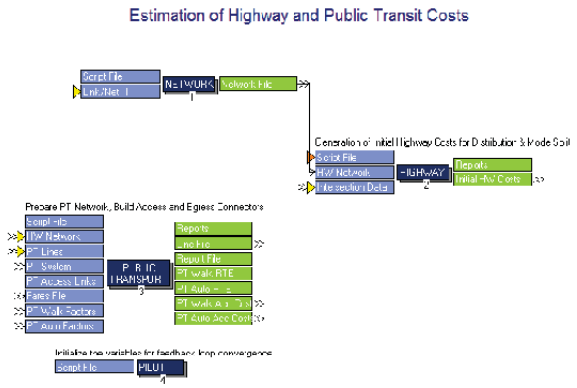
Next Level Down has the Programs



Further Discussion during practical example

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The Voyager Programs

- Pilot Program
- Fratar
- Highway
- Network
- Matrix
- Distribution
- Generation
- Public Transport

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Pilot

- The Pilot program is the basic driver for Cube Voyager application programs.
- Most users will use Pilot only to invoke the individual programs in the order desired.
- Pilot can check the return codes of the individual programs, invoke system commands, perform complex mathematical.
- Use in loops and conditional branching, application programs can be run in any order desired.

21

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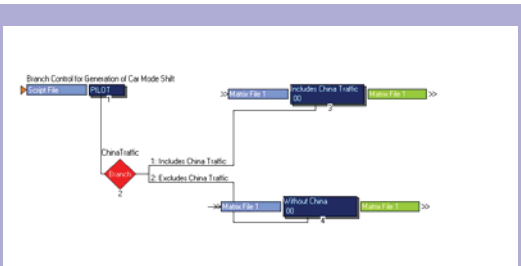
Pilot-An Example



- Through the Pilot Program the model will follow one of two Paths

22

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Generation

Input-- Traffic Zone Data

- Resident Workers in Income Class by Employment Category
- Resident Students
- Employment Opportunities in Income Class by Employment Category
- Student Places

Output--- Zonal Trip Ends

- Productions by Income Class by Trip Purpose
- Attractions by Income Class by Trip Purpose

23

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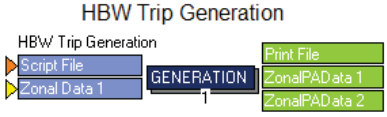
Generation - Example



Model has 5 trip purposes for each of three Income Classes:
1. Home-Based Work Trips
2. Home-Based School Trips
3.Home-Based Other Trips
4.Non-Home Based Business Trips
5. Non-Home Based Other Trips
(Trip Purpose 1-3 balnce A to P-for 4 and 5 balannce P to A)

24

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Network

Reads input network files of various formats: ASCII records, standard database in dBASE style (DBF), Cube geodatabase networks, or any Cube Voyager, TP+, MINUTP, Tranplan, or TRIPS binary network format.

Generates a data record for each unique node and each link found in any of the input files.

A valid node record, the Network program requires a node variable, named N.

A valid link record, the Network program requires an A-node, named A, and a B-node, named B. Each A-node and B-node must exist on a node record.

25

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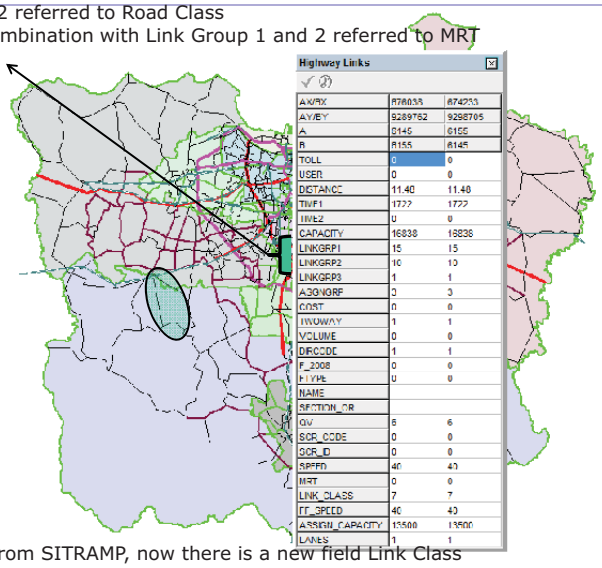
Network --Example

Link Group 1 and 2 referred to Road Class
Link Group 3 in combination with Link Group 1 and 2 referred to MRT



Link Group 1-3 from SITRAMP, now there is a new field Link Class

26

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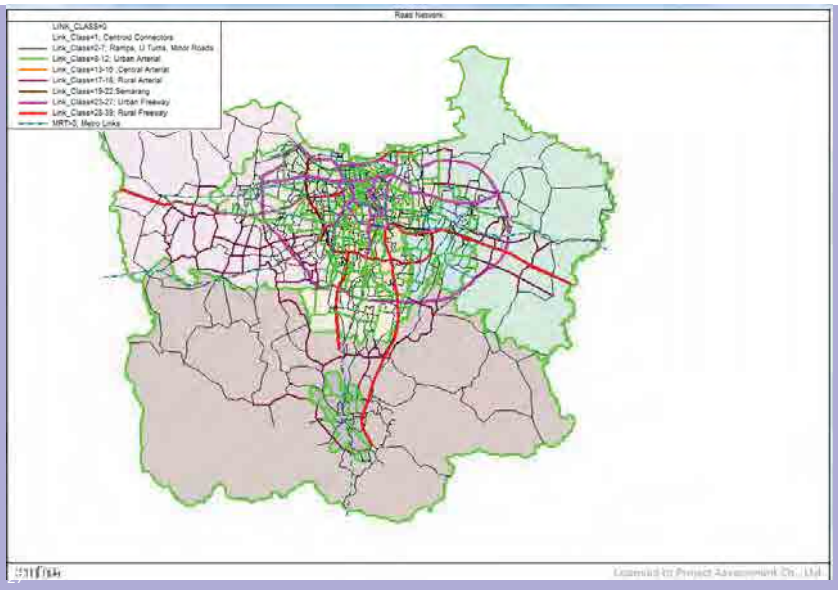
Network showing Link Class



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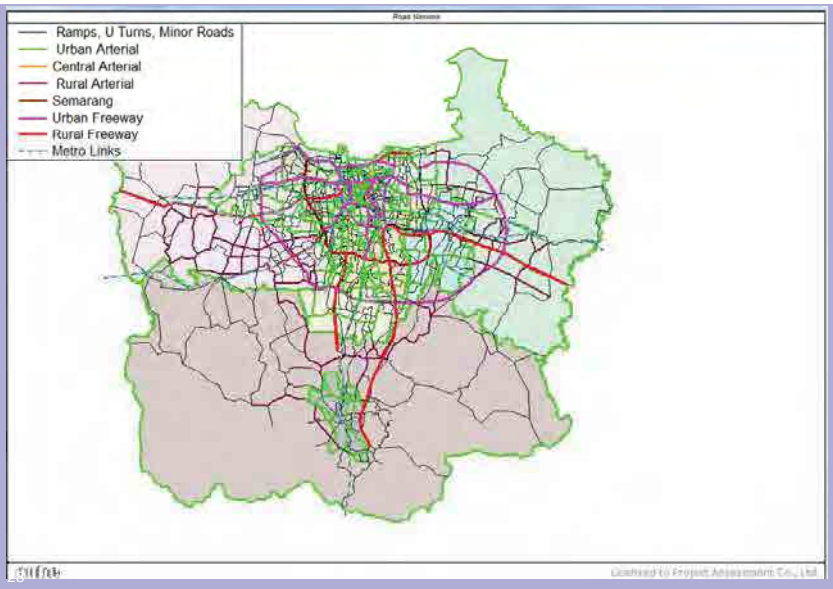
Network
For presentation better without reference to link class.



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Distribution

Input-- Zonal Data

- Productions by Income Class by Trip Purpose by Income Class
- Impedance Functions
- Network Travel Skims

Output--- Travel Matrix

- Travel Matrices by Income Class by Trip Purpose by Income Class

29

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Trip Distribution, the Structure

$$Trip_{ij} = P_i A_j f(T_{ij}) / (\sum_{j=1}^{n} A * T_{ij})$$

Where :
P = the number of trip productions for a zone.
A = the number of trip attractions for a zone.
T = the travel impedance factor between zones.
i = the production zone.
j = the attraction zone.
n = the number of zones.

This states that the trip productions in zone I will be distributed to each zone according to the relative attractiveness of zone J. Each J's attractiveness is determined by the product of its attractions and some function of the spatial separation between i and j. The sum of the these products for all j's (relative to i) is obtained . Each j will then be given a pro rata share of the productions for i based upon its attractiveness.

30

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Matrix

- Computation of new matrix values
- Converting and merging matrices between various formats
- Reporting values from matrices and zonal data:
  - Selected rows
  - Marginal summaries (trip ends, etc.)
  - Frequency distributions
  - User formatted files
- Transposing matrices
- Generating matrices
- Renumbering, aggregating, and disaggregating matrices
  - Matrix Splitting eg Mode Split

31

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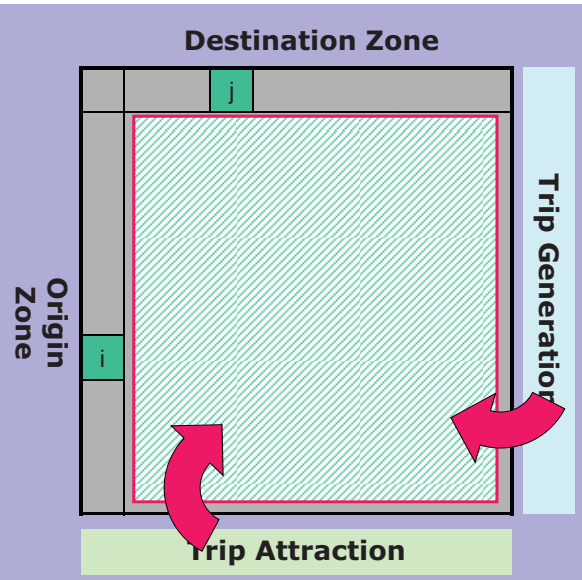
What is a Matrix??



32

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Fratar

Inputs

- Starting Matrix
- Column and Row Factors

Outputs

- Revised Matrix with same distribution but with new row and column totals

33

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Fratar Procedure

Start Matrix

Zone	1	2	3	Total
1	57	24	19	100
2	64	106	30	200
3	102	61	137	300
Total	223	191	186	600
Target	240	200	160	600

After Several Iterations

Zone	1	2	3	Total
1	60	25	16	102
2	70	190	26	206
3	113	64	118	292
Total	240	200	160	600

Target is achieved in new column totals with little change in row totals

34

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Highway

Inputs

- Networks
- Associated Link and Node Files
  - Toll Files
  - Turn Penalties
  - Node Descriptions
- Travel Matrices

Outputs

- Travel Impedances
- Loaded Network
  - Link Volumes
  - Intersection Analysis

35

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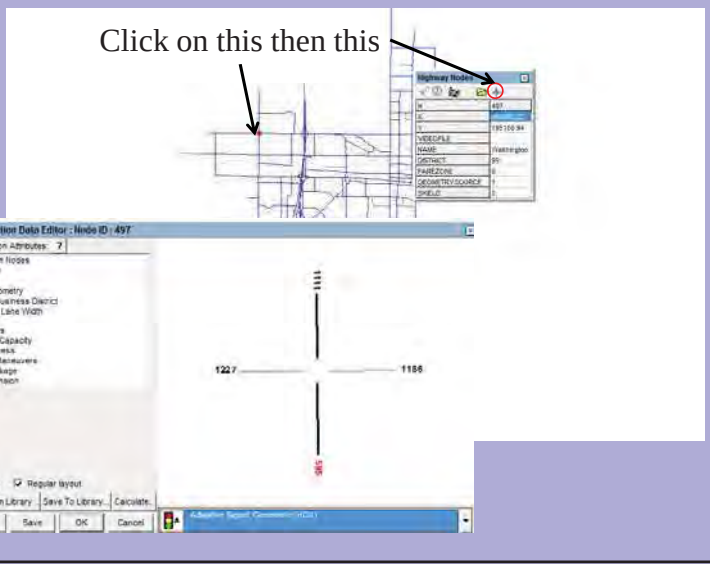
Highway Node Prior to Assignment



36

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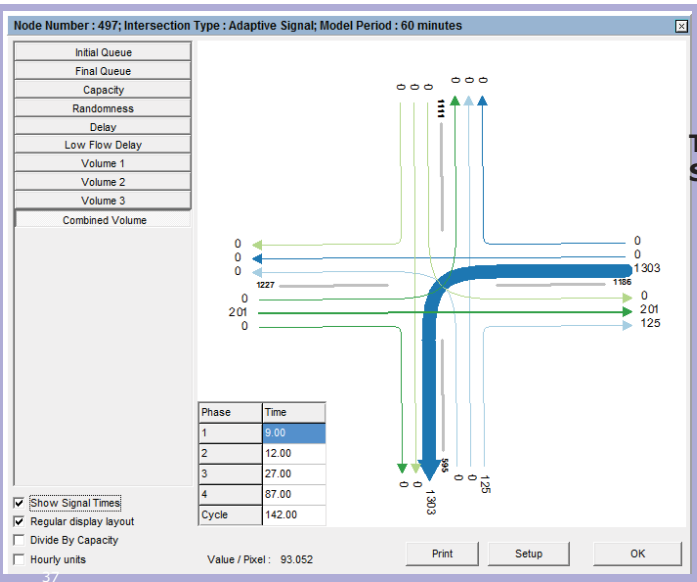
Highway Node After Assignment



Traffic Volume and Signal Settings

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Public Transport

Inputs

- Network File
- Line File
- Associated Line Data
  - Fares
  - Mode and Operator Descriptions
- Access Links
- Travel Matrices by Mode

Outputs

- Travel Impedances
- Loaded Network
  - Link Volumes
  - Line Volumes

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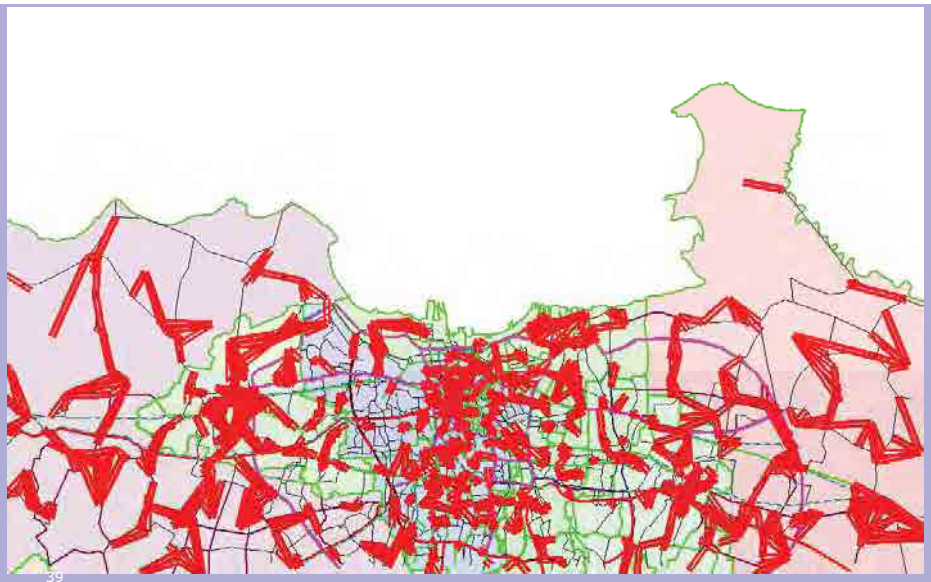
Public Transport-Walk Access Links to PT Routes



39

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Itinerary

Counterpart Training Program

Stage 1 – Knowledge Building Stage

Day 3 - Session 1

1

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The CUBE Demonstration Program

- Before we start today
- Make sure that you have the Cubetown application installed correctly on your computer
- This way you can follow some of the material directly on your computer

2

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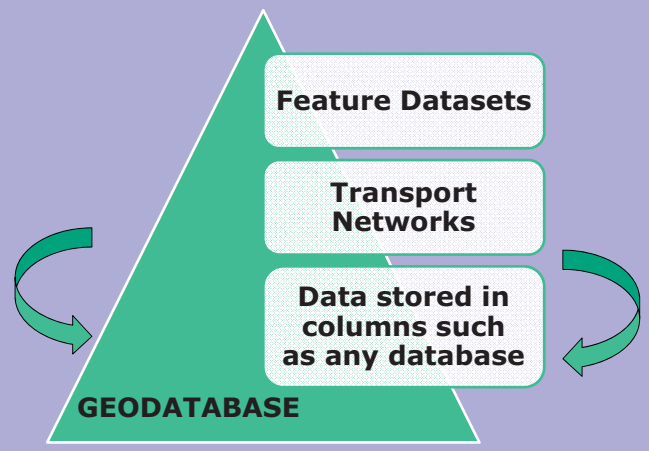
The GeoDatabase



ESRRI ArcGIS 9.2 personal Geodatabase format

3

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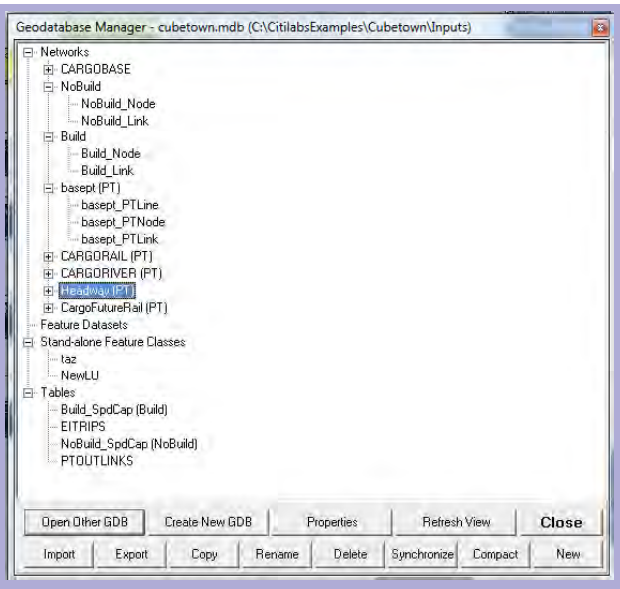
Geo Database Structure



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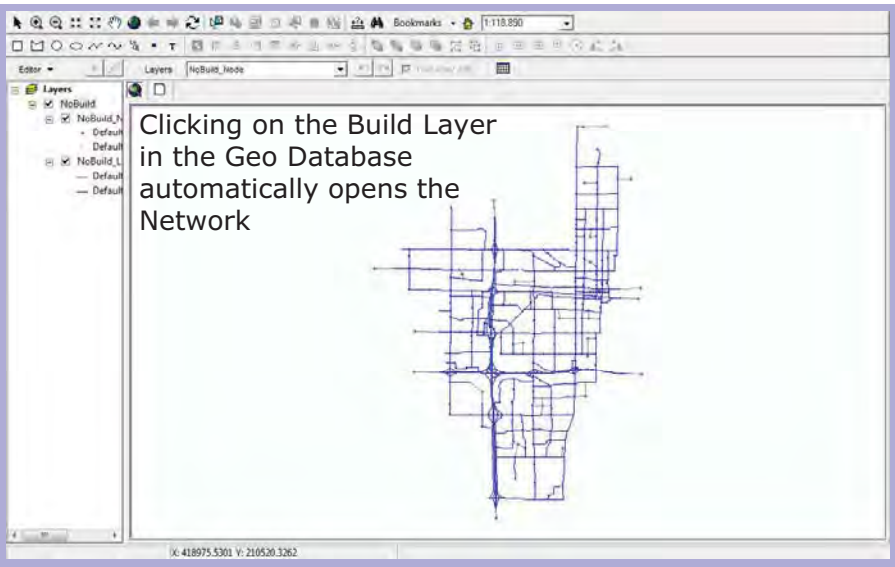
Geo Database Example



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The Geodatabase

Convenient for data transfer

- All base year data and scenario data in a single file.
- Easy to transfer most basic data associated with a transport model scenario.
- Previously have to copy several files now only a single file.

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CUBE Voyager Extensions

- Analyst - Voyager Extension
- Avenue – Voyager Extension
- Land –a new type of model that links land use and the real estate market.
- Cargo - Voyager Extension

7

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Analyst

Inputs

- Earlier Travel Matrix
- Count Data
  - Vehicle Counts
  - Passenger Counts

Outputs

- Updated Travel Matrices that matches Counts both Vehicles and or Passengers

8

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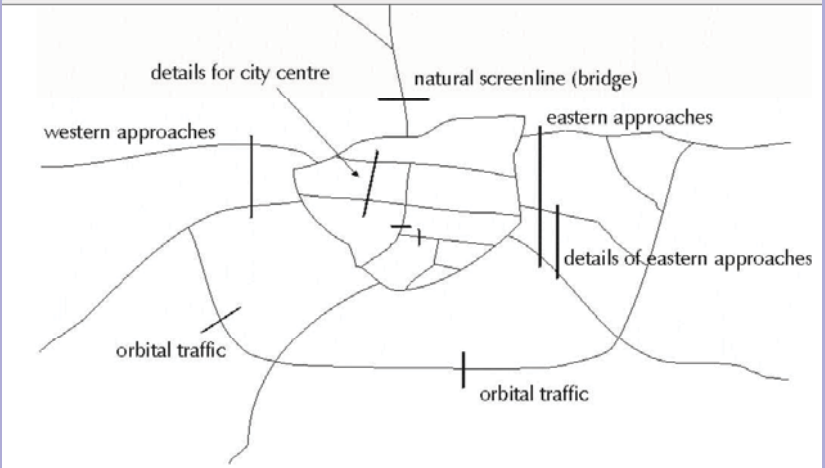
Typical Screenlines in a City



Typical screenline configuration for an urban area

9

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The Process

- Comparison across screenline shows a large difference between assignment and traffic counts
- Input in available traffic counts
- Improve the match between traffic counts and model by using the maximum likelihood procedure.

10

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Avenue

What is Avenue
- Hybrid Model between Network Assignment and Animation
- MesoSimulation Model

Inputs
- Travel Matrix by Time Slice
- Network

Outputs
- Loaded Network by Time Slice

11

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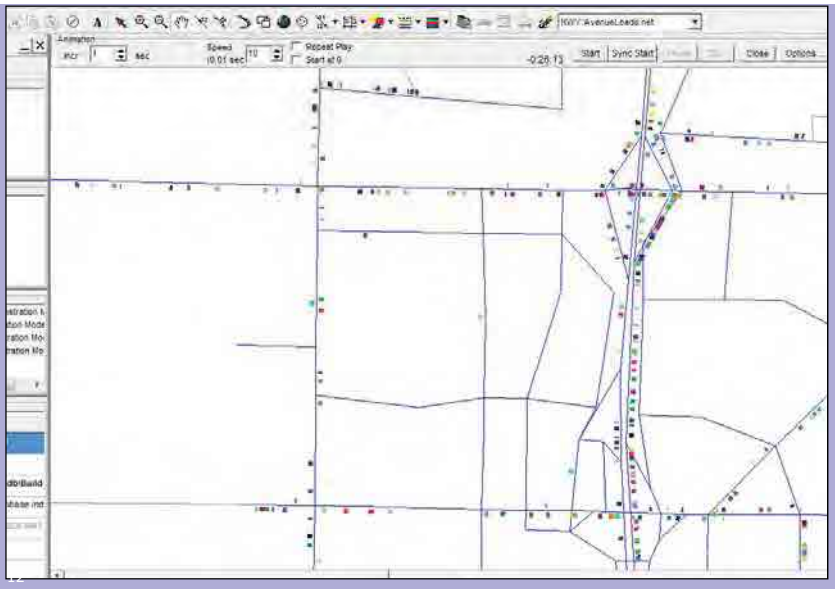
CUBE Avenue Packets moving to Simulate Traffic Movements



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A Pause Live Demonstration

- **In Model CUBETOWN**
- **Select Avenue Application**
- **Select Scenario – Build Road**
- **Click on Dynamic Loads**
- **Post – Packet Animation**
- **Post Packet File from Build Road Directory**

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Different Application of Avenue

- Used extensively in the development of emergency evacuation procedure
- Used to develop for Houston, USA an emergency evacuation in case of Hurricane
- Used in Bangkok to develop emergency evacuation procedures for Major Government Centre in case of emergency event such as the Centre becoming involved in a major protest event.

14

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Land

- **Cube Land is economic land-use modeling software designed especially for land-use and transport interaction models.**
- **Input data are stored in attribute tables of polygon GIS layers in the CUBE Geo Database.**
  - **Market segmentation used to represent variations within population.**
- **The level of Detail is the Traffic Zone.**

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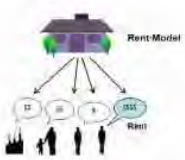
General Characteristics -Economic Principles

- Real estate market equilibrium between suppliers (developers) and consumers (households and firms)
- Subject to bounds, constraints, restrictions, and policy assumptions
  - Fixed development & institutional uses
  - Limits on growth and re-development
  - Taxes, subsidies, and zoning rules
  - Vacant uses; undeveloped land
- Clear behavioral logic
  - Real estate properties are occupied by the household or firm willing to pay the most
  - Developers maximize profits when deciding what type of buildings to provide

Supply/demand interaction



16

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Input Data Requirements

- Households and firm totals by type
  - Households stratified by size and income
  - Firms stratified by size and industry
- Zonal accessibility and attractiveness
- Fixed or "base" real estate supply stock
- Base zonal characteristics
  - Total area by land use category
  - Average household income
- Real estate characteristics by zone
  - Average lot size
  - Average built area
  - Average monthly cost (to supplier)
- Bid functions, constraints, and restrictions

17

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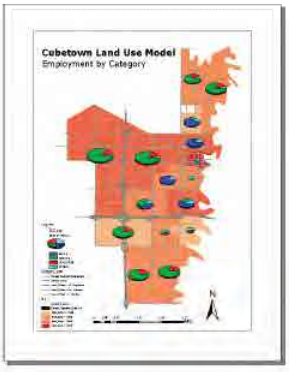
Output Datasets

- Number of real estate properties (e.g. housing units) by type in each zone
- Built area by land use type in each zone
- Average residential income by zone
- Households and firms by zonal location and real estate property type
- Rents by real estate type and zone (simulated property prices)
- Bids of each consumer type on each real estate property type and zone



18

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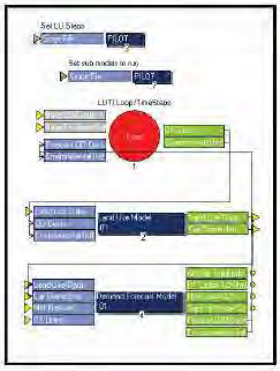
Technical Specifications

- Classification scheme:
  - Industrial, Retail, Service, Educational, Other
  - Households by size and income
  - Real estate lot size, built area & cost
- Demand model
  - Catastrophic – allocates totals anew each run
  - Flexible bid function – linear, non-linear forms
  - Characteristics of agent, property and zone including existing land use characteristics
- Supply model
  - Incremental – informed by base land use, fixed supply stock, limits on pace of change
  - Both "hard" and "soft" constraints on growth
  - Explicit consideration of taxes, subsidies, etc…



19

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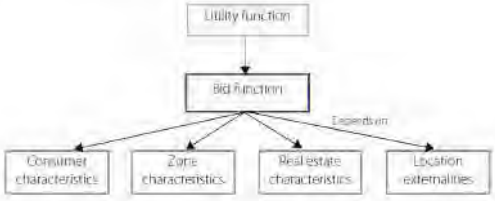
Land Bidding Functions

- Real estate auctions are simulated using random utility modeling (discrete choice)
- The bid function is the deterministic component of utility in a logit model
- Its coefficients are estimated using maximum likelihood principles



B_{ihv} is defined as the bid of consumer category h for real estate type v located in zone i. For a given supply, the probability $P_{ihv}(j)$ of each household h being located in zone i with type v buildings is defined by the likelihood that the agent will be the highest bidder in that location and, therefore, will win the auction. This probability is as follows:

$$P_{ihv}(j) = \begin{cases} 0 & \text{if } j \notin \Omega_{iv} \\ \dfrac{\alpha_{ihv} H_{ihv} \exp(\mu \cdot B_{ihv})}{\sum_{\omega \in \Omega_{iv}} \alpha_{\omega} H_{\omega} \exp(\mu \cdot B_{\omega})} & \text{if } j \in \Omega_{iv} \end{cases} \quad (2.1)$$

Where:

- H_{ih} is the total number of consumers existing in category h. You specify this value in the input files. $H_{ih} \in [0, H]$, where H is total agents in the city.
- μ is the scale factor associated with MNL and it is proportional to the inverse of the bid variance. This value is not calibrated given that it is implicit in the other bid parameters; therefore $\mu = 1$ is assumed without affecting the model results.
- Ω_{iv} is the set of all consumers competing in the auction at location vi. This set is defined exogenously and enables the separation of submarkets, such as residential bid submarkets, where consumers are households, and the nonresidential submarket, where consumers are firms. In any case, modelers may define real estate types where households and firms compete against each other, to represent, for instance, apartments that can be used as either residences or offices.
- α_{ihv} represent "cutoff functions"[1] that define all the restrictions with which the modeler believes consumers (households and firms) must comply.

20

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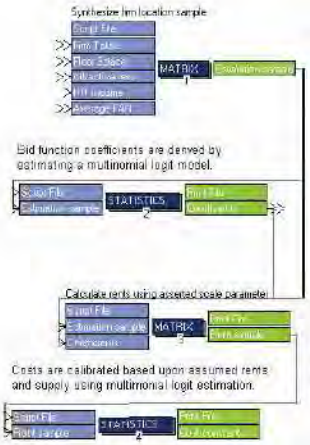
Estimation of various Bid Functions

- External tools (e.g. R, Biogeme, Gauss) can be run separately or integrated into Cube applications as user programs
- The ideal estimation data set ties together zone attributes (including transportation), household attributes, firm attributes, and an inventory of built real estate
- Population synthesis (e.g. in Voyager) can be used to "fit" Census or other survey micro-data to zonal characteristics
- If location externalities are not included, then simpler data sets can be used



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Land Summary

- Cube Land allocates household and firm totals by type to real estate properties according to sound economic principles & methods
- Market segmentation principles are used and permit translation between population/job and household/firm input and output statistics
- Real estate supply is generated based upon the assumption that developers maximize profit subject to constraints and restrictions
- The supply model can be run incrementally using an input "fixed supply stock", or with upper and lower bounds on development
- Data requirements for model application are low and involve tabulations by zone and real estate market segmentation category
- Data and software requirements for model estimation can be met using publicly available information and free tools

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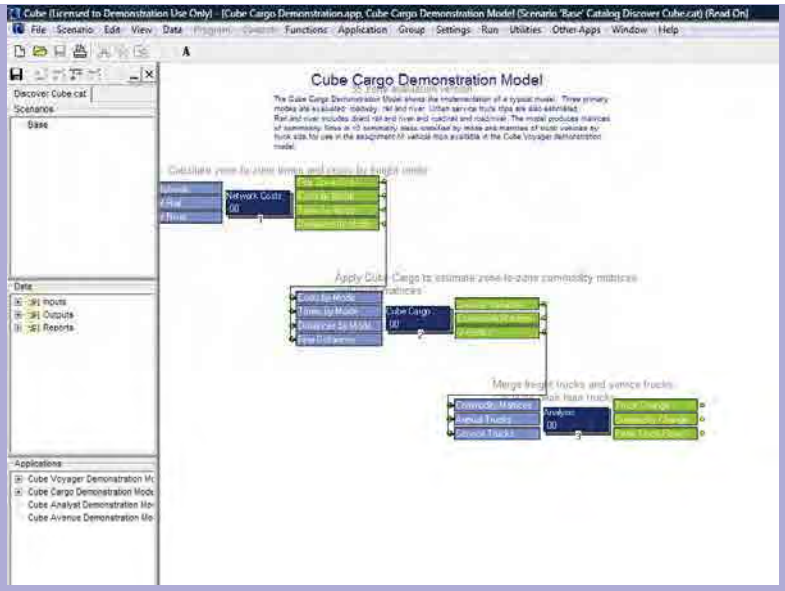
CUBE Cargo



23

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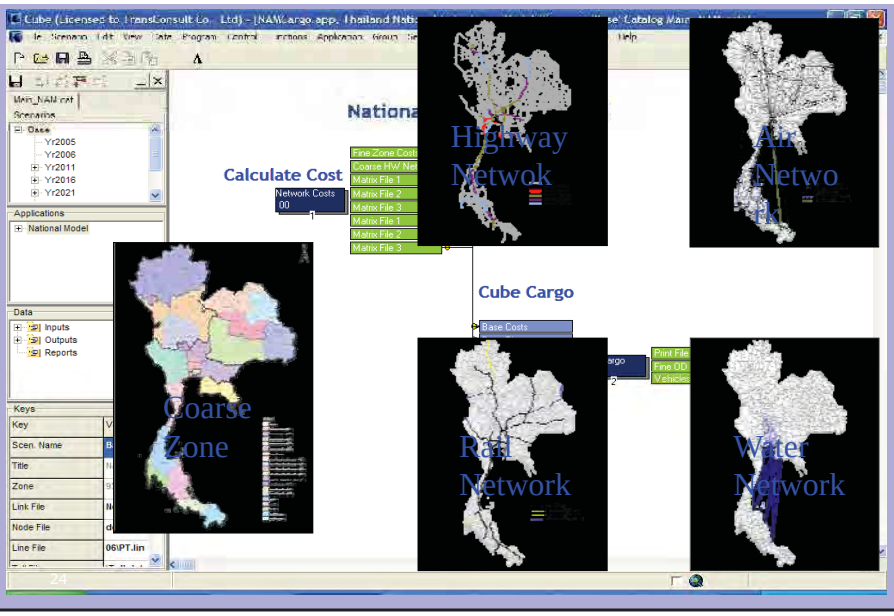
A Cargo Model



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Cargo

What is Cargo
- Model to estimate Cargo Flows based on Production and Consumptions
- Model to estimate service vehicle flows

Inputs
- Socio Economic Data
- Network Characteristics
- Calibrated Freight Parameters

Outputs
- Loaded Network flows in terms of tonnes of products

25

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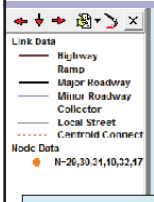
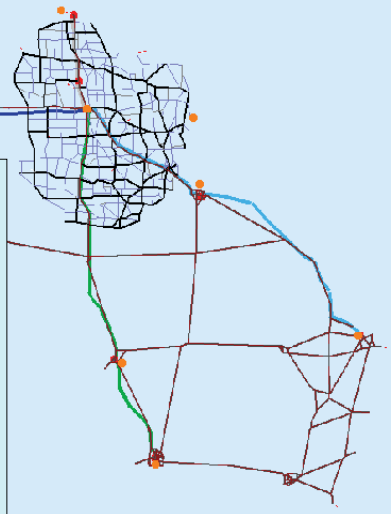
Cargo – Key Features
CUBE Productions





NO	Cargo
1	Agriculture
2	Foodstuffs
3	Solid minerals fuels
4	Petroleum products
5	Ores and metal waste
6	Metal products
7	Building materials
8	Fertilizers
9	Chemicals
10	Manufactured goods

26

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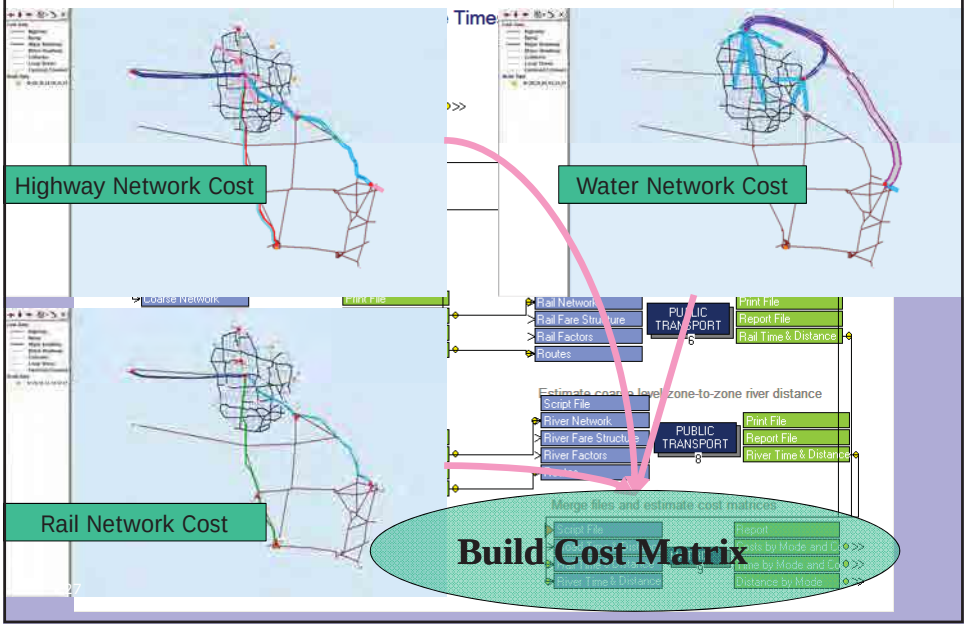
Building Costs



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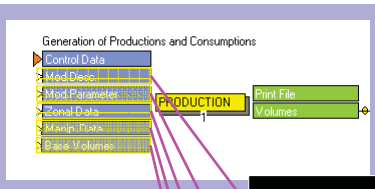
Cargo Production



PRODUCTION

INPUT FILE

- Model Description
- Model Parameter
- Zonal Data
- Manipulation Data
- Base Volume

28

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Trip Generation Model

- Emis (Production)

  = 3.93* E_AGRICULTURE + 1.04* E_FOODINDUSTRY

- Dest (Attraction)

  = 0.00058*POP +2.62* E_AGRICULTURE +
  1.50* E_FOODINDUSTRY

29

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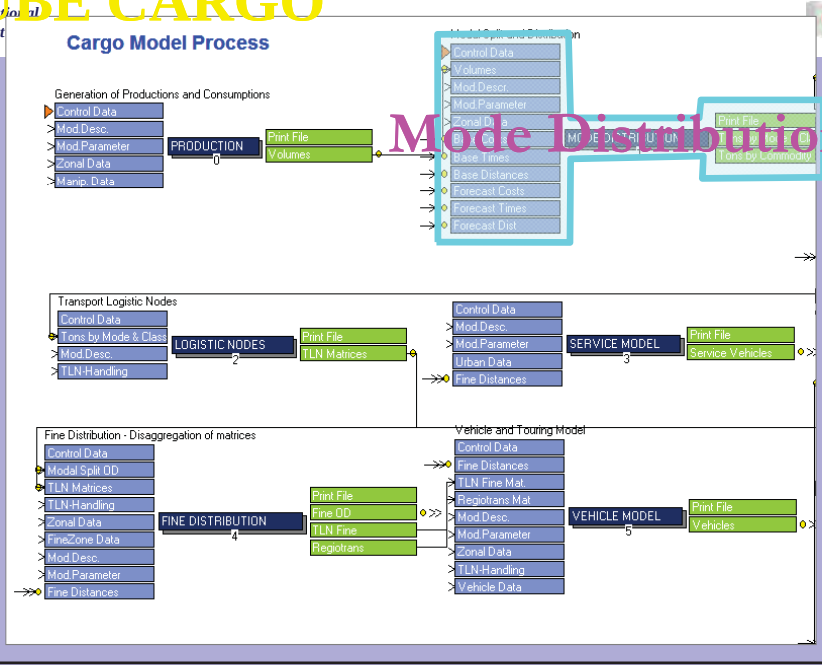
CUBE CARGO



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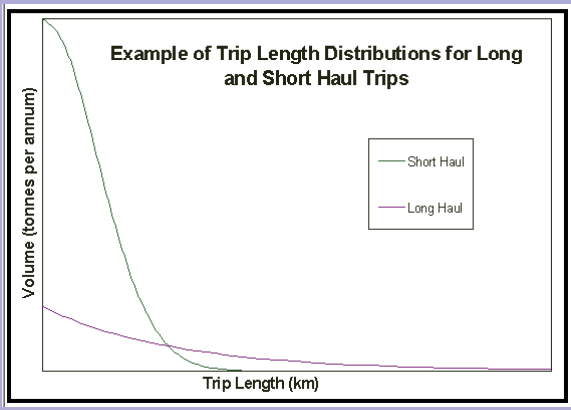
Trip Length Distributions



31

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Sample Deterrence Function

Deterrence Function for Short-haul Gravity Model

$$F_c(d) = e^{\left(\frac{-d^2}{2\sigma_c^2}\right)}$$

where:

c	A commodity group
e	The base of the natural logarithm function (approximately 2.718282)
d	The distance
$F_c(d)$	The deterrence function of distance used in the gravity model
σ_c	The calibration parameter for commodity c from field Para.DistPar.gravitydistribution

Deterrence Function for Long-haul Gravity Model

$$\Phi_c(G_c) = e^{-P_c\left(1+\frac{\Gamma_c}{100}\right)^y G_c}$$

where:

c	A commodity group
e	The base of the natural logarithm function (approximately 2.718282)
G_c	The Cube Cargo generalized cost: this is the composite cost derived from the logit model used for modal split; its calculation is described in '*Mathem... Equations for the Modal Split Model*'
$\Phi_c(G_c)$	The deterrence function of Cube Cargo generalized cost used in the gravity model
P_c	The calibration parameter for commodity c from field Para.DistPar.longdistribution
Γ_c	The growth factor for the calibration parameter for commodity c. This value is taken from table Para.DistParTrend.
y	The time, in years, from the base year to the year for which Cube Cargo is being run. This is found by subtracting the two control data parameter values.

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Itinerary

Counterpart Training Program

Stage 1 – Knowledge Building Stage

Day 3 - Session 2

1

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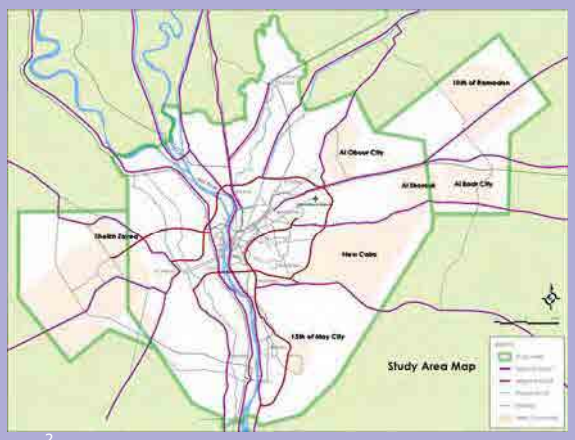
GREATER CAIRO URBAN TRANSPORT TMODEL

WHY Did CAIRO NEED A TRANSPORT MODEL ??22



- Many Proposed Transport Projects
- Limited Resources
- Evaluate Best Use of Resources
- Rank Projects in Order of Priority

2

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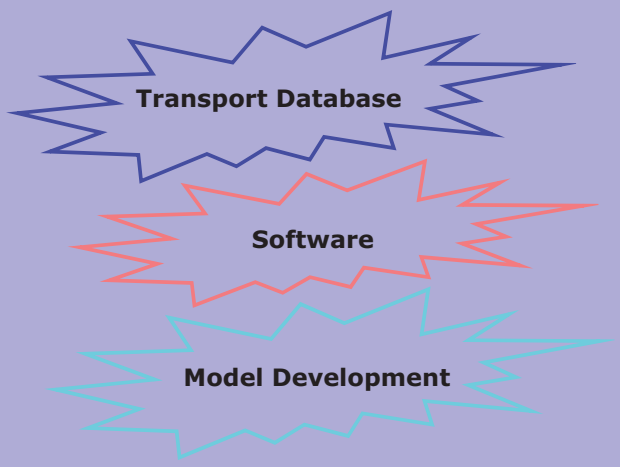
MODEL NEEDS

WHAT IS NEEDED FOR THE MODEL DEFINITION ??



3

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FOCUS OF PRESENTATION

THE PREVIOUS SLIDE IS ONE THAT WE HAVE SEEN SEVERAL TIMES SO FAR BUT IT REMAINS IMPORTANT TO UNDERSTAND THAT THIS IS THE ESSENCE OF ANY TRANSPORT MODEL….THIS PRESENTATION WILL FOCUS ON THE DEVELOPMENT OF THE **THE CAIRO EXTENDED CITY MODEL or CECM, developed during the CREATS project in 2001 and 2002.**

4

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MODEL NEEDS

TRANSPORT PLANNING SURVEYS

- Home Interview Surveys
- Traffic Counts
- Roadside Cordon Surveys
- Passenger Surveys
- Travel Speed Surveys
- Cargo Surveys
- Parking Surveys
- Inventory Surveys

DEMOGRAPHIC DATA

- Population
- Number of Households
- Household Income
- Employment
- Student Enrolments

TRANSPORT PLANNING DATABASE

5

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Home Interview Survey

The Major Survey for the Model Development

HOME INTERVIEW SURVEY

6

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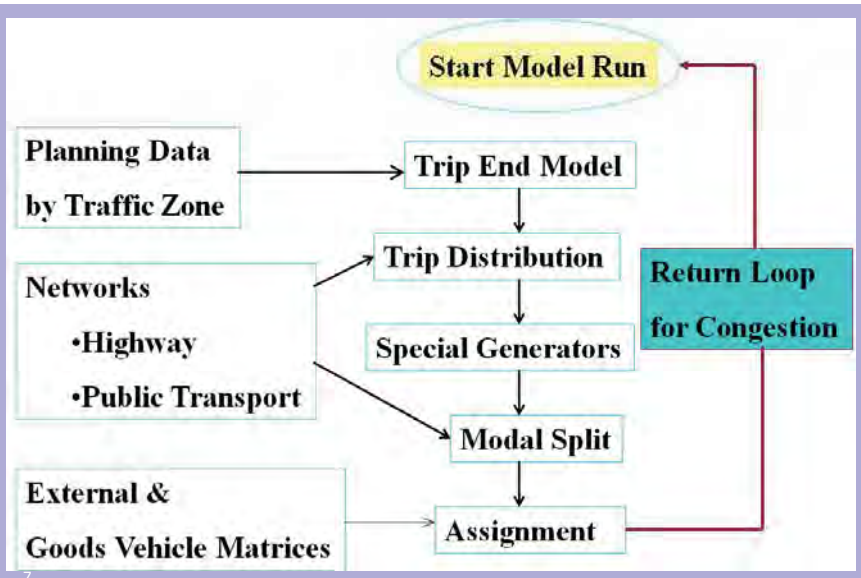
Model Flowchart



7

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Aspects of the Transport Model

A. Network and Zoning System

B. Trip Generation

C. Trip Distribution

D. Modal Split

E. Trucks and External Trip Tables

F. Trip Table Development

G. Assignment /Calibration

H. Future Year Results

I. Snapshots of the Transport Model

8

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A- Zoning System and Network

ZONING SYSTEM

--- For Cairo Transport Model, based on some Combined Shiakhas - 464 Internal Zones and 19 External Stations

9

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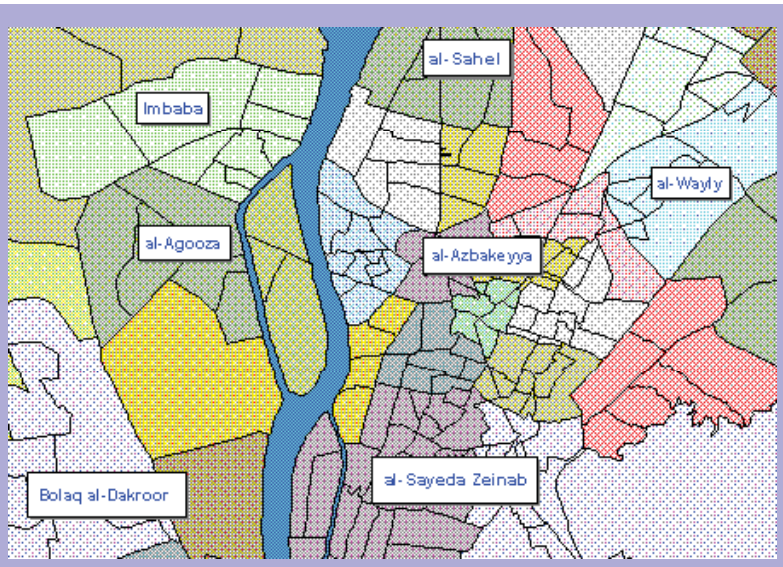
Traffic Zones in Central Cairo



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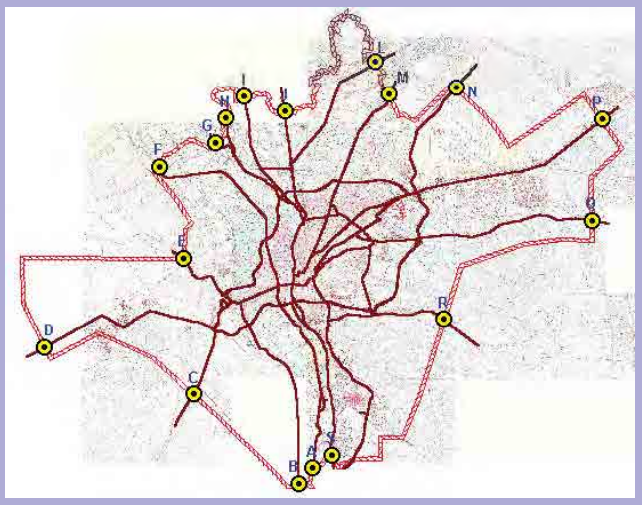
External Stations



11

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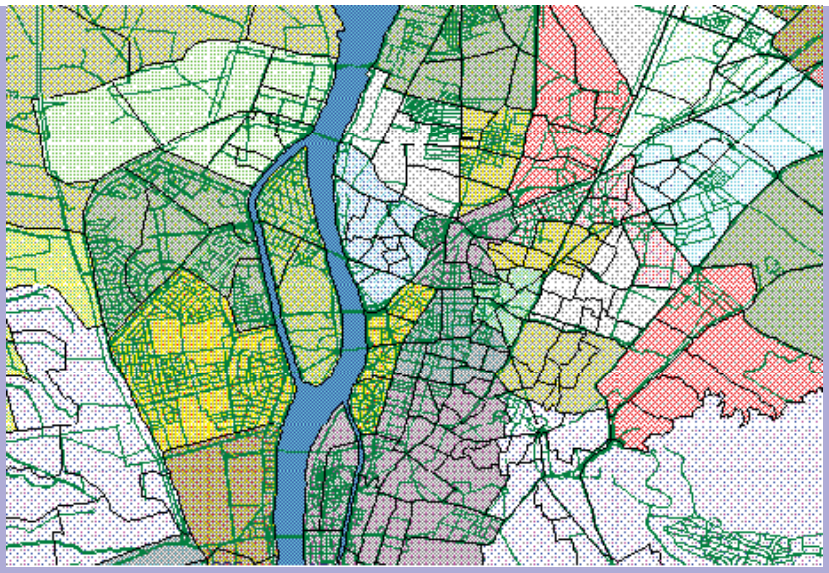
Underlying Road Network in Central Cairo



12

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Summary Statistics

Networks

- o 1,500 Kilometers Road
- o 550 Bus Routes
- o 550 Shared Taxi Routes
- o 464 Internal Traffic Zones

Spatial Summary Characteristics

- o 18 Sectors
- o 60 Qisms
- o 464 Traffic Zones

13

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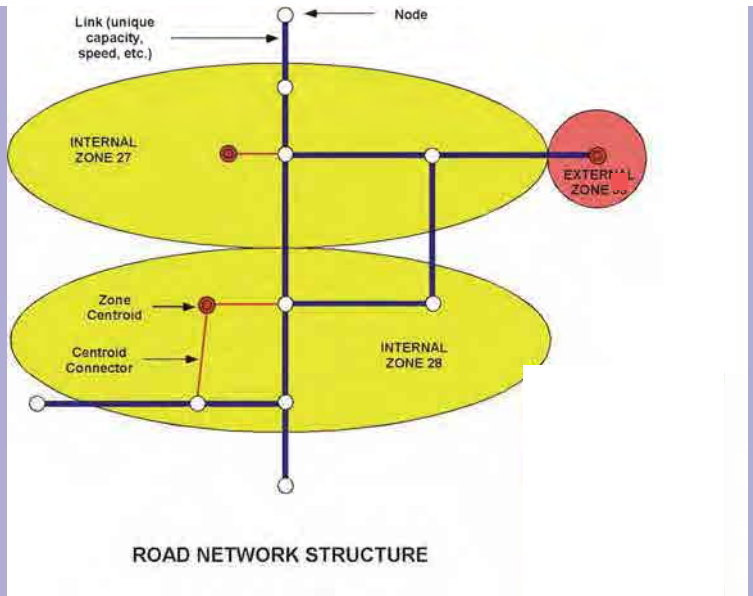
Road Network Structure



ROAD NETWORK STRUCTURE

14

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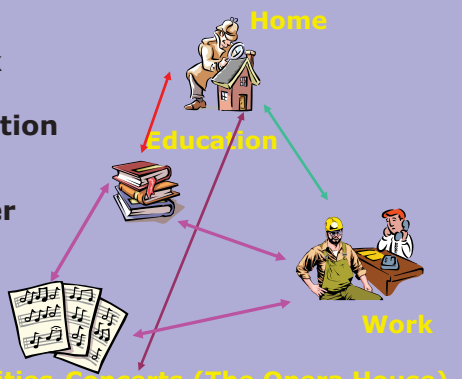
Trip Purpose

HBW – Home Based Work

HBE – Home Based Education

HBO – Home Based Other

NHB – Non Home Based



15

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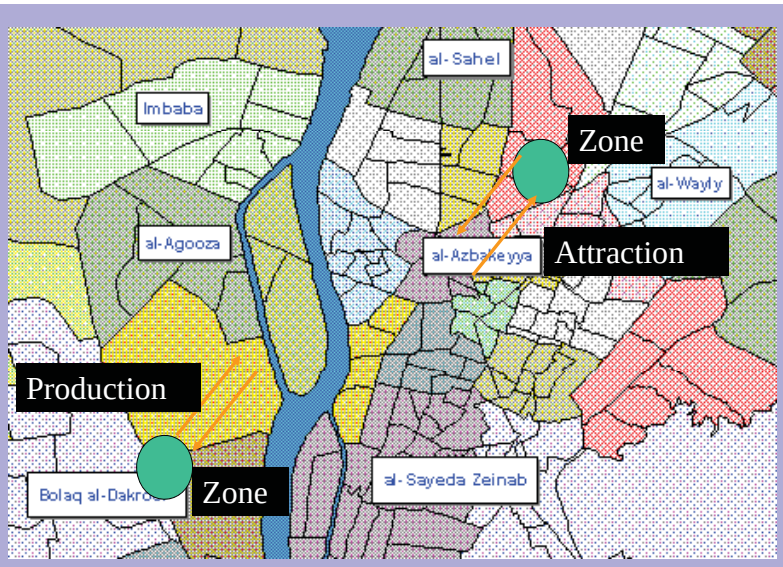
B-Trip Generation



16

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Category Analysis of Trip Generation

Trip Production Rate for Each Disaggregate Group or Bin

For Each Trip Purpose HBW etc

	HOUSEHOLD SIZE			
INCOME CLASS	1	2	3	4 etc
1	??	??	??	??
2	??	??	??	??
3	??	??	??	??
4	??	??	??	??
5	??	??	??	??

17

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Income Class Range

Class	Income Range (LE per Month in 2001 Value)
1	<300
2	300-500
3	500-1,000
4	1,000-2,000
5	>2,000

18

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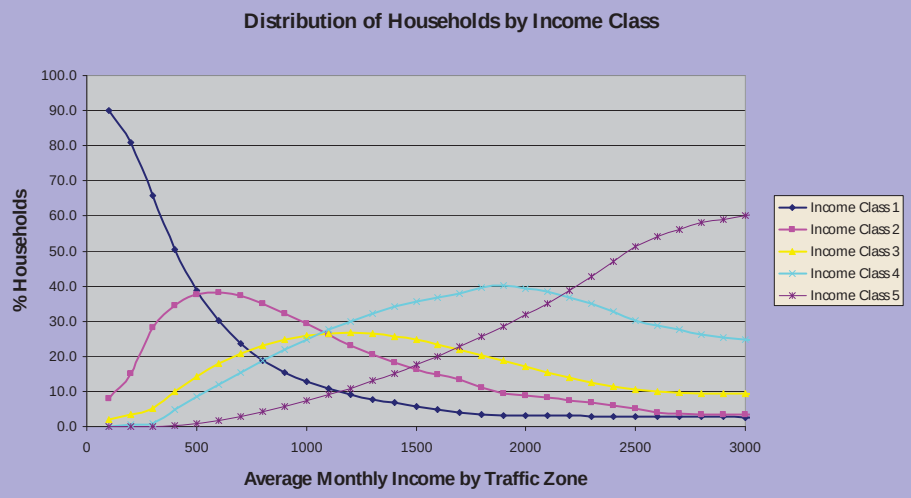
Distribution of Households by Income Class



19

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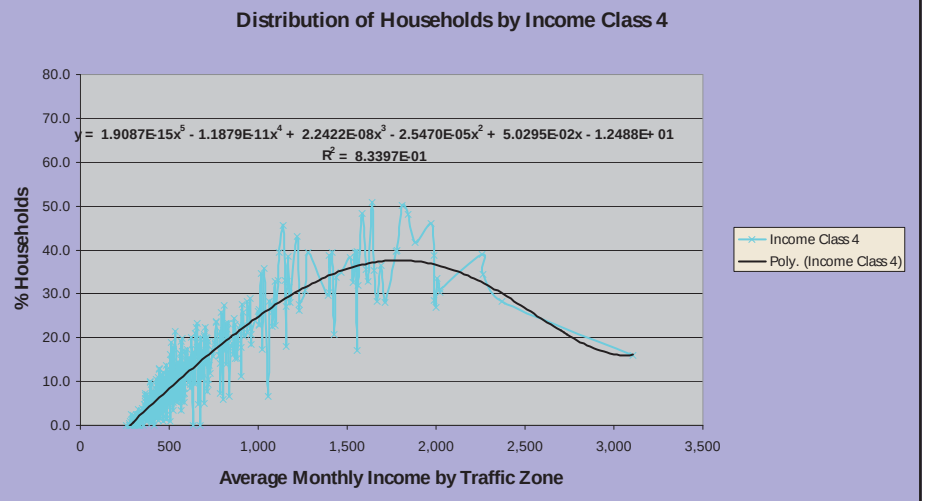
Distribution of Households by Income Class 4



20

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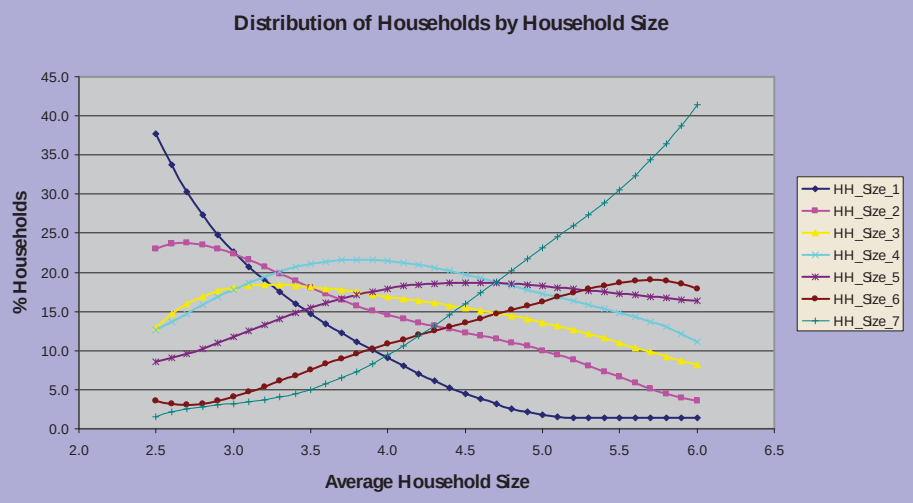
Distribution of Households by HH Size



21

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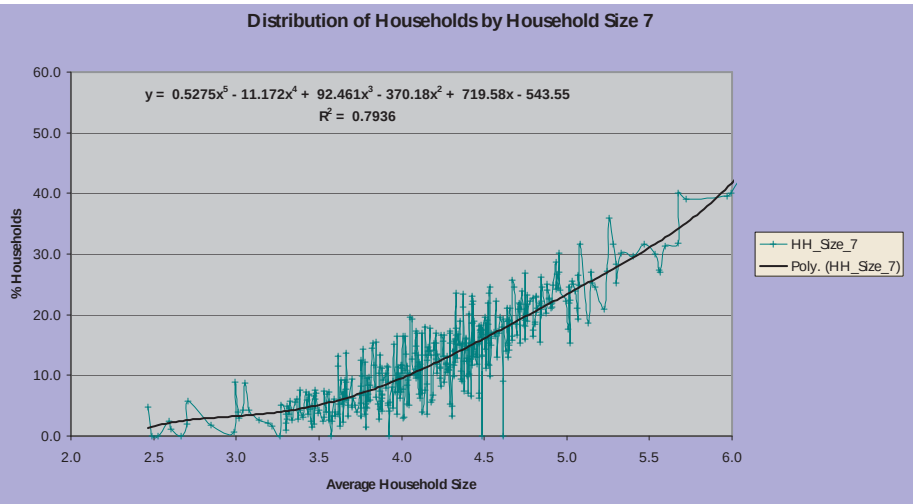
Distribution of Households by Household Size 7



22

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Observed Percentage Distribution of Households

	Household Size						
Income Class	1	2	3	4	5	6	7
1	2.5	5.1	5.2	5.5	5.0	3.6	4.1
2	3.0	4.2	5.2	6.7	6.5	4.2	4.7
3	0.8	2.1	2.4	4.0	3.2	2.1	2.1
4	0.4	1.4	2.1	3.4	2.7	1.9	1.8
5	0.1	0.4	0.7	1.1	0.8	0.5	0.4

23

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Modeled Percentage Distribution of Households

	Household Size						
Income Class	1	2	3	4	5	6	7
1	2.1	4.7	5.1	5.7	5.2	3.8	4.4
2	3.0	4.1	5.2	6.8	6.5	4.3	4.7
3	1.0	2.3	2.4	3.9	3.1	2.0	1.9
4	0.6	1.7	2.2	3.3	2.6	1.7	1.5
5	0.3	0.5	0.7	1.0	0.7	0.4	0.4

24

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Trip Attractions

TRIP ATTRACTION are a

f(Employment Characteristics by Class, Households, Student Enrolments)

e.g. A_{HBW}= a*Primary Employment+
b*Secondary Employment+
c*Tertiary Employment

where a, b, and c are calibration constants

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HBW Trip Attraction Co-efficients

Income Class	Primary Employment	Secondary Employment	Tertiary Employment	R^2
1	1.205	0.215	0.465	0.97
2	-	0.690	0.627	0.97
3	-	0.187	0.564	0.92
4	-	0.008	0.733	0.84
5	-	-	0.281	0.69

26

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Other Trip Attraction Co-efficients

Purpose	Constant	Students	University Students	Household	Tertiary Employment	R^2
HBE	-	2.129	2.336	-	-	0.99
HBO	292.8	-	-	-	0.406	0.67
NHB	-	-	-	0.00918	0.175	0.54

27

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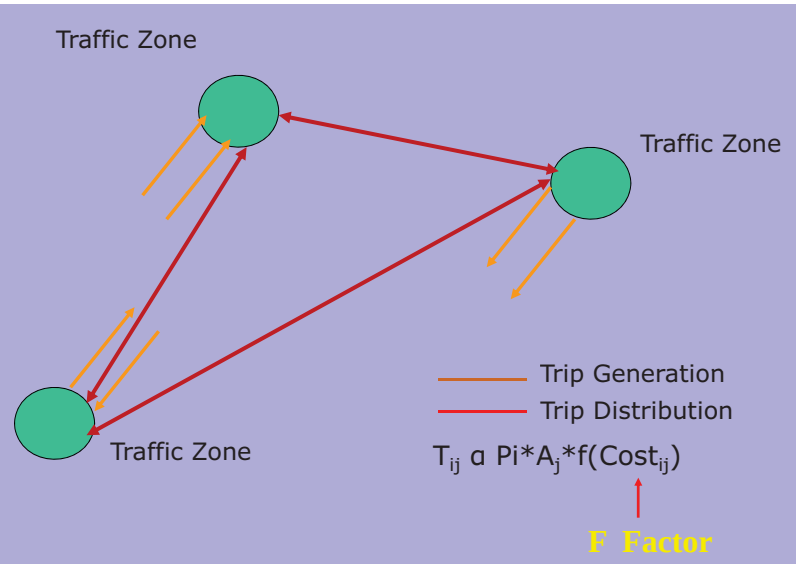
C- Trip Distribution



28

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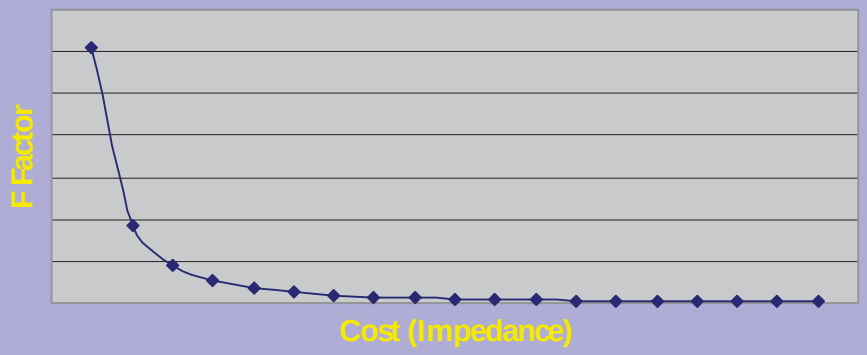
What is a F Factor Curve

Typical F Factor Curve



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F Factor Function

$$F(C_{ij}) = C_{ij}^{X_1} \exp(X_2 C_{ij})$$

Where :
C_{ij} - Weighted Generalized Cost of Travel; an
X_1 and X_2 are Calibration Constants

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Results of Trip Distribution

Income Class	Purpose	X1	X2	Observed Mean	% Difference
1	HBW	0.85	-0.02	168.9	0.01
1	HBE	0.65	-0.02	144.2	-0.02
1	HBO	-0.36	-0.02	147.6	-0.02
1	NHB	-0.99	-0.02	119.4	0.00
2	HBW	-0.06	-0.01	158.0	0.01
2	HBE	0.47	-0.02	139.1	0.03
2	HBO	-0.29	-0.02	139.9	-0.01
2	NHB	-0.88	-0.02	113.5	0.02
3	HBW	0.15	-0.02	153.8	0.15
3	HBE	0.56	-0.02	136.1	0.03
3	HBO	-0.24	-0.02	132.3	0.06
3	NHB	1.15	-0.03	129.6	0.00

31

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D – Mode Split

Value of Time - Derived from Household Income

- Estimated also for Various Modes of Travel;

- Range 1 – 18 Pt per Minute from Income Class 1 to Income Class 5.

32

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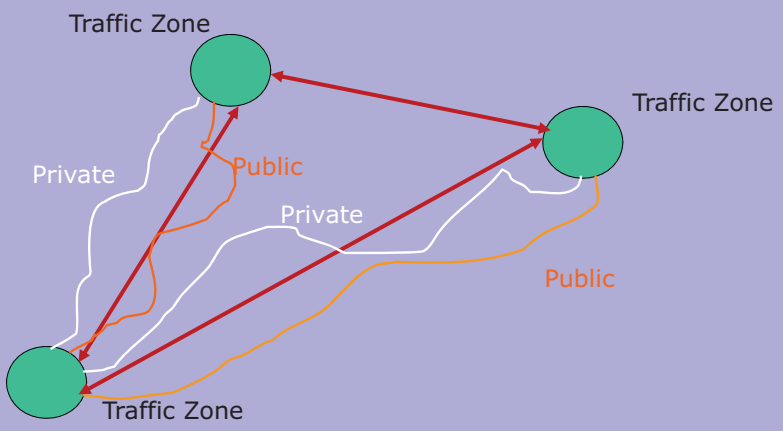
Mode Split



33

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GENERAL LOGIT MODEL FOR BINARY MODE SPLIT

$$\% PT = \frac{1}{1+\exp(\lambda\,(CPT-CPR+\zeta)}$$

Where :
CPT -- Generalized Cost of Public Transport in Equivalent Minutes
CPR -- Generalized Cost of Private Transport in Equivalent Minutes
λ -- Cost Co-efficient
ζ -- Bias Term
The Generalized Cost of Travel includes all travel time and costs associated with a particular mode of travel.

34

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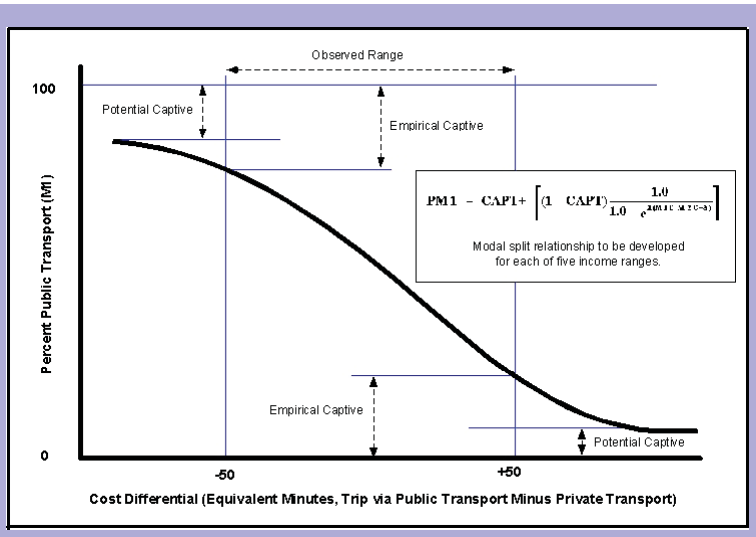
Typical Mode Split Curve



35

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Overall % Modal Split

Mode of Travel	*Model*	*Observed*
Special Bus (Employee/School)	8.4	8.4
Public Transport (CTA Bus, Shared Taxi etc)	62.9	63.2
Car	20.6	20.4
Taxi	8.1	8.0
Total	*100.0*	*100.0*

36

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E – Trucks and Externals

- Small Trucks
  - oPick Up/Utility – Goods Vehicle
  - o2 Axle Trucks
- Large Trucks
  - o 3 Axle Trucks
  - o >3 Axle Trucks

37

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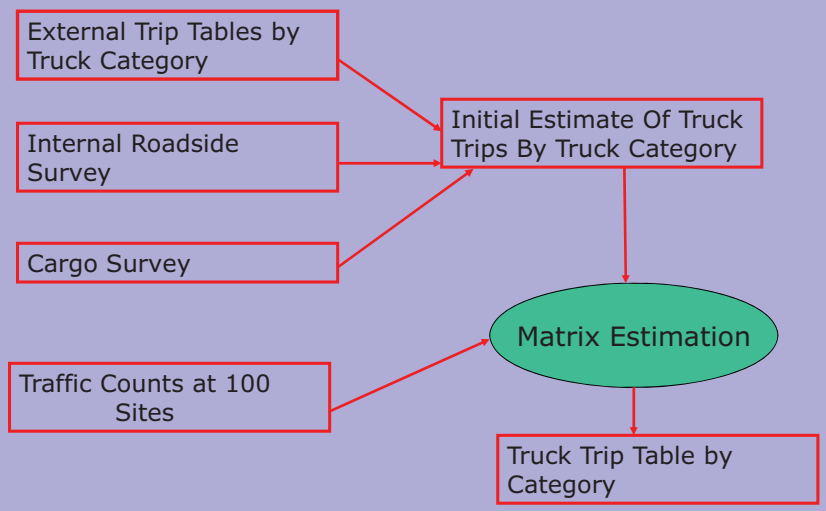
Development of Truck Trip Tables



38

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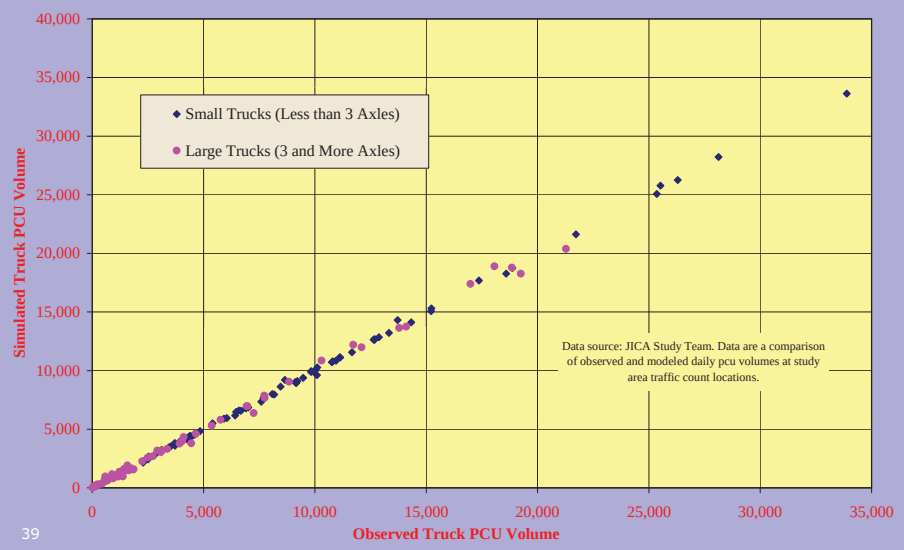
Truck Calibration Simulated Vs Observed



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Estimation of Future Truck Trip Ends

Small Trucks
$Y=aX^b$

Large Trucks
$Y= a+bX$

Where
Y = Internal Trip Ends(pcu) per zone
X = Secondary Employment for Small
X = Total Employment per sq km for Large Trucks
a, b = Calibration Constants

$T_{Future}=T_{Base}*(T_{Est\ in\ Future}/\ T_{Est\ in\ Base})$

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Truck Trip End Parameters

Category	Constant (a)	Secondary Employment (b)	Total Employment per Sq Km (b)	Correlation Coefficient
Small Truck	0.0266	-	1.015	0.77
Large Truck	69.5	0.021	-	0.69

In the case of External Trip Tables Derived from Cordon Surveys

--- 5 Categories

- **Car**
- **Taxi**
- **Bus**
- **Small Truck**
- **Large Truck**

--- Future Growth derived from Overall Trip Growth

41

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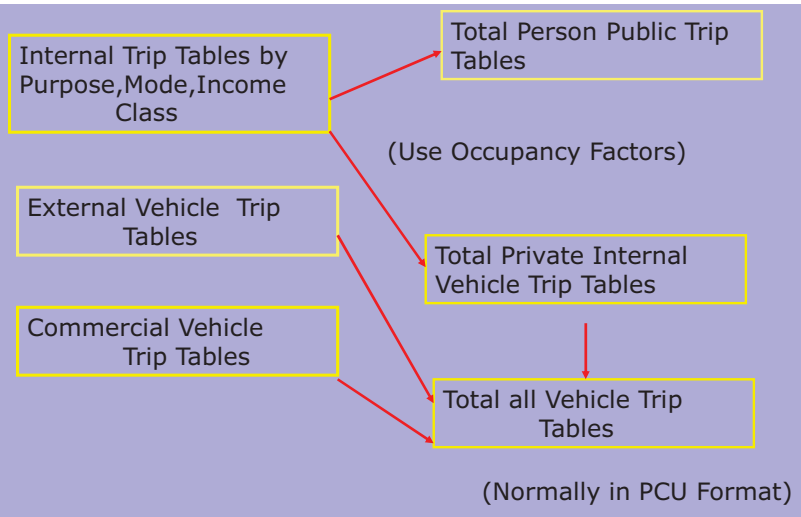
F – Trip Table Development



42

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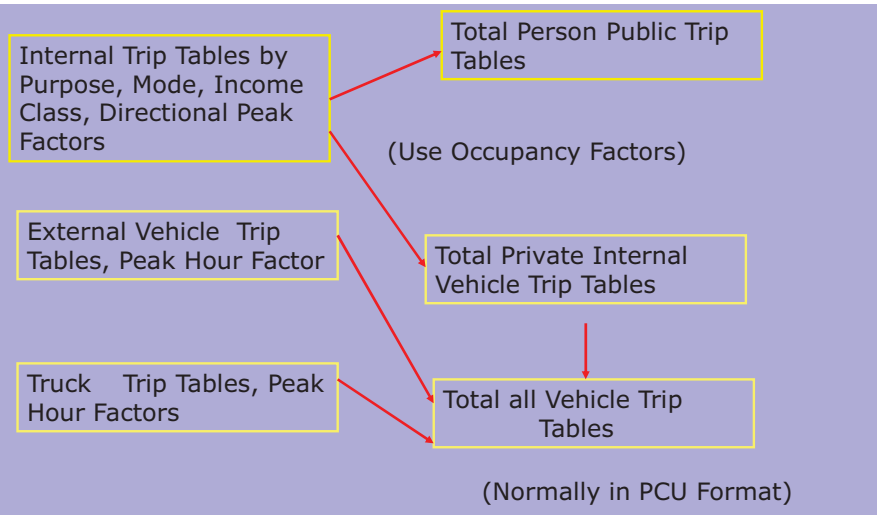
Combination of Trip Tables for Peak Hour Assignment



Peak Hour is the Morning Peak, Average Hour between 0700 and 0900

43

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G-Assignment Procedure and Calibration

Road Network Assignment.

- **Preload Bus and Shared Taxi**
- **Load Trucks**
- **Load Cars, Taxis and Special Bus**
- **Equilibrium Generalized Cost Assignment**

44

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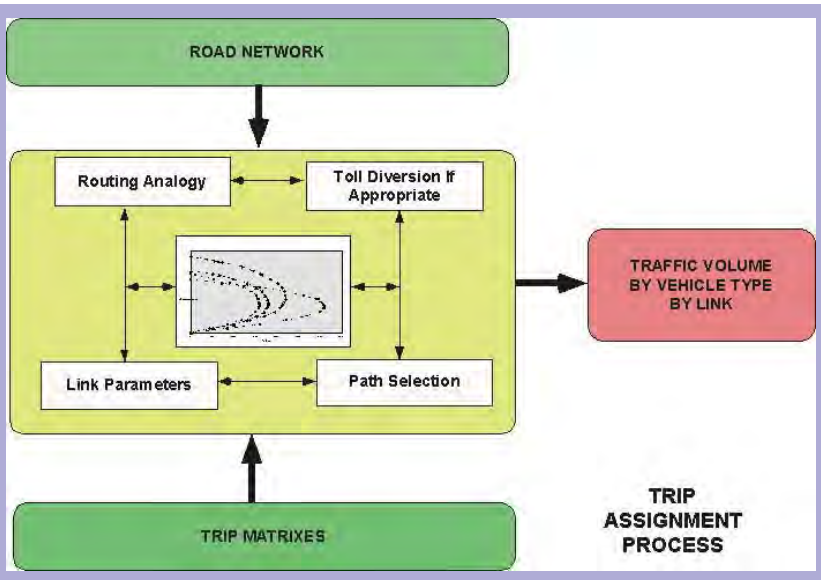
Road Network Assignment



45

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Road Network Link Volumes

Every Link in the Road Network

- Shared Taxis
- Bus
- Trucks
- Total PCU Volume

46

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Public Transport Assignment

- Road Network Travel Speed from Road Assignment
- Travel between any two zones may have several routes available
- Probability of using Route i, from a set j is

$$P_i = \frac{e^{-SF(TD_i - ETD)}}{1 + e^{-SF(TD_i - ETD)}}$$

Where TDi is the time using Service i. , ETD_i is an average time using all available services and SF is a scale factor.

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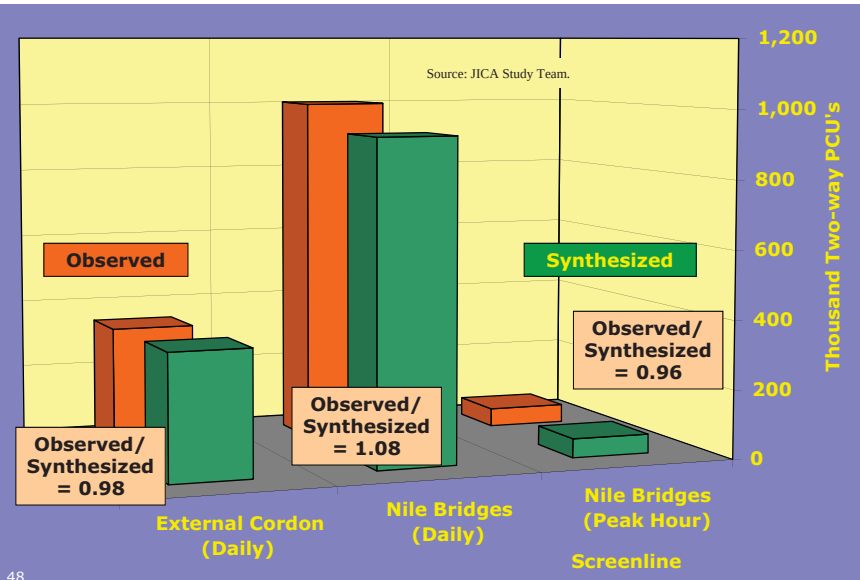
Year 2001 CREATS Model Calibration - Road Network -



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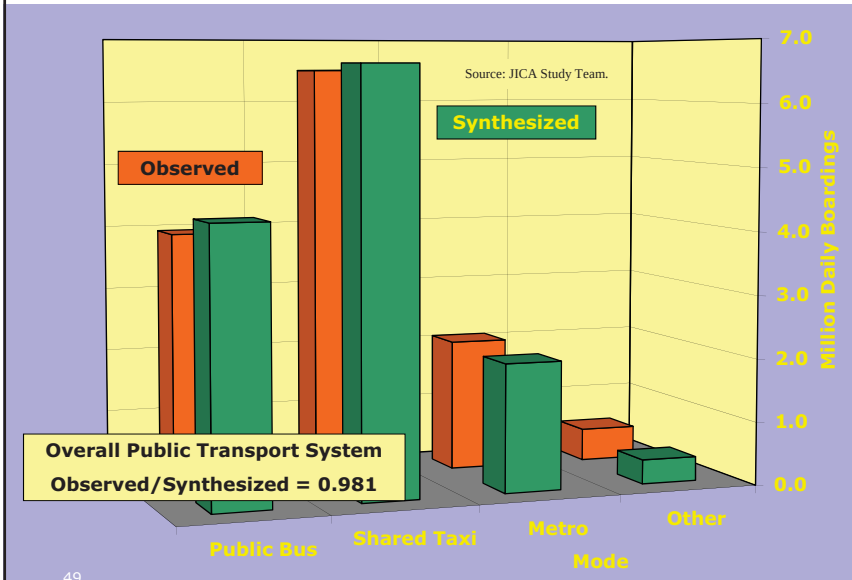
Year 2001 CREATS Model Calibration
- Public Transport -



49

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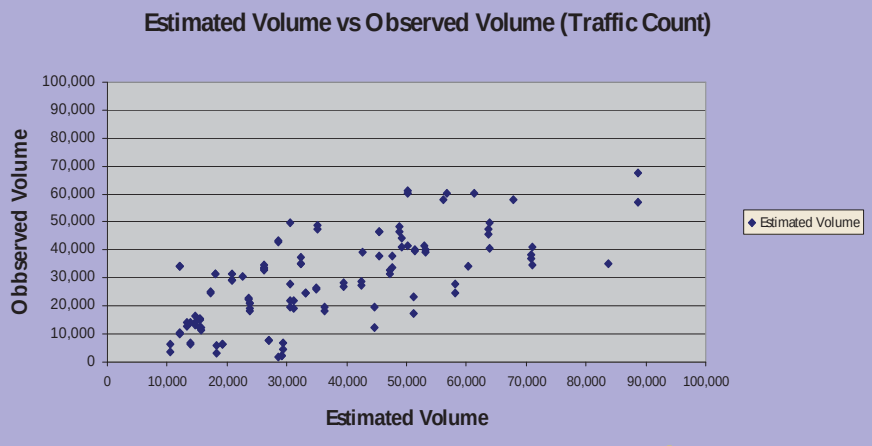
Year 2001 CREATS Model Calibration
- Traffic Count Comparison~~ Daily PCU-



MAD Ratio = 0.34

50

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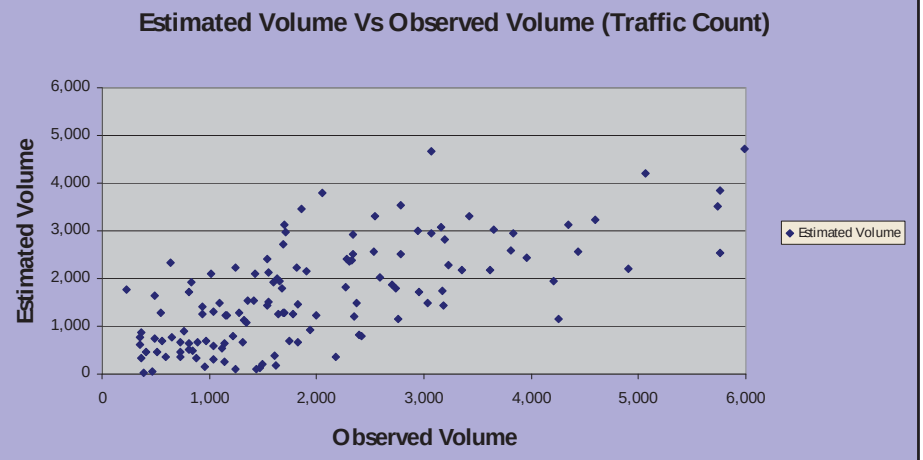
Year 2001 CREATS Model Calibration - Traffic Count Comparison ~~ Peak Hour PCU-



MAD Ratio = 0.39

for counts > 700

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H.

FUTURE YEAR RESULTS and Typical Model Outputs

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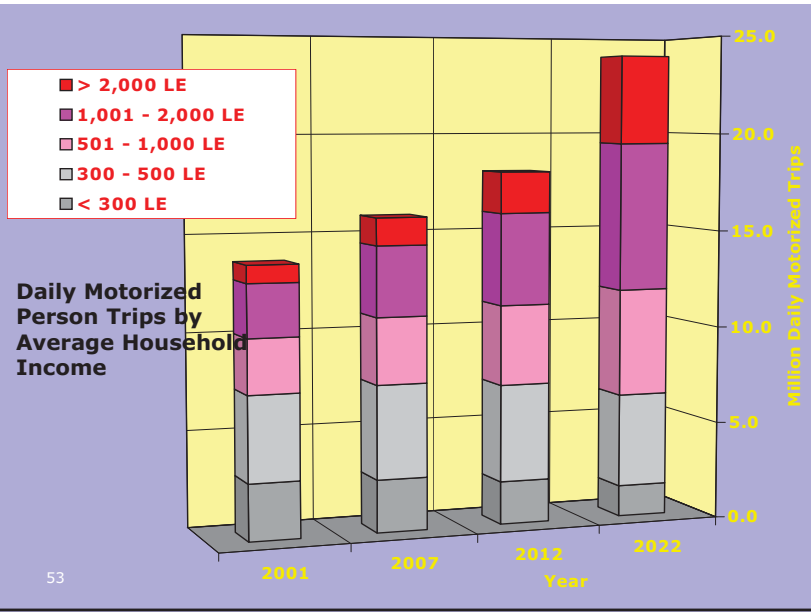
H- Future Year Projections



53

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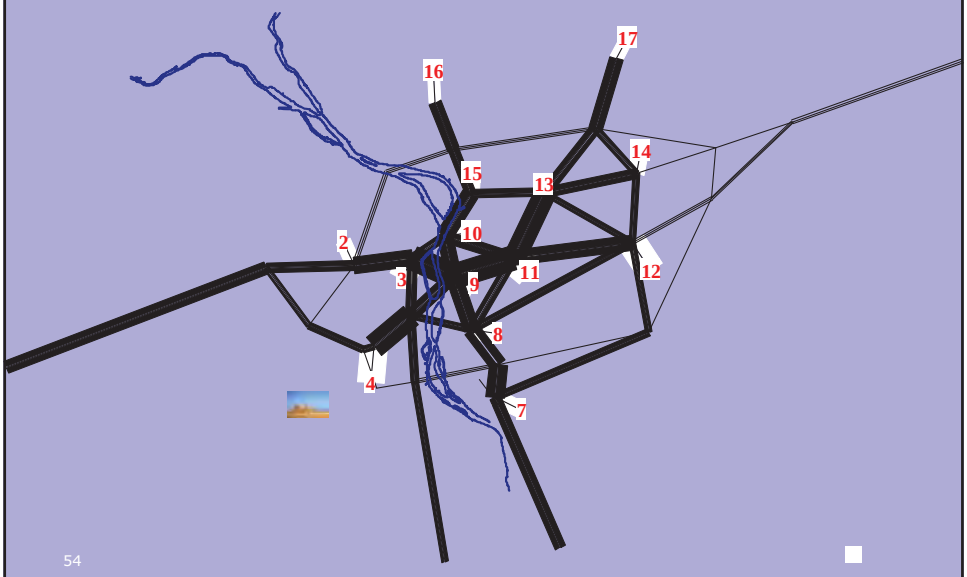
Initial Screening Process
Example of Spider Network Volume Band Diagram



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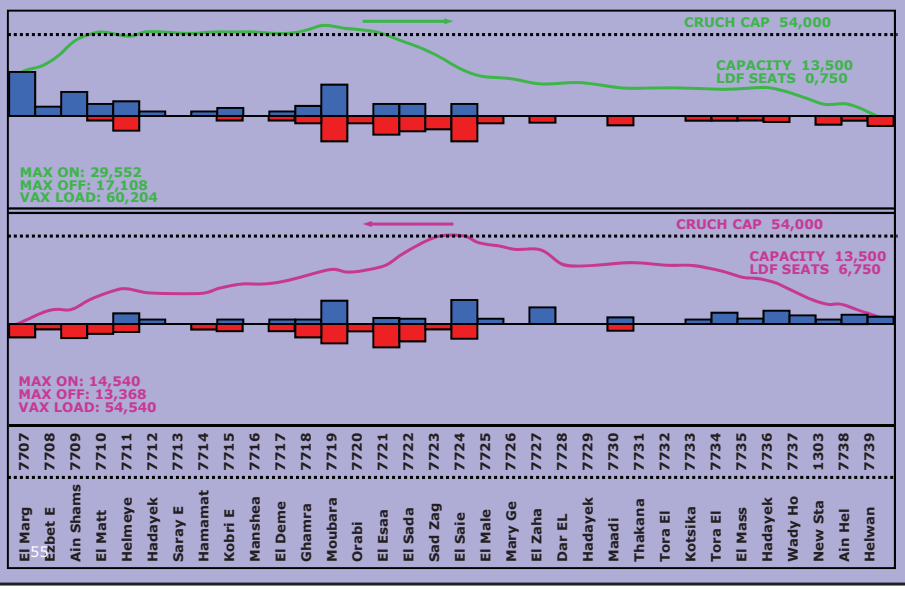
Example of Boarding and Alighting Pattern Scenario 2, Year 2022, Metro Line 1



55

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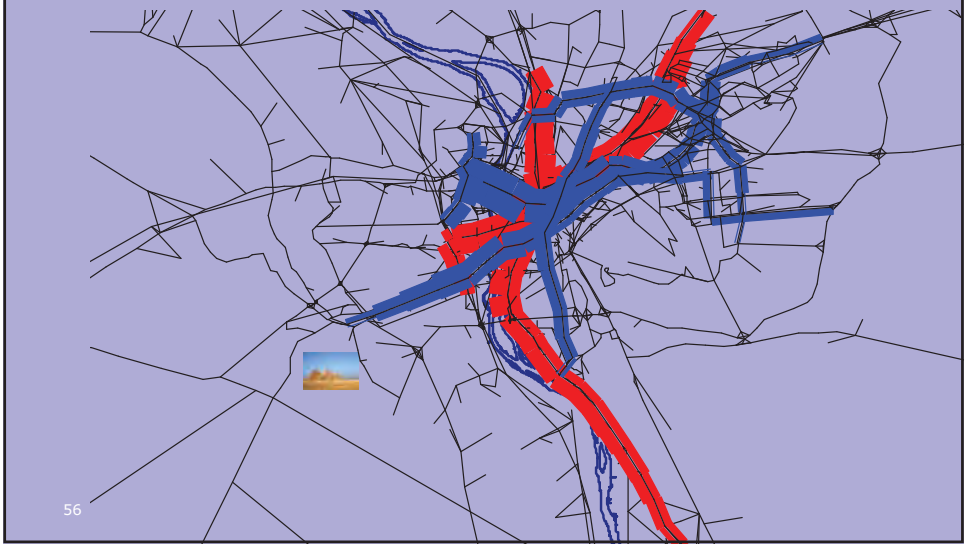
PT Scenario 2, 2022: MRT Volume Band Diagram



56

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Trip Generation Results

Year	Household Income ('01 LE)	Total Mechanised Trips(Mil)	Trips in Class 4 and 5 (Mil)	Trips per HH
2001	672	14.4	3.7	4.11
2012	879	19.2	7.2	4.65
2022	1,176	25.1	12.7	4.94

57

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Average Personal Travel Speed Speed

Scenario	Person Speed Index
Base Year 2001	100
Do Minimum 2022	64
Master Plan Network in 2022	95

36 % Decrease

50 % Increase

58

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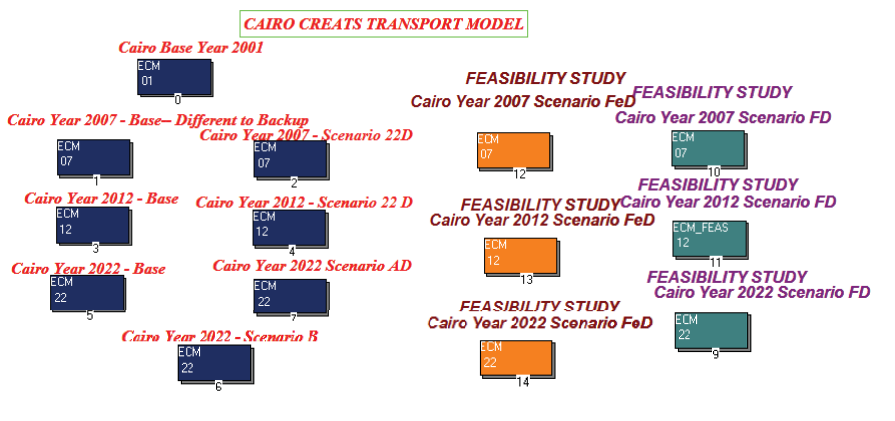
I. Snapshots of the Transport Model



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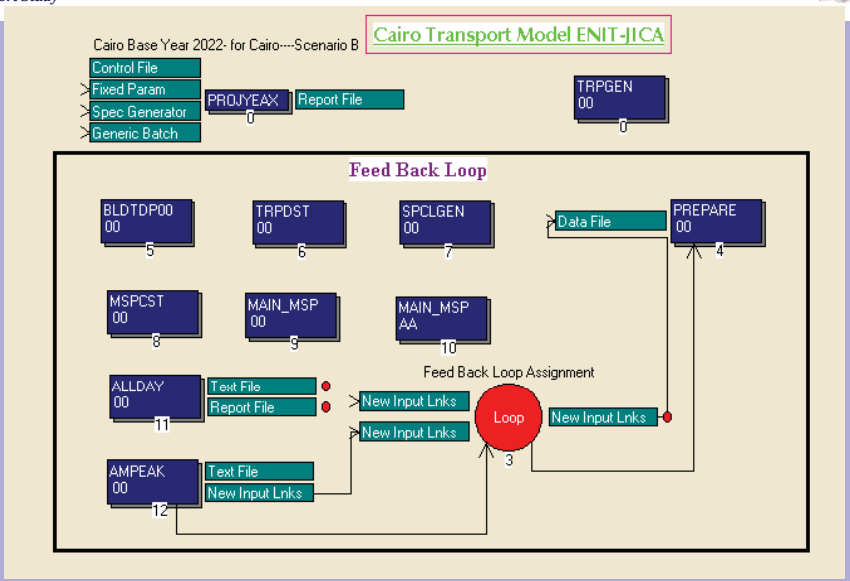
Snapshots of the Transport Model - Main Model



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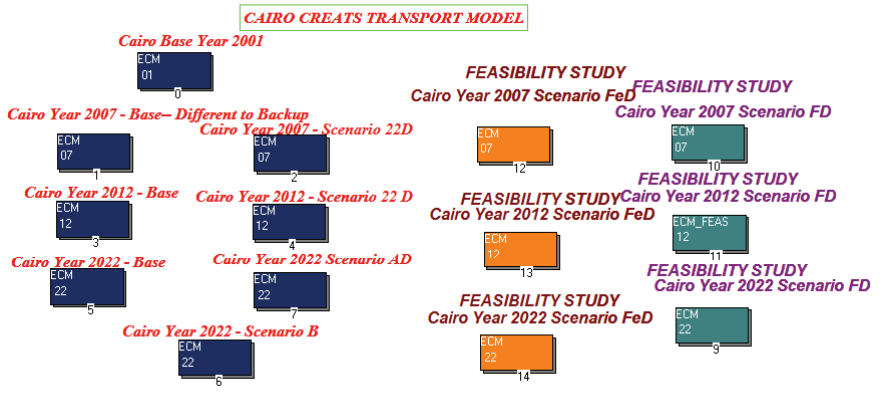

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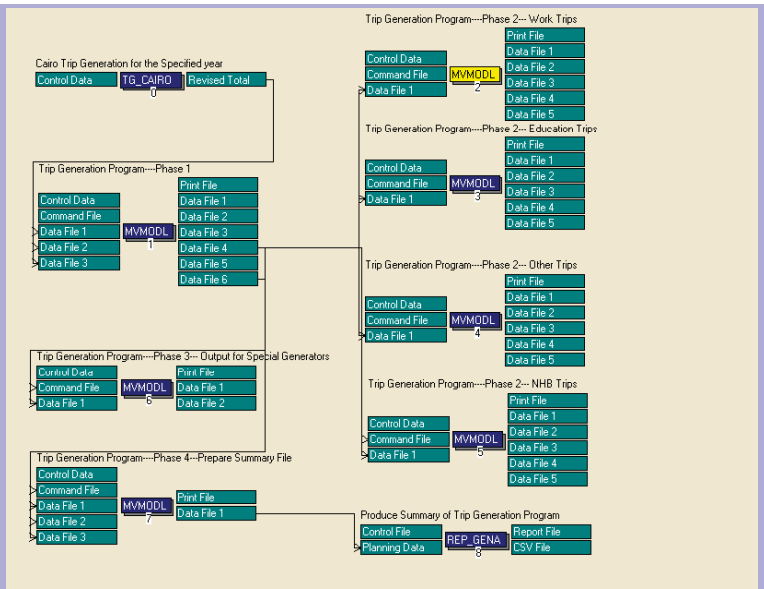
Snapshots of the Transport Model -Trip Generation



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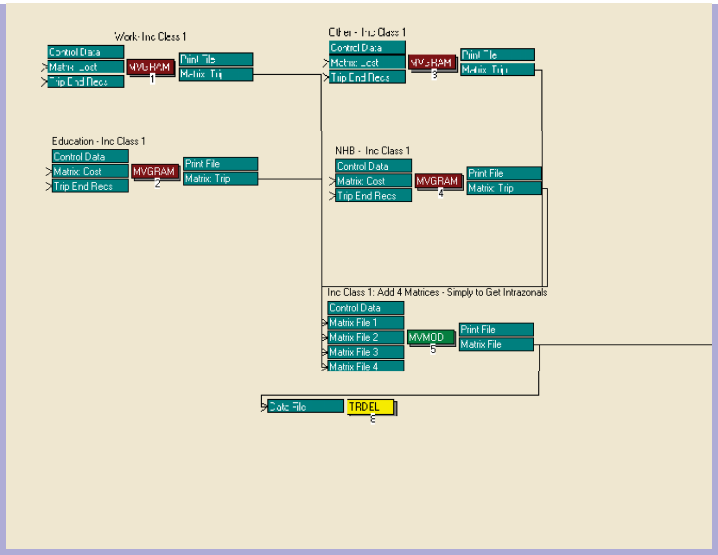
Snapshots of the Transport Model -Trip Distribution



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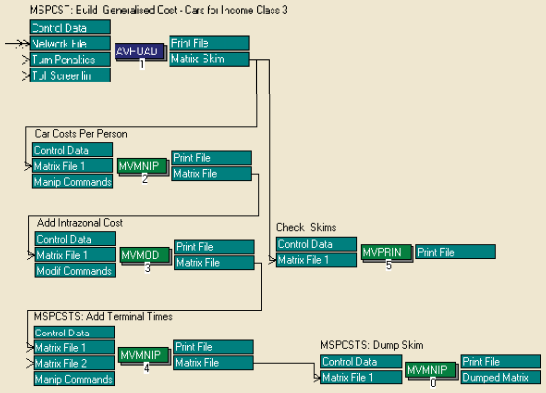
Snapshots of the Transport Model - Mode Split Costs



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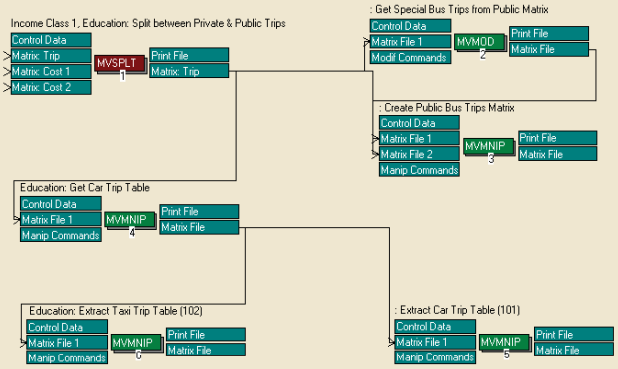
Snapshots of the Transport Model -Modal split



65

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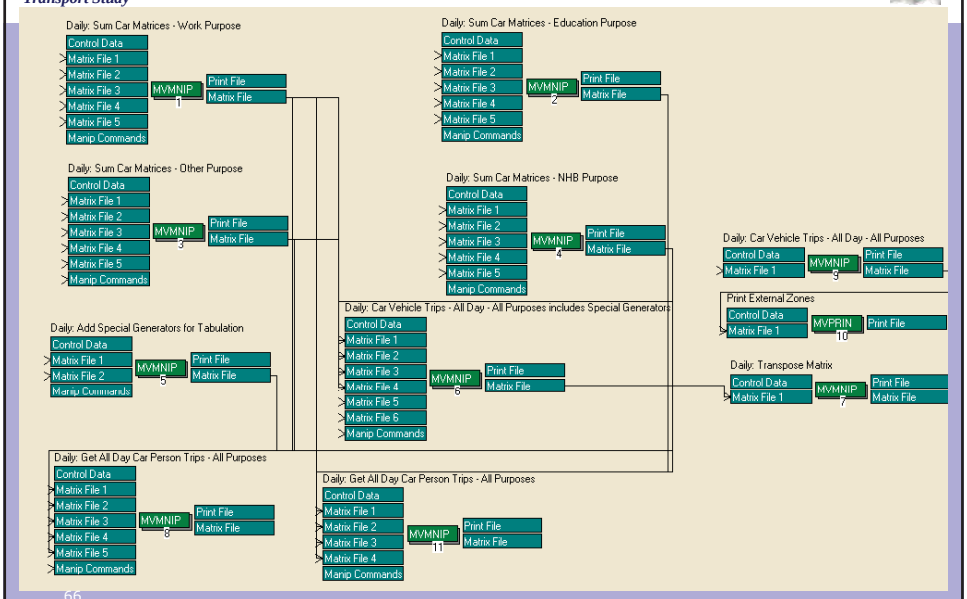
Snapshots of the Transport Model - Daily Trip Table



66

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Future Average Household Income

Year 2001---- 672 ('01 LE per Month)

Year 2007 ---- 754 ('01 LE per Month)

Year 2012---- 879 ('01 LE per Month)

Year 2022--1,176 ('01 LE per Month)

67

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Future Average Household Income

Year 2001---- 672 ('01 LE per Month)

Year 2007---- 754 ('01 LE per Month)

Year 2012---- 879 ('01 LE per Month)

Year 2022---- 1,176 ('01 LE per Month)

(Even in 2022, there are only 16 zones with income greater than 3,000 LE per Month)

68

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A- Zoning System and Network

ZONING SYSTEM

--- For Cairo Transport Model, based on some Combined Shiakhas - 464 Internal Zones and 19 External Stations

69

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Itinerary

Counterpart Training Program

Stage 1 – Knowledge Building Stage

Day 3 - Session 3

1

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Overview

- **What is a Freight Model?**
- **Why do we need Freight Models?**
- **Components of Freight Models**
- **Freight Models in Voyager and Cargo**
- **California Central County Truck Model**
- **Los Angeles County Freight Model**
- **Conclusions**

2

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What is a Freight Model?

- A tool to model the movement of goods in a region
- Goods (in tons) movement can then be split into modes (trucks, rail, air, ship)
- Example: 300 tons of timber is moving from A to B by truck. Each truck can carry 3 tons – translates to 100 trucks

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Why develop separate Freight Models

- Significant growth in goods movement require improved models to evaluate impacts on roadway capacity and air quality
- Models needed to address different potential improvements
  - Higher capacity intermodal rail terminals
  - Truck-only lanes
  - Extended working hours at the ports
  - Short-haul shuttles from ports to inland freight facilities

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Data Requirements for Freight Models

- Commodity Flow Data like tonnage movement to/from a large zone by commodity and mode
- Population and Detailed Employment Data
- Details on Ports, Warehouses and Distribution Centers
- Truck, Rail, Air and Ship freight networks
- Observed Data for validation – Average trip length, Truck Classification Counts etc

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Components of Freight Models

- Components of the freight model should include
  - Long-haul freight (includes goods coming in and out of the region)
  - Short-haul freight (local goods movement)
  - Service truck movements
- Trip Generation
  - Trip rates to generate trips
  - Trips directly from commodity flow data
  - Reliable commodity flow for base year and future years.

6

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Components of Freight Models

- Trip Distribution
  - Directly from commodity flow data
  - Gravity Model / Modified Gravity Model
- Mode Choice Model
  - Directly from commodity flow data
  - Estimated Mode Choice Model
- Trip Assignment / Trip Chaining
- Forecasts should recognize trends in labor productivity, imports, and exports

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Freight Models in Voyager and Cargo

Central California Voyager Model with linkages to remainder of USA

- Long Haul Freight directly from Commodity Flow Data (CFD)
- Short Haul Freight from trip generation model
- Long Haul freight distribution directly from CFD, Short Haul by gravity model

Los Angeles County Cargo Model

- Total Freight estimated from trip generation model
- Trip rates for long and short haul freight estimated from CFD
- Freight distribution done by a joint distribution-mode choice model.

8

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Freight Models in Voyager and Cargo

Central California Voyager Model with linkages to remainder of USA

- No Mode Choice
- No trip chaining
- Multi – class assignment
- Forecasts using growth factors

Los Angeles County Cargo Model

- Multinomial Logit - Mode Choice
- Trip Chaining represented in the TLN Model
- Forecasts use changes in productivity and trends in imports / exports

9

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Trip Generation Models –Central California

- Based on County Level Commodity Flow Data (Data on tonnage of goods from place to place.
- Convert County Level CFD to TAZ level
- Model structure is based on two overlapping elements
  - Intercity trips estimated using ITMS commodity flow data and local employment data
  - Local truck trips estimated based on a combination of land use, employment, and special generator data

10

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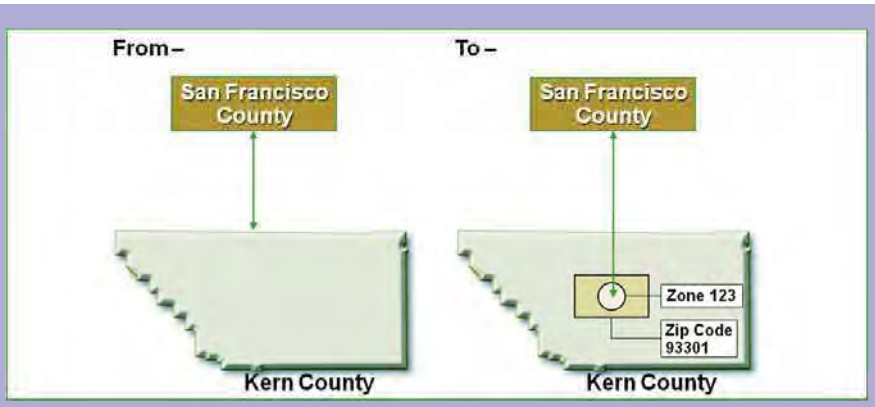
Transforming County Level Flows to TAZ's –Central California



- County-to-county flows cannot generate sufficient detail for local traffic assignment
- Zone-level flows can utilize local employment data (on zip code level), and network zone data to disaggregate flows for better assignment results
- Particularly important for intra county and adjacent county flows

11

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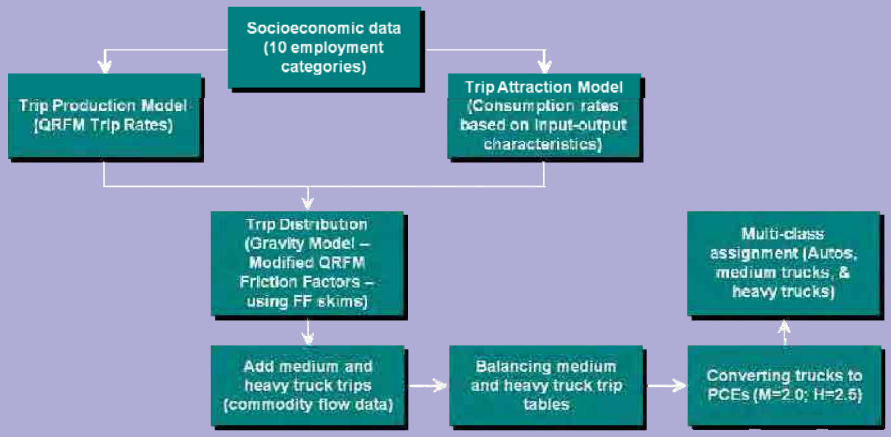
Description of Central California Truck Model Process



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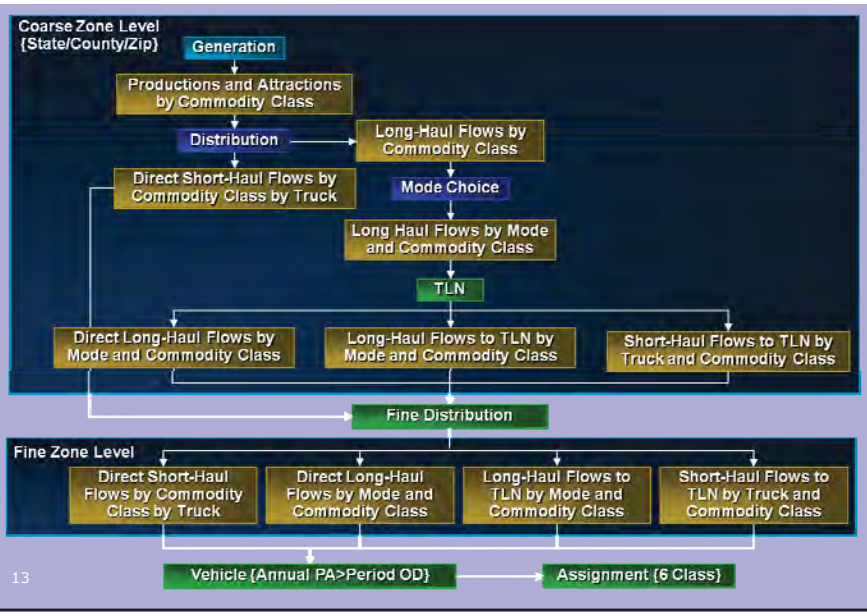
Los Angeles Cargo Modeling Process



13

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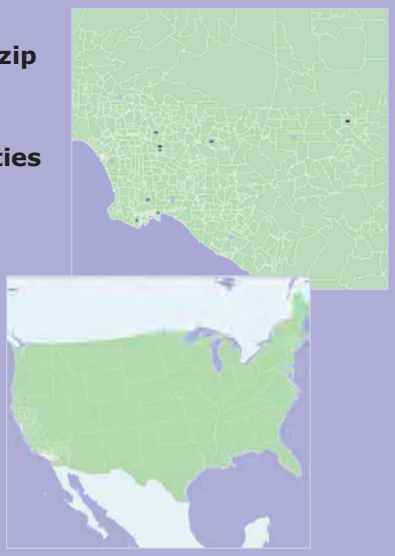
Study Area

- Within 5 county SCAG region – zip codes
- Remainder of California – counties
- Remainder of USA – states
- 4 external zones; 2 each for Canada and Mexico



14

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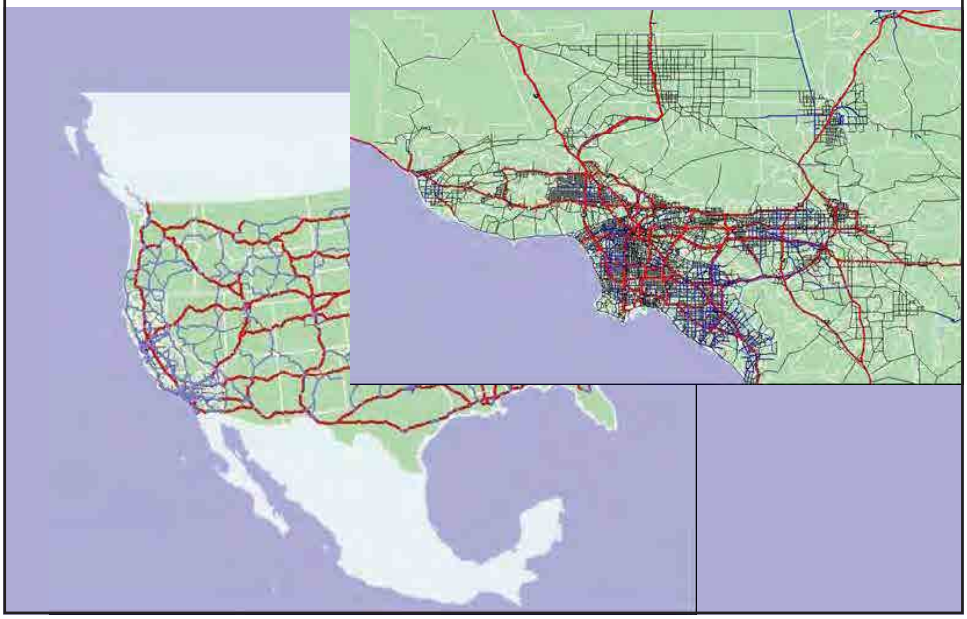
Truck Networks



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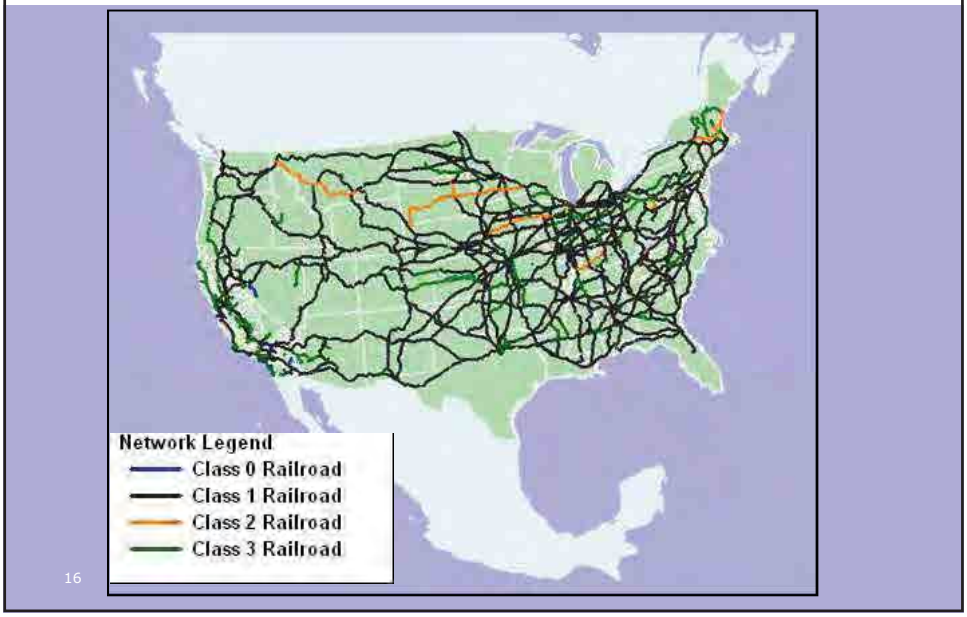
Rail Networks



16

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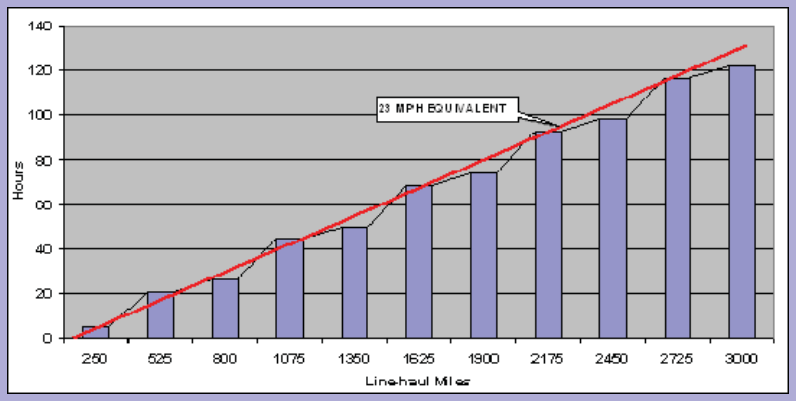
Truck Time Functions

- LTL Time = Time+40 hrs for loading / unloading
- TL Times – Drive 11 hrs between rest periods of 10 hrs



17

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Truck Cost Functions

Costs are based on labor and fuel costs:

- LTL Costs
  - 500 to 1,000 mile trips - $1.80 to $2.30 per mile
  - > 1000 mile trips - $1.75 to $2.00 per mile
- TL Costs
  - 500 to 1,000 mile trips - $1.35 to $1.74 per mile
  - > 1,000 miles trips - $1.32 to $1.51 per mile

18

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Rail Time ad Cost Functions

- Average rail speed of 33mph and 24hrs terminal / dray time
- Intermodal trailer shipments @ 14 tons/unit: = $26.43/ton + $.05/ton-mile;
- Intermodal container shipments @ 16 tons/unit: = $23.13/ton + $.04/ton-mile; and

19

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Model Descriptions – Freight Generation

- Forecasts annual tons by commodity
- Implemented at the Coarse Zone Level
- Internal tonnage based on tonnage rate per employee
- Consumptions based on Input-Output matrix
- I-E and E-I trips allocated based on factors derived from ITMS
- Port trips added directly from the Port's models

20

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Tonnage Rates by Commodity

Category	Description	Tonnage Rate
Agriculture	Crops	311.51
	Livestock	4,863.69
	Forestry, fishing, hunting, and trapping	7,329.10
Cement and Concrete Manufacturing	Stone, clay, glass products	472.50
	Concrete products	7,502.27
Chemical Manufacturing	Chemicals and allied products	488.26
Equipment Manufacturing	Industrial machinery and equipment	36.83
	Electrical and electronic equipment	36.60
	Transportation Equipment	72.96
Manufactuing	Textile mill products	200.58
	Apparel and other textile products	8.15
	Furniture and fixtures	49.60
	Printing and publishing	24.47
	Rubber and miscellaneous plastics	170.78
	Leather and leather products	412.91
	Instruments and related products	1.84
	Miscellaneous manufacturing industries	7.86

21

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Tonnage Rates by Commodity (contd.)

Category	Description	Tonnage Rate
Metals Manufacturing	Primary metal industries	816.73
	Fabricated metal products	101.65
Mining and Fuels	Mining and oil and gas	5,123.91
Motor Freight Transportation	Motor freight transportation and warehousing	512.42
Nonmetallic Minerals	Nonmetallic minerals, except fuels	45,695.22
Other Transportation	Transportation by air	802.89
	Transportation services	562.11
Paper and Wood Products Manufacturing	Lumber and wood products	763.23
	Paper and allied products	243.28
Petroleum	Petroleum and coal products	7,506.25
Wholesale Trade	Wholesale trade – durable goods	62.57

22

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Model Descriptions – Freight Distribution

- Trips split into short-haul and Long Haul
- Short trip distribution based on a gravity model
- Long trips are distributed using a joint distribution and mode choice model

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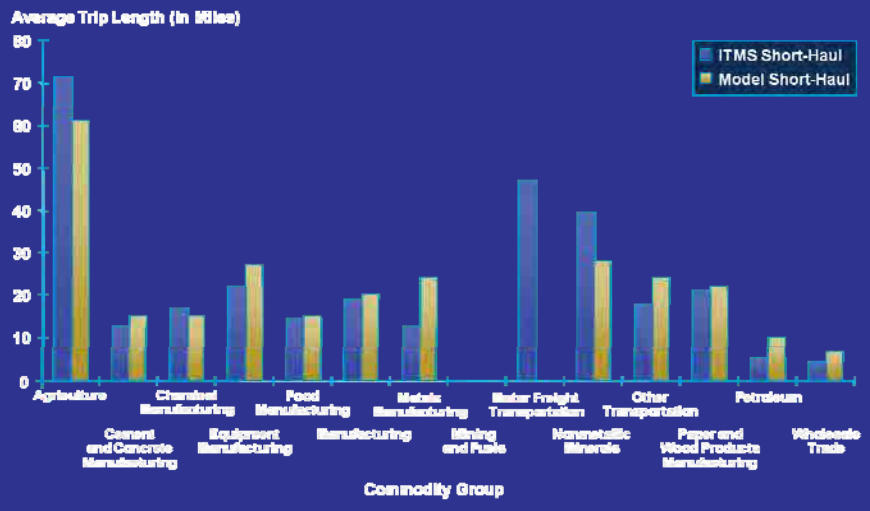
Trip Distribution Validation for Short-Haul Trips



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Model Descriptions

- **Mode Choice**
  - Estimates Truck and Rail Trips
  - Based on a multinomial logit model
  - Applied for 3 distance classes
- **Service Model**
  - Estimates safety, utility, public / personal vehicles
- **Fine Distribution Model**
  - Disaggregates trips from coarse zone level to the fine-zone system

25

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Vehicle Model

- Converts tons to trucks
- Parameters to influence empty trucks
- Standard Vehicle Model to generate direct O-D flows
- Touring vehicle model that simulates multi-point pick-up and drop off

26

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Assignment Validation – External Cordons

Gateway	Routes	Count Volumes	Truck Model Volumes	% Difference
San Diego / Mexico	I-8, I-15, I-5	26,058	24,436	-6%
Rest of CA	US-101, I-5, CA-14, US-395	29,698	31,840	7%
Arizona	I-8, I-15, I-40, I-10	25,534	27,133	6%
Total		81,291	83,409	3%

27

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Assignment Validation – Screenlines

Screenline	Dir	Number of Counts	Truck Counts	Model Volumes	% Diff
1	N-S	18	51,277	54,718	7%
2	E-W	28	96,480	91,096	-6%
3	N-S	18	70,323	53,375	-24%
4	E-W	12	71,266	56,140	-21%
5	E-W	23	77,268	74,714	-3%
6	E-W	13	78,972	86,753	10%
7	N-S	20	47,733	25,909	-46%
8	E-W	14	64,199	60,048	-6%
10	E-W	8	19,356	20,397	5%
11	E-W	8	16,278	18,389	13%
12	E-W	5	19,064	18,617	-2%
13	N-S	6	17,291	14,349	-17%
18	N-S	4	29,958	31,331	5%
Total		191	700,699	644,421	-8%

28

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2030 Model – Tonnage Generation Model Change in Labor Productivity

Commodity Group	Growth
Agriculture	1.43%
Cement and Concrete	0.66%
Chemical Manufacturing	1.85%
Equipment Manufacturing	2.55%
Food Manufacturing	1.47%
Manufacturing	3.39%
Metals Manufacturing	2.12%
Mining and Fuels	0.93%
Motor freight transportation	1.18%
Nonmetallic minerals	1.88%
Other transportation	1.93%
Paper and Wood Products	1.71%
Petroleum	2.57%
Wholesale Trade	3.94%

29

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2030 Model – Tonnage Generation ModelChange in Imports and Exports

Region / State	Exports	Imports
Remainder of CA	-8%	-1%
Sacramento	-1%	0%
San Francisco Bay Area	-4%	0%
San Diego	-2%	4%
Florida	1%	0%
Illinois	1%	0%
Iowa	0%	-1%
Arkansas	0%	-1%
Texas	2%	-2%
Colorado	0%	2%
Arizona	1%	7%
Utah	1%	0%
Nevada	2%	-3%
Washington	1%	-2%
Oregon	1%	0%
Mexico	0%	2%

30

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Conclusions

- Freight Models can be developed in Voyager and Cargo
- Custom Scripts prepared in Voyager
- Easy to produce freight movements at different levels of detail (zip codes and TAZs) in Cargo
- TLN and service models provide more accurate accounting of truck trips
- Cargo uses changes in labor productivity and trends in the future model
- Cargo model can evaluate a wider range of alternatives

31

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Vehicle Model

- Converts tons to trucks
- Parameters to influence empty trucks
- Standard Vehicle Model to generate direct O-D flows
- Touring vehicle model that simulates multi-point pick-up and drop off

32

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Itinerary

Counterpart Training Program

Stage 1 – Knowledge Building Stage

Day 4 - Session 1

1

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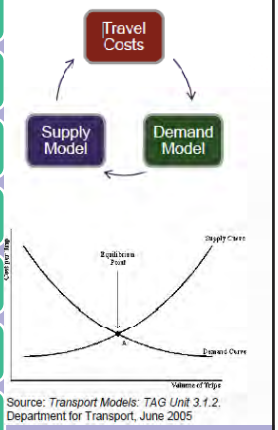
The Model

- Roots in transportation economics and theory of supply / demand equilibrium
- Transportation supply = The Network --- roads, bridges, trains, buses, airports, boats, planes
- Transportation demand – the demand for activities (goods & services) and Travel
- Transportation costs = expected time, distance, money, and other penalties associated with using a travel option
- Weighted combination of these costs is called —generalized cost
- Costs increase with demand -congestion
- Demand on a Mode or Route decreases with cost –diversion



Source: *Transport Models: TAG Unit 3.1.2.* Department for Transport, June 2005

2

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Script File Structure

A script is essentially a software language:

- **Process Templates**
- **Input and Output files**
- **Program Module**
  - **Program Phases**

3

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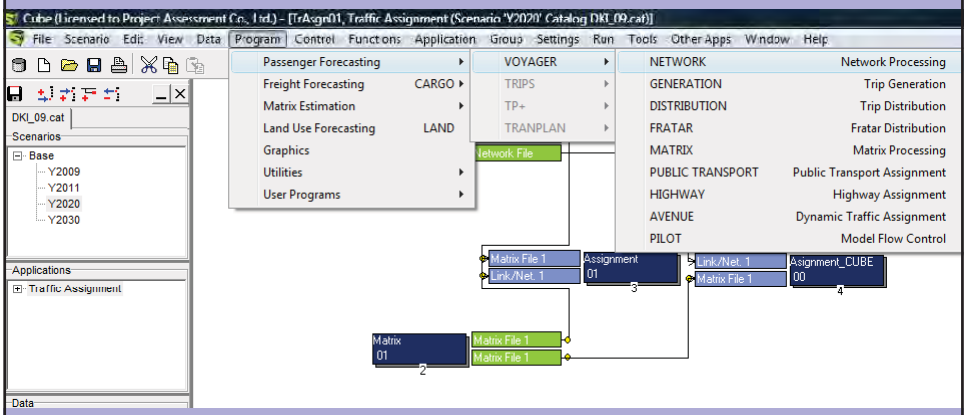
Available Templates



4

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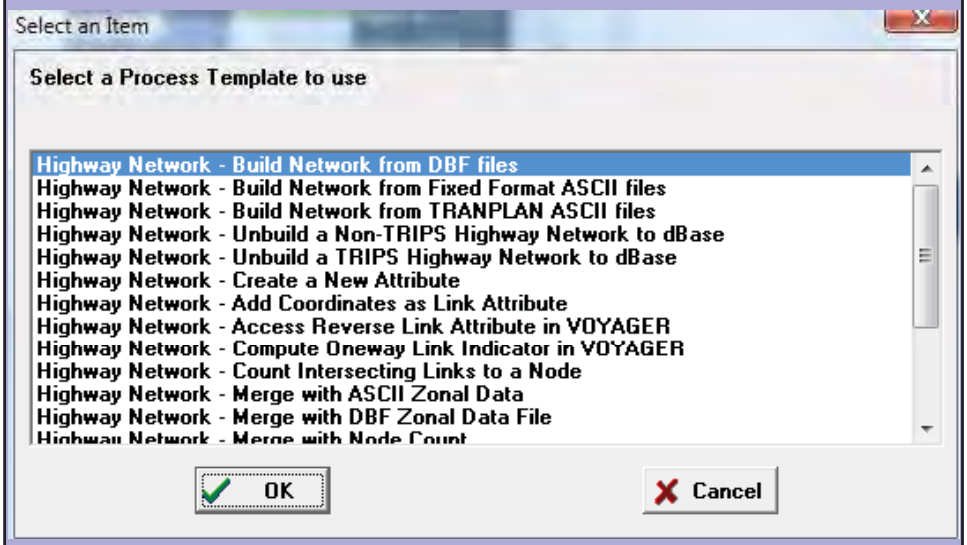
Sample Templates



5

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Demand Data used in the Model

- **Zonal Data**
  - Stores socio-economic & demographic information, trip ends
  - Exchange formats: ASCII (e.g. CSV) text, DBF (SHP)
  - Best GIS format: geodatabase polygon feature class
- **Matrix Data**
  - Zone-to-zone information of any kind e.g. trips, costs
  - Native binary MAT format for compression, efficiency
  - ASCII (e.g. CSV) text, DBF formats for exchange
- **Record and Database Files**
  - ASCII (e.g. CSV) text, DBF, MS Access 2003, ESRI personal geodatabase formats
- **Lookup Tables**
  - ASCII (e.g. CSV) text, DBF formats

6

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Supply Data used in the Model

- Highway networks
  - Native binary Citilabs format for compression & efficiency
  - ESRI custom personal geodatabasefeature dataset for GIS
  - ASCII (CSV) text and DBF for exchange
- Intersection / junction data
  - ASCII text format (Cube Voyager syntax)
  - Roundabout, priority, fixed-time and adaptive signals, two-way and all-way stops
  - Used to apply HCM 2000 or saturation flow lane group capacity and delay
- Public transport services
  - ASCII text format (Cube Voyager syntax): lines, system data, fares, factors
  - Binary format to consolidate data with underlying multimodal network
  - ESRI personal geodatabaseformat: lines, non-transit legs

7

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CUBE Voyager Syntax and Structure

- All statements follow the same general structure: COMMANDKEYWORD=VALUE, SUBKEYWORD = VALUE
- Some KEYWORDs automatically invoke an associated COMMAND
- KEYWORDs are always followed by an equals sign and a VALUE
- The VALUE may be the result of an expression or computation
- Continuation characters (commas, equals signs, any operator) distribute statements across multiple lines
- E.g.: COMMAND,KEYWORD=VALUE,SUBKEYWORD=VALUE

8

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Voyager Expressions

- **Operators:**

+ addition	|| logical OR
- subtraction	&&logical AND
* multiplication	==, =equals
/ division	!=, <>does not equal
% modulus	>=greater than or equal to
^ exponentiation	<=less than or equal to
() parentheses	>greater than
	<less than

- **Numeric functions: ABS, INT, ROUND, MAX, MINEXP, LN, LOG, POW, SQRTRAND, RANDOM, RANDSEED**
- **Character Functions**

DELETESTR(s1,n1,n2), DUPSTR(str,n), FORMAT(x,w,d,str), INSERTSTR(s1,s2,n),LEFTSTR(s1,n), LTRIM(str), REPLACESTR(s1,s2,s3,n), REPLACESTRIC(s1,s2,s3,n), REVERSESTR(s1),RIGHTSTR(s1,n), STR(v,w,d), STRLEN(str), STRLOWER(str), STRPOS(str,str2),STRPOSEX(s1,s2,n1), STRUPPER(str), SUBSTR(str,b,n), TRIM(str), VAL(str)

9

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Commands used in all Modes

- **COMP var= expression; usually without explicit COMP**
- **IF (condition)… ELSEIF (condition)… ELSE… ENDIF**
- **LOOP… ENDLOOP**
- **LOOKUP**
- **PRINT LIST= a, b, c; where a, b, and c are variables or expressions**
  - FORM = w.d; where w is the default width and d is the number of decimals
  - FILE = filename or PRINTO=#
  - CSV = T; automatically format as comma-separated values

10

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Comments and Style Guidelines

- Include plenty of comments—for yourself and others
- Everything following a semi-colon on any line is a comment
- Use ; comments to explain intent behind coded commands
  - Everything between /* and */ is a control block
  - Use control blocks to turn off sections of script without deleting
- Use full COMMAND KEYWORD=VALUE syntax when possible
- Write system commands, keywords, and functions in UPPERCASE, reserve lower and proper case for user-defined variables and names
- NEVER have your script file open when you are linking new files into a Voyager Module. Input and output files will not get updated!
- Try right-clicking when you are unsure what should come next

11

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Program Module Structure

- Cube Voyager program modules may contain one or more "phases"
- Each phase performs a user-specified sequence of operations on each element of a data structure, such as links in a network
- Typical program script:

```
;Comments preceded by semicolon
RUN PGM=name
FILEI … ;specify input files
FILEO … ;specify output files
PARAMETERS … ;global settings not in any phase
PROCESS PHASE=…
     COMMAND KEYWORD=…
     ;more commands…
ENDPROCESS
 ;more phases…
ENDRUN
```

Note: *The Colours*
1. **Green is a comment**
2. **Red is the beginning and ending of a program**

- Additionally, some programs have an iterative looping framework that will repeat certain phases until a convergence criterion is met

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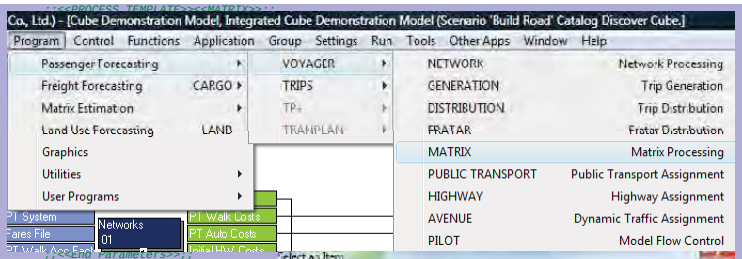
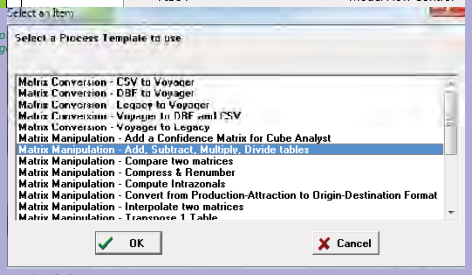
Sample Script File from a Process Template




```
;;<<End Parameters>>;;

; Do not change filenames or add o
editor. Use Cube/Application Manag

RUN PGM=MATRIX
FILEI MATI[1] = {MATI1.Q}
FILEI MATI[2] = {MATI2.Q}

FILEO MATO[1] = {MATO.Q},
      MO=10


MW[1]=mi.1.1
MW[2]=mi.2.1

if ('{operator}'<>'/')
   MW[10]=MW[1]{operator}MW[2]

else
   JLOOP
   if (MW[2]<>0) MW[10]=MW[1]{operator}MW[2]
   ENDJLOOP
ENDIF

ENDRUN
```



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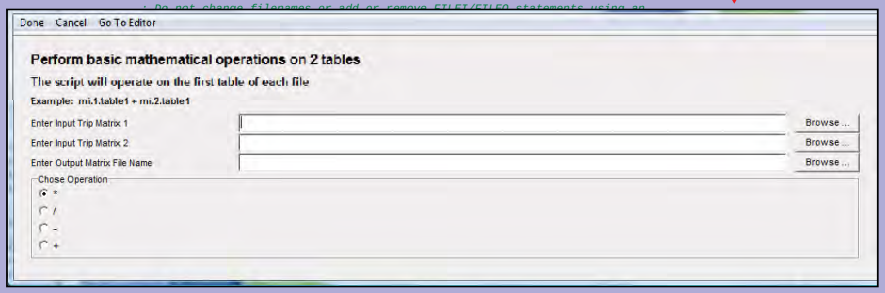
Sample Script File from a Process Template

```
;;<<PROCESS TEMPLATE>><<MATRIX>>;;
;{note1,note,12,"Perform basic mathematical operations on 2 tables"}   >>>
;{note2,note,10,"The script will operate on the first table of each file"}
>>>
;{note3,note,8,"Example:  mi.1.table1 + mi.2.table1"}   >>>
;Input Matrix File 1: {mati1,filename,"Enter Input Trip Matrix
1",x,"","Trip Matrix (*.mat)|*.mat"}
;Input Matrix File 2: {mati2,filename,"Enter Input Trip Matrix
2",x,"","Trip Matrix (*.mat)|*.mat"}
;Output Matrix File:   {mato,filename,"Enter Output Matrix File
Name",x,"","Matrix File (*.mat)|*.mat"}
;Mathematical Operator: {operator,RadioBtn,"Chose Operation","*","/","-
","+"}
;*****************************************************************
;                    BASIC MATHEMATICS                            *
;*****************************************************************
;
; BY CITILABS
;
; THIS SCRIPT READS TWO TRIP MATRICES, CREATES A MATRIX WITH THE RESULT
;;<<End Parameters>>;;

; Do not change filenames or add or remove FILEI/FILEO statements using an

ENDRUN
```

Allows inclusion of specific input menu



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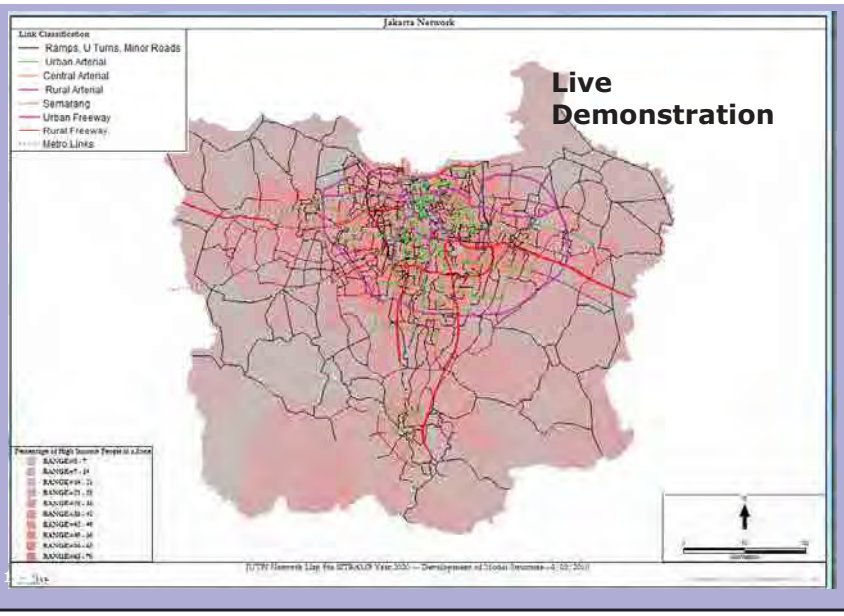
Development of Mapping



Live
Demonstration

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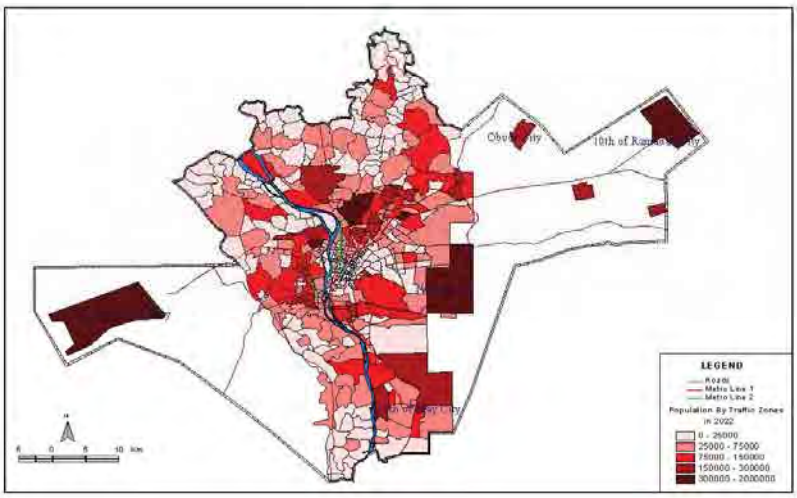
Population Distribution



16

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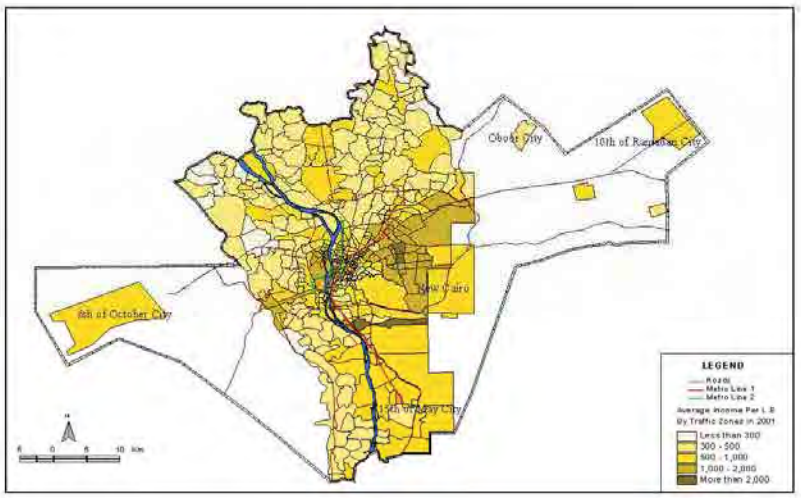
Income Distribution



17

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Development of a Master Network

- All Future Road Projects
- Project Classification
- New Alignment or Old Alignment
- Old or existing alignment means an increase in Capacity
- Opening Year
- Dependent on Scenario Year Project is included or excluded

SCRIPT CODING:
mYear={Year}
if (year > mYear & oldcap =0) delete
if (year > mYear & oldcap >0) capacity=oldcap

18

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Itinerary

Counterpart Training Program

Stage 1 – Knowledge Building Stage

Day 4 - Sessions 2 and 3

1

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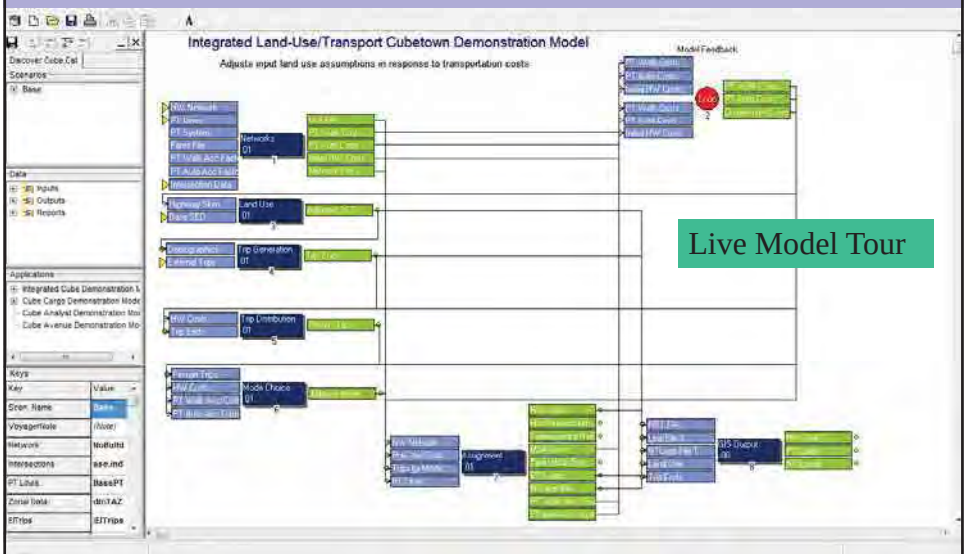
A Model



2

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Building a Model from the Beginning

- We will now build our first transport model
- Based on a Training Course developed by Citilabs
- We will only to do some of this today but you can finish in your own time, this is your homework.
- **WE SHOULD MEET ONE WEEK FROM NOW TO SEE IF YOU HAVE FINISHED THIS EXERCISE OR HAVE ANY PROBLEMS???**

3

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Applications

- The Applications are the Model Processes
- A single Catalog may have many Applications
  - Passenger Forecasting
  - Freight Forecasting
  - Land-Use Forecasting
  - Sub-Area Analysis
  - Impact Studies
- The Application file is a single page which tracks data flows and organizes modeling functions. These functions may be either from Cube Libraries or User Defined.
- Application files may be nested to provide model structure.

4

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Starting Cube

The 'Welcome to Cube' Screen

- Used to Access a Catalog
- Easy access to the most recent Catalog

1. Double-Click the Cube Icon to Access the Welcome Screen
2. Click 'Cancel' to open Cube without opening a Catalog

5

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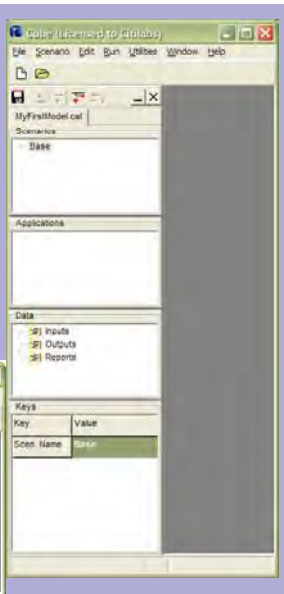
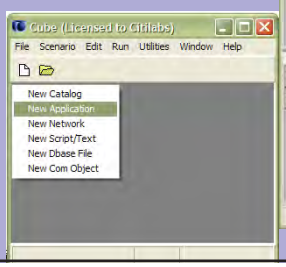
Create a Catalog

1. Select File > New
2. Choose 'New Catalog'
3. Save the new Catalog to: the directory,

C:\CitilabsExamples\Training\ Models

The Scenario-Manager opens for the new Catalog along the left-side of the window.





6

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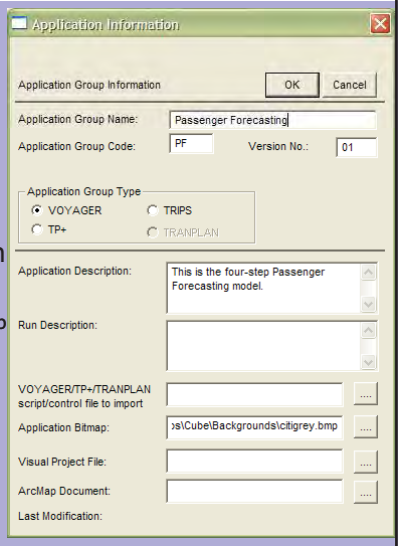
Create an Application

1. Select File > New
2. Choose 'New Application'
3. Enter an Application Name
4. Enter an Application Code
   - Used for File Naming
5. Select the Application Type
6. Enter a Description for the Application
7. Browse to a Background File

C:\Program Files\Citilabs\Cube\Backgrounds\citigrey.bmp

8. Click 'OK'
9. Save the file
   - C:\Training\Models\Passenger.APP



7

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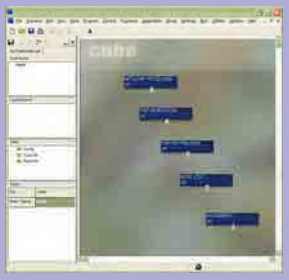
Creating Groups

- Model structure can be defined using Groups.
- Groups are Application files nested in the 'Parent' Application.
- Groups may contain other groups.

1. Select 'Group' > 'Make New Sub-Group…'
2. Create a Sub-Group for a Network processing step and then each of the 'four-steps'.
   a) Network Processing
   b) Trip Generation
   c) Trip Distribution
   d) Mode Split
   e) Assignment



8

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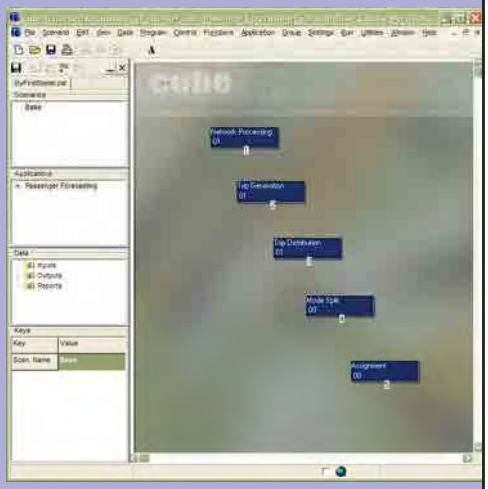
Add Application to Catalog

In order for the Catalog to track the Application, it must be added to the Application section of Scenario-Manager.

1. Right-Click in the Application
2. Select: 'Add Application to Catalog'
3. Save the Application
4. Save the Catalog
5. Close Cube
6. Start Cube
7. Select 'Open Last Catalog'
8. Double-Click the Application



9

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Add Processing Steps

- In addition to groups, applications contain processing steps.
- These steps can be Cube programs (Voyager, TranPlan, TP+, Trips, Cargo, Land, ME, DTA…)
- These steps can be any user defined program (EXE, DLL)

1. Browse to the Network Processing Group
   - Double-click the group in the 'parent' application or
   - Navigate to the group in the 'Applications' window in SM
2. Select Program>Passenger Forecasting>Voyager>Highway
3. In the Trip Generation Group, add a 'Generation' step.
4. In the Distribution Group, add a 'Distribution' step.

10

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Program Structure

- A program has input files, output files, and execution order.
- The input files are displayed on the left.
- The output files are displayed on the right.
- The execution order is the number attached program.
- Every program has two key files
- Script file – Contains Program Instructions
- Automatically created
  - Print File – Contains Run Results
  - Auto-Named by the user

11

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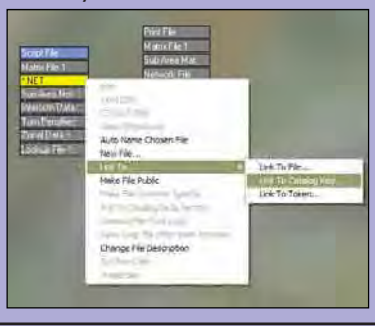
Linking Data Files

Data can be linked in two ways

1. Link to File
   - A hard link to a specific file. This file cannot be changed when running the model scenarios.
2. Link to Catalog Key
   - A soft link to a user input. For each model scenario the user is responsible to verify the input.



12

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Catalog Keys

- Keys are the parameters that are input to the model which the developer would like the applier to be able to access and change.
- The values of the Keys are unique for each scenario and are tracked by the scenario manager.
- Keys may be numeric variables, file names, or text strings.
- The user accesses the keys through a user menu by double-clicking on a scenario.
- When the developer defines a key, they also define the user menu.

13

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Creating a Catalog Key

1. Right-click in the Keys window and select 'Add'
2. Enter a Name for the Key (Input Network)
3. Enter a Prompt (Browse to the Input Network File)
4. Select the Type (File Name)
5. Select the Control (Edit Box)
6. Click on File Filters. Create a new filter.
   - Enter a Filter Name: Networks (*.NET)
   - Enter a Filter: *.net
7. Click on Advanced
   - Select 'Store File Location Relative to Catalog Directory'
8. Click 'OK'. The Key appears down in the Key window.
9. Double-click on the 'Base' scenario to see the new addition to the user interface.

14

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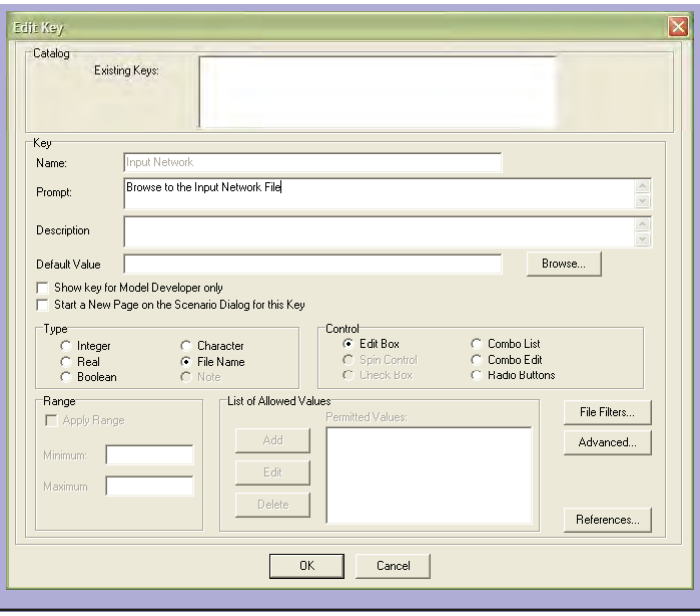
Catalog Key Properties Window



15

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Linking Files to a Program

1. Go to the Network Processing Group
2. Right-Click on the 'HIGHWAY' box and select 'Set Title'
3. Enter 'Skim Free-Flow Impedances'
4. Right-click on the 'Print File'
5. Select 'Auto-Name Chosen File'
6. Click Yes to create the file in the Model Directory
7. Right-Click on the input 'Network File'
8. Select 'Link to… > Link to Catalog Key'
9. Double-Click the 'Input Network' Key, Click 'OK'
10. Right-Click on the output 'Matrix File 1'
11. Select 'New File…'
12. Name it 'FFSkims.MAT' and save it in the Models directory.

16

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Creating a Highway Network

1. Open the Network Shape File
   - C:\Training\GISData\Network2005.shp
2. Select 'GIS Tools > Build Network From Shape…'
3. Save the new network as 'Network2005.net' in the scenario folder 'Base'.
4. Select the A-Node and B-Node Field Name (A, B)
5. For 1-way/2-way, use indicator field (ONEWAY_TWO)
6. Do not add distance field
7. Set Node grouping limit (1)
8. Set Starting New Node Number (2000)
9. Set Highest Zone Number (25)
10. Click OK

17

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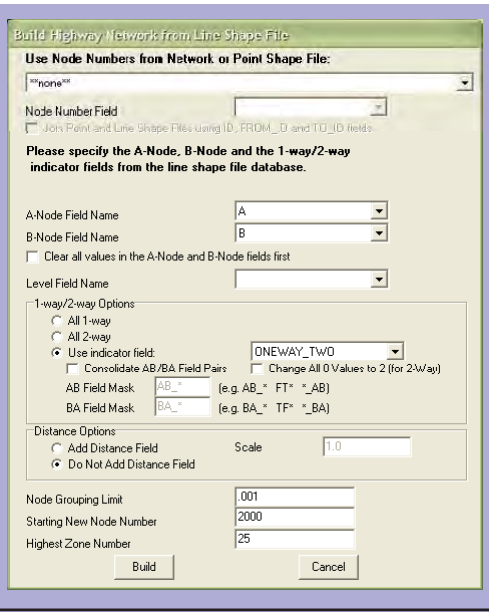
Build Network Dialog



18

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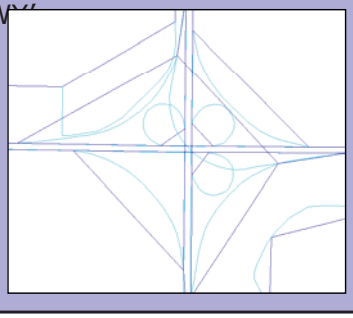
Adding Layers to Map

Once the network has been built it needs to be added to the map as a new layer.

1. Click the 'Layer Control Dialog' button.
2. Check on the 'Highway' layer
3. Browse to the newly created network
4. Click 'All Done'
5. Zoom into the central interchange
6. In the layer drop-down, select the 'HWY' layer
   - By default the network is displayed in 'logical view'



19

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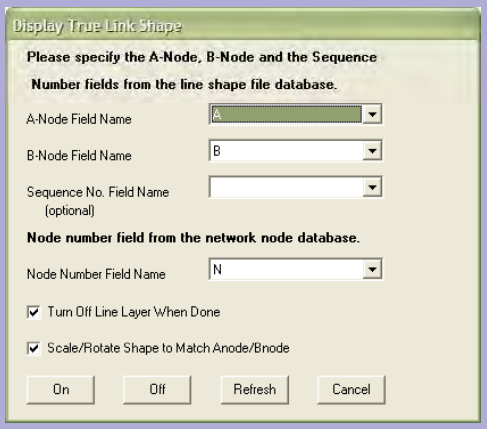
True-Shape Display

It is possible to use a shape file to control the geometry of the .net file logical network.

1. Select 'GIS Tools > True Shape Display…'
2. Identify the A and B Node fields in the shape file to link to.
3. Click 'On'
4. The network is displayed using the GIS shape file.



20

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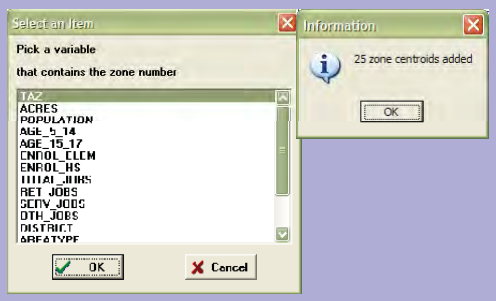
Develop Centroid Locations

It is possible to use a boundary layer to automate the creation of network centroids.

1. Add a Boundary Layer using file 'Zones2005.shp' from the 'GISData' folder to the map.
2. 'Select Node > Automatic Add Centroid'
3. Select the variable 'TAZ'
4. Click 'OK'



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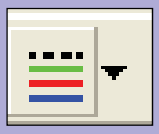
Color Links

It is possible to set up color sets for link data.



1. Click on the 'Link/Line Color' button
2. Enter a 'Group Name' (Road Class)
3. Click 'Insert' 4 times

4. Enter four different conditions
   a) {blank}
   b) FUNC_CLASS=2-4
   c) FUNC_CLASS>=5
   d) _CENTROID=1

5. Select the 'Road-RandMcNally' Color Pallette
6. Set a unique Color/Line-Style/Size for each condition
7. Click 'Close'

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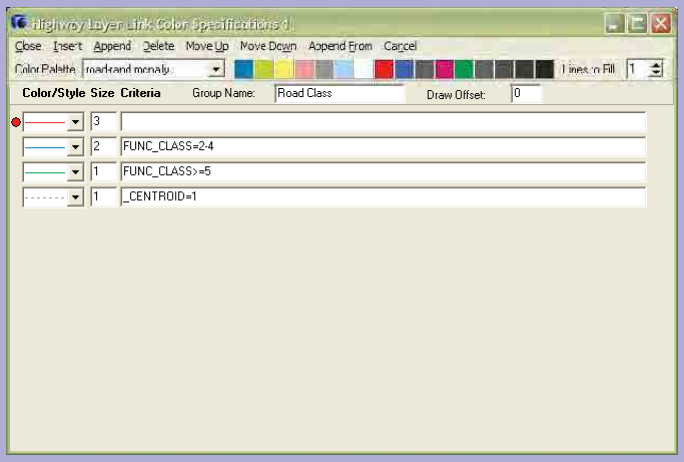
Link/Line Color Dialog



23

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Develop Centroid Connectors

1. Now that the Centroids are created, we can automate the process of connecting them to the network.

1. Click the 'View Center on Nodes' button
2. Enter Node Number '14' and Window Width '10000'
3. Select 'Node > Automatic Add Centroid Connections'
4. Enter Maximum Number of Connectors (4)
5. Enter Maximum Distance for Connections (5000)
6. Enter Directional Weighting Factor (4)
7. Place a 'Do NOT Connect to a Link' condition
   - FUNC_CLASS=1-2

24

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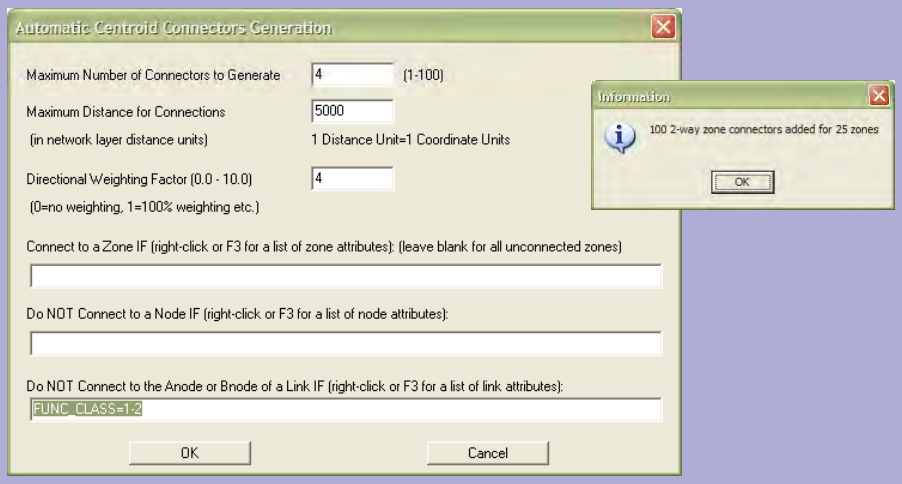
Automatic Centroid Connectors



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Network Computations

1. Select 'Link > Compute'
2. Name Set 1 (Connector Defaults)
3. Right-Click in the open area, select 'Append'
4. Enter the calculation (right-click to access variable list)
   - SPEED=15
5. Append the following calculations
   - NUMLANES=2
   - ONEWAY_TWO=2
   - FUNC_CLASS=7
6. Apply a condition so only connectors are calculated
   - _CENTROID=1
7. Click Apply
8. Click Close

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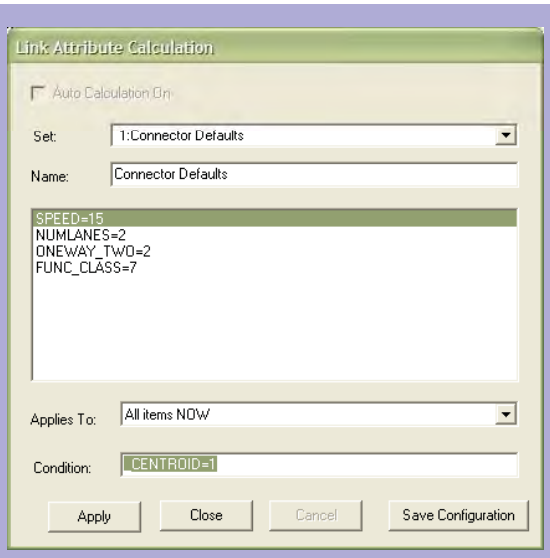
Compute Dialog



27

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Color Nodes

It is possible to set up color sets for node data.

1. Click the 'Node/Point Color' button 
2. Enter a Group Name (Zones and Nodes)
3. Color ALL the nodes as a Blue Square
4. Color Centroids as a Gold Star

28

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Post Nodes

It is possible to set up color sets for node data.

1. Click the 'Post Node' button 
2. Select a Set (Set 1)
3. Name the Set (All Nodes)
4. Select the variable N
5. Click 'OK'

29

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Edit Network Connections

It is very easy to setup and adjust the existing network links and nodes.

1. Zoom into Centroid 14.
2. Select the Centroid by clicking it once.
3. Click and drag to move the Centroid.

4. Select the link between nodes 14 and 1332
5. Click and drag the 1332 end to node 691

30

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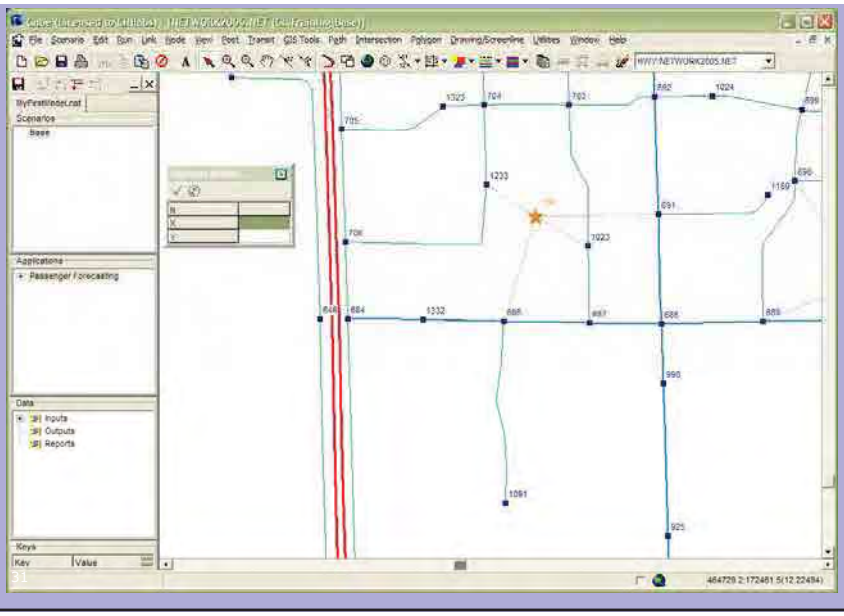
The New Network



31

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Visual Project Files

Visual Project Files have a VPR Extension and contain all the map settings.

1. Close the Network.
2. Cube asks you if you want to 'Save Project File?'
3. Click 'Yes'
   - o This saves a VPR file with the same name.
   - o If a Network (*.NET) file is opened and a VPR file with the same name exists in the directory, Cube automatically opens the VPR file as well.

32

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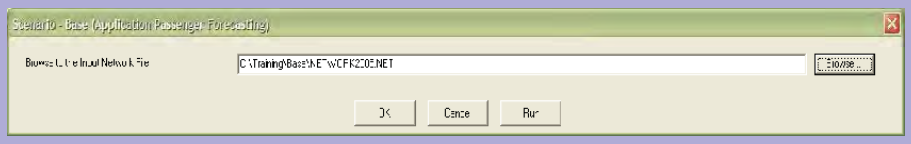
Editing Scenario Data

Every Scenario saves a unique set of Key values.
To edit the Keys:

1. Double-Click the scenario 'Base'
2. A Scenario window opens.
3. Browse to the newly created Network file.
4. Click 'OK'



33

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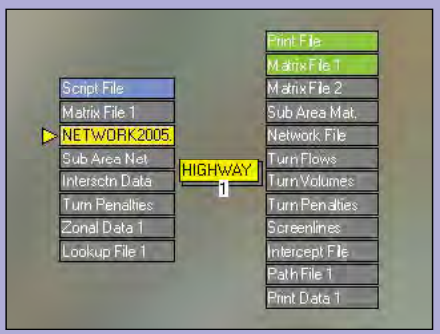
Accessing Files from AM

Users may directly access any of the files shown in AM.

1. Open the 'Network Processing' group in AM.
2. Click on the input 'Network File'. It will highlight yellow and you will see the file name (NETWORK2005.NET).
3. Double-click the input 'Network File'. Cube opens our newly created network.
4. Close the Network
5. Open the 'Script File'



34

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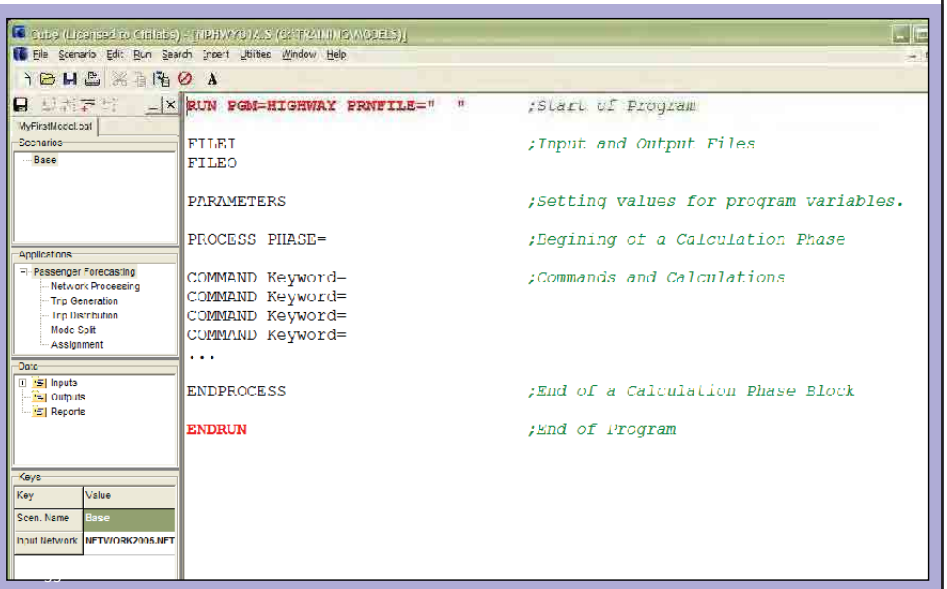
Script File Structure



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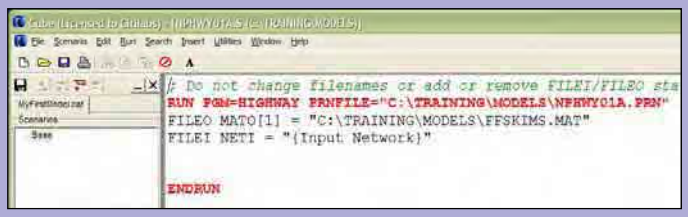
Generated Script Files

- When a script file are created and maintained by AM
- AM automatically generate the basic structure
- AM keeps track of all the input and output files
- The user will add Parameters, Process blocks, Calculations
- The user should NEVER edit the file names and locations
- All changes to the file names and locations should be done in AM



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Comments

Comment is any text following a ;(on the same line)

- may be at start of line
- may be midway through a line
- may be midway through a command
- Example

```
A=1     ;command followed by comment
        ;comment line here
```

Block comment: enclosed by /* … */

- Example

```
A=1 /* comments start here…
…
… comments end here */
B=2
```

37

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Voyager Programs –a Revision

- NETWORK
  - Building, Comparing and Manipulating Highway Networks
- HIGHWAY
  - Pathbuilding, Skimming, and Assignment of Highway Networks
- PT
  - All Public Transit Functions
- GENERATION
  - Trip Generation
- DISTRIBUTION
  - Trip Distribution
- FRATAR
  - Matrix Growth Factoring
- MATRIX
  - Demand Modeling and Matrix Manipulations

38

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Highway

- Primary function is to Build Paths between all IJ pairs
- Once Paths are built, the user may:
  - Skim network variables
  - Assign trips to network
- Input may include
  - Highway network
  - Zonal matrices
  - Zonal data files
  - Turn penalties
- Output may include
  - Loaded network
  - Matrices
  - Junction Output Data

39

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Highway PHASE=LINKREAD

- Defines required values for each link.
- Built-in Variables and Functions may be set here.
- Script:
  - DISTANCE = (LI.SHAPE_LENG/5280) ;Link Distance in Miles
  - T0 = (DISTANCE/LI.SPEED)*60 ;Free-Flow Time (Minutes)

```
PROCESS  PHASE=LINKREAD
   DISTANCE = (LI.SHAPE_LENG/5280) ;Link Distance in Miles
   T0 = (DIST/LI.SPEED)*60     ;Link Time in Minutes
ENDPROCESS
```

40

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Highway PHASE=ILOOP

- Builds paths from each origin zone to every destination
- Script:
  - PATHLOAD ;Defines Process
  - PATH=TIME, ;Defines Impedance Variable
  - MW[1]=PATHTRACE(TIME) ;Skims Network Variable

```
PROCESS PHASE=ILOOP
   PATHLOAD                  ;Defines Process
   PATH=TIME,                    ;Defines Impedance Variable
   MW[1]=PATHTRACE(TIME)             ;Skims Network Variable
ENDPROCESS
```

41

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Highway File Definition

- The user needs to tell the output matrix what working matrixes will be saved.
- The user may name these matrices
- Script (appended to MATO):
  - MO=1, NAME=TIME

```
FILEO MATO[1] = "C:\TRAINING\MODELS\FFSKIMS.MAT",
   MO=1,  NAME=TIME
FILEI NETI = "{Input Network}"
```

42

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Running Programs

As well as running entire models, AM provides the ability to run individual steps in the modeling process.

1. Navigate to the 'Network Processing' group.
2. Double-Click the 'Highway' program box.
   - The program runs.
3. Examine the output Matrix
4. Examine the output Print File

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Highway Functions

Functions may be defined and used in the Highway program. Functions are usually placed in the LINKREAD Phase Script:

- FUNCTION Cost = (Distance * 0.50) + (TIME * 0.20)

1. Define the Cost Function
2. Use Cost as the Pathbuilding Impedance
3. Skim Distance and Cost as well as time
4. Save all 3 matrices

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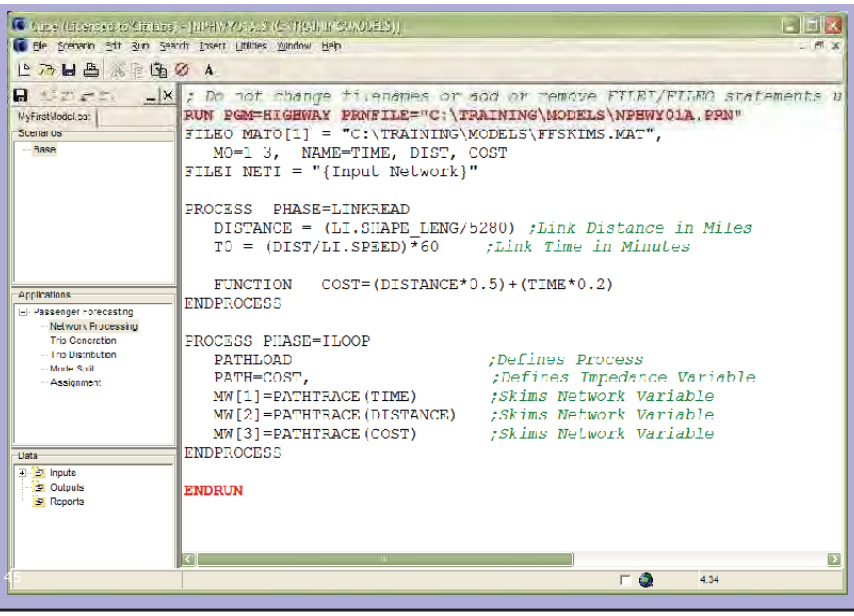
Highway Script



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Cleaning Up the Application

1. Right-click the 'Highway' program
2. Select 'Hide unused files for program'

3. Right-click the 'Highway' program
4. Select 'Set Title'
5. Label the program (Initial Free-Flow Highway Skims)

6. Right-Click on output 'Matrix File 1'
7. Select 'Change File Description'
8. Label the file (Initial FF Skims)

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Generation

- Primary function is to process zonal data and generate arrays of productions and attractions
- Calculations and balancing functions are user defined
- Input may include
  - Up to 10 zonal data files
- Output may include
  - Up to 10 production and attraction files

47

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Generation PHASE=ILOOP

- In this step the stack of calculations are performed on each zone.
- The user usually accessed a Zonal Data File and supplies regression equations.
- Script:
  - P[1]=3.2*ZI.1.HOUSEHOLDS
  - P[2]=2.5*ZI.1.HOUSEHOLDS
  - P[3]=1.2*ZI.1.HOUSEHOLDS
  - A[1]=1.6*ZI.1.TOTAL_JOBS
  - A[2]=34 *ZI.1.TOTAL_JOBS
  - A[3]=19 *ZI.1.TOTAL_JOBS

48

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Generation PHASE=ADJUST

- This phase is used to balance the attraction and production totals.
- The user can use the 'BALANCE' function to set:
  - Production Totals to Attraction Totals (P2A)
  - Attraction Totals to Production Totals (A2P)
  - Attraction Totals to Production Totals then the Number of Productions set to the Number of Attractions (NHB)
- This can be accomplished using 'math' or the 'Balance' function.
- Script:
  - BALANCE A2P=1,3 NHB=2

49

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Generation FILE and PARAMETERS

- The Output data file's structure must be declared.
- The Output data file's format may be declared.
- Script:
  - FORM=6.0, DBF=T, LIST=Z, P[1], P[2], P[3], A[1], A[2], A[3]

- A PARAMETER declaring the number of zones to process must be declared.
- Script:
  - PARAMETERS ZONES=25

50

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Preparing 'Trip Distribution'

- When we begin to look at the files for distribution, we see that the inputs for the matrix and the trip ends are coming from other programs.
- If we link these directly to the files, it will be static and will not change if we rename or change the output file.
- We need to instead link these to the other programs graphically in AM. This provides a 'dynamic' link

51

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Public Files

In order to directly link files from the output side of one program processing step to the input side of another, they must be present on the same level.

For readability, it is best to have all files which are 'external' to the sub-group (overall input and outputs of the group) to be exposed to the parent application.

1. Browse to the Network Processing group
2. Right-click on the input Network File
3. Select 'Make File Public'
4. Repeat for the output 'Initial FF Skims' file
5. Repeat for the primary input and output files in:
   a) Trip Generation
   b) Trip Distribution

52

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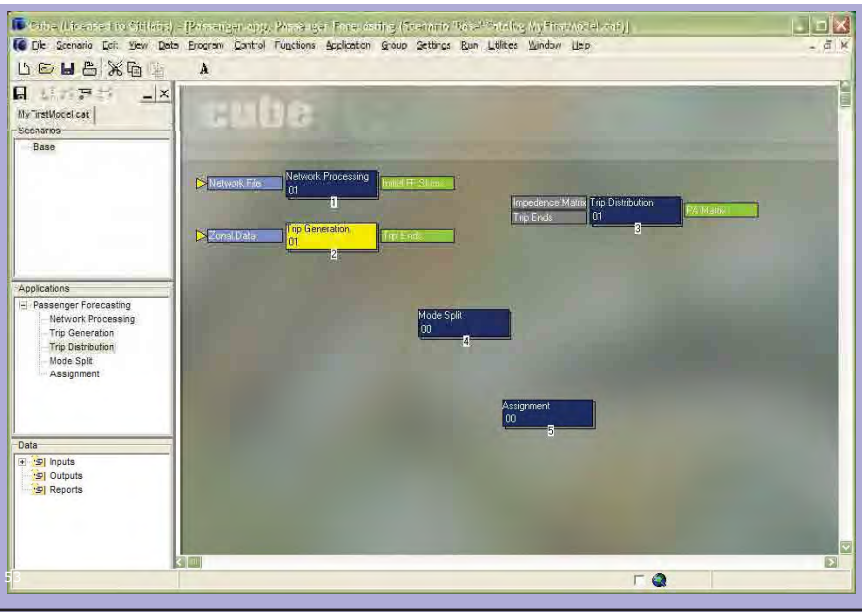
Exposed Files



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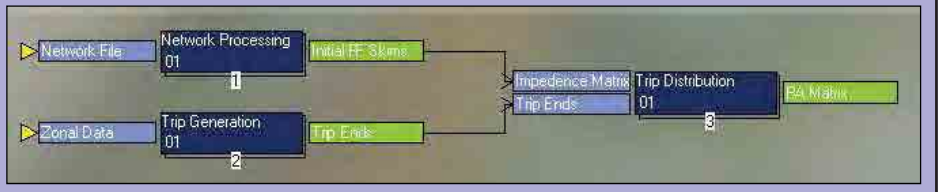
Linking Files

To create a direct (dynamic) link between program files, simply highlight the output file you want to connect 'from' and then click and drag a link to the file you want to connect 'to'

1. Click on the output 'Initial FF Skims' file
2. Click and drag a link onto the input 'Impedance Matrix' file



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Distribution

- Uses the number of trip ends in each zone as the starting point. These 'margin' totals are distributed to the rows and column of a generated matrix.
- The distribution is weighted by the 'Impedance'
- The impedance is calibrated with a Friction Factor Curve.
- Most common process is the "gravity" model, but there is no automatic, or default, trip distribution process.
- Input may include:
  - Up to 20 matrix files
  - 1 text data file of data (friction factors)
  - Up to 10 production and attraction files
- Output may include:
  - Up to 32 trip matrix files

55

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Distribution PARAMETERS

- To control the number of iterations, it is possible to set the convergence thresholds as well as the maximum number of iterations.
- Script:
  PARAMETERS MAXITERS=99,MAXRMSE=5

56

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Distribution SETPA

- The initial values to use for the row and column totals need to be set.
- These will be equal to the number of Productions and Attractions calculated in trip generation.
- Script:

```
SETPA     P[1]=ZI.1.P1,      A[1]=ZI.1.A1,
          P[2]=ZI.1.P2,       A[2]=ZI.1.A2,
          P[3]=ZI.1.P3,       A[3]=ZI.1.A3
```

57

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LOOKUP Functions

Traditionally the Friction Factors are described with a Lookup function.

Script:

```
LOOKUP NAME=FF,                ;Declare a function name
LOOKUP[1]=1, RESULT=2,         ;Curve 1 definition
LOOKUP[2]=1, RESULT=3,         ;Curve 2 definition
LOOKUP[3]=1, RESULT=4,         ;Curve 3 definition
INTERPOLATE=Y,          ;Interpolate to define missing values
R= '0.01   1200   1000   800',
   '1      1000   900    700',
   '5      500    400    300',
   '7      200    150    75',
   '10     100    75     25',
   '25     50     50     10',
   '50     5      5      5'
```

58

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Distribution GRAVITY Function

GRAVITY Function: Performs distribution based on traditional gravity model

- PURPOSE can be applied to different 'purpose' matrices
- LOS defines the cost matrices
- FFACTORS defines the impedance curve
- KFACTORS allows additional weighting

Script:

```
MW[20] = MI.1.COST
GRAVITY PURPOSE=1, LOS=MW[20], FFACTORS=FF
GRAVITY PURPOSE=2, LOS=MW[20], FFACTORS=FF
GRAVITY PURPOSE=3, LOS=MW[20], FFACTORS=FF
```

59

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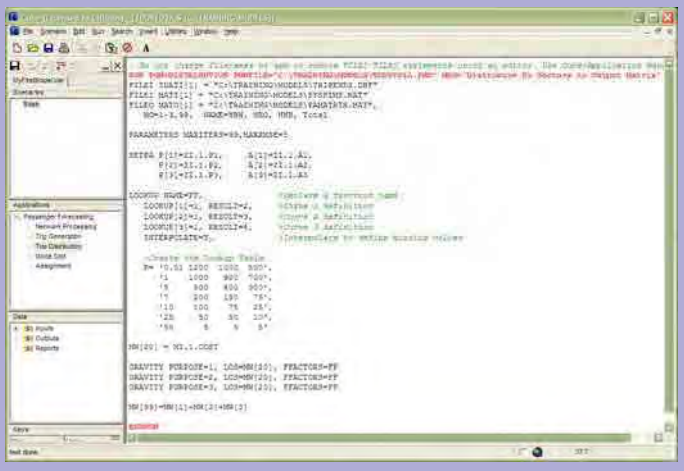
Distribution Additional

- Create a Total Trips matrix
- Name the matrices
  - HBW
  - HBO
  - NHB
  - Total



60

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Matrix

- Matrix is primarily a calculator. It simply processes matrices, zonal data, or text records according to user specified expressions.
- Inputs may include:
  - Matrices
  - Zonal data files
  - Record Data files
- Outputs may include:
  - Matrices
  - Print Data files
  - Record files
- Various file formats for both input and output are supported
- User is responsible for specifying what is to be accomplished

61

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Matrix – Common Uses

Commonly used to:

- Calculate new matrix values
- Convert and merge matrices between various formats
- Report values from matrices and zonal data by:
  - Selected rows
  - Marginal summaries (trip ends, etc.)
  - Frequency distributions
- Transpose matrices
- Generate matrices
- Renumber, aggregate, and disaggregate matrices
- Process Record data

62

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Matrix Implied ILOOP

- Matrix has only one 'PROCESS PHASE' it is a ILOOP and being the only option, is not declared.
- To convert the PA matrices to OD matrices, assume a 50/50 split of travel.
- Script:

```
MW[1]= (MI.1.HBW+MI.1.HBW.T)/2
mw[2]= (MI.1.HBO+MI.1.HBO.T)/2
mw[3]= MI.1.NHB
```

63

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Matrix Additional

- In a new Matrix Step, Factor the Person Trips to Vehicle Trips using a user input Vehicle Occupancy for each trip type.
  - Hint: Create Keys, Link Keys into Equations
- Create a Total Trip Matrix
- Name the Matrices in the output file

```
; Do not change filenames or add or remove FILEI/FILEO statements using an editor. Use Cube/Appli
RUN PGM=MATRIX PRNFILE="C:\TRAINING\MODELS\MSMAT00A.PRN" MSG='Convert PA Matrix to OD Format'
FILEI MATI[1] = "C:\TRAINING\MODELS\PAMATRIX.MAT"
FILEO MATO[1] = "C:\TRAINING\MODELS\ODMATRIX.MAT",
   MO=1-3,99, NAME=HBW, HBO, NHB, TOTAL

MW[1]= (MI.1.HBW+MI.1.HBW.T)/2
MW[2]= (MI.1.HBO+MI.1.HBO.T)/2
MW[3]= MI.1.NHB

MW[1]= MW[1]/{OccHBW}
MW[2]= MW[2]/{OccHBO}
MW[3]= MW[3]/{OccNHB}

MW[99]=MW[1]+MW[2]+MW[3]

ENDRUN
```

64

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Assignment

- Assigning the OD matrix to the network uses an iterative approach in HIGHWAY.
- Process:
  - Paths built from link costs (impedances) and assigns trips to those paths for each origin zone
  - Link costs are then updated based on the link congestion levels
  - Entire path and assignment process is repeated until some criteria for termination is reached
  - Volumes from each iteration are combined to form a weighted assignment

65

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Highway PHASE=LINKREAD

- In addition to setting variable values groups may be setup.
- Script:

```
DISTANCE = (LI.SHAPE_LENG/5280) ;Link Distance in Miles
T0 = (DISTANCE/LI.SPEED)*60 ;Free-Flow Time (Minutes)
IF (LI.FUNC_CLASS=1)                    ;Highways
   C=2200*LI.NUMLANES                   ;Set Capacity
   LINKCLASS=1                          ;Road Class Group
ELSE                                    ;Other Roadways
   C=1100*LI.NUMLANES
   LINKCLASS=2
ENDIF
```

66

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Highway PHASE=LINKREAD

- In addition to setting variable values and groups, functions may also be setup.
- Functions are defined for individual Link Classes (Undefined Classes use Class 1)
- One FUNCTION statement can be used to define a number of functions by grouping them with {…}
- Script:

```
FUNCTION {
   tc[1]=t0*(1.0+0.15*((v/c)^8))
   tc[2]=t0*(1.0+0.15*((v/c)^4))
   cost[1]=TIME*0.2+DISTANCE*0.8
   cost[2]=TIME*0.2+DISTANCE*0.5}
```

67

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Highway PHASE=ILOOP

- Builds paths from each origin zone to every destination
- Keywords Can be added to assign Volume Sets. If present, this will force it into a iterative assignment process.
- Script:

```
PATHLOAD                    ;Defines Process
PATH=TIME,                  ;Defines Impedance Variable
VOL[1]=MI.1.PCTOTAL
```

68

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Add Path File

- Path Files are a complete record…
- Script (within path-load)

```
PATHO=1,                ;Path File Number to save to
NAME='PT Loads',        ;Path set name
ALLJ=T,                 ;save all paths even 0 trip interchanges
INCLUDECOSTS=T          ;save costs as well as paths
```

69

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Live Demonstration

- Viewing Path File Data
- Adding Map Layers
- Drawing Layers
- Add Truck Volumes
- Running the Application
- Appliers Mode
- Creating Scenarios
- Scenario Specific Files

70

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Public Transport (PT)

- Key Features
  - o 'True' Multi-Routing Between Zones
  - o Demand Stratification by User Class
  - o Comprehensive Fares Modeling
- Handles all aspects of assigning trips to a public transport network
  - o Network Building
  - o Route Enumeration
  - o Route Evaluation
  - o Skimming
  - o Loading (Assignment)
  - o Analysis (Reporting)
- The PT Models:
  - o Determine the probability of use for alternative routes
  - o Trips are then loaded on the routes based upon these probabilities

71

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PT Network Development

- A Network, produced by NETWORK, PUBLIC TRANSPORT (PT), or the User containing:
  - o Characteristics of zones
  - o Links and Nodes
  - o Walk and Transit travel times
  - o Distance etc
- System information
  - o used to describe the characteristics such as modes, operators and waiting curves
- Service or Line data
  - o Describes the Routes and Stops
- Non-Transit Legs - Records possible ways to:
  - o Access the Public Transport System
  - o Egress from the Public Transport System
  - o Transfer between services during the course of a journey.

(Non-transit legs may be determined externally and/or generated by Public Transport under user control.)

72

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PT Route Enumeration & Evaluation

- Determines 'reasonable' or 'attractive' multiple discrete routes between zones.
- May take into account (by user class):
  - Number of transfers
  - Spread
  - The margin of cost over the minimum cost route;
  - Non-transit and In-Vehicle Costs
  - Boarding and Transfer Penalties by mode;
  - Waiting Time
  - Derived from the combined frequency of services between stop nodes
  - Fares (considered only for Evaluation)

73

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PT Skimming

- Skimming extracts:
  - Composite costs
  - Value of Choice
  - Perceived and Actual journey costs
    - Non-Transit Costs
    - In-vehicle and Wait times
    - Boarding and transfer penalties (Fares)
  - Best journey cost
- Journey costs may be extracted Network Wide or Stratified by Mod
- Used for:
  - Model validation
  - Demand modeling
  - Scheme evaluation
  - Loading demand on the networks
  - Producing operational statistics (passenger miles, hours, and revenue)

74

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PT Assignment (Loading)

- Loads demand, in the form of trips between zone pairs
- Uses a series of models during a journey:
  - The Walk Choice Model
    - Allocates trips between attractive choices at access, egress and transfer points.
  - The Service Frequency & Cost Model
    - Allocates the transit share at a stop between the attractive services available at that stop
  - The Alternative Alighting Model
    - Apportions the share of a service to the attractive alternative alighting points of that service

75

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Creating a PT Network

1. Click on the Layer control icon .
2. Check on the Transit Layer
3. The Open TRNLAYER Layer Parameters dialog opens
4. Click Browse
5. Save C:\Training\example.lin
6. Click 'Open'
7. Click 'Yes' to create this new file.
8. Select 'Voyager PT Line Format'
9. Select 'Voyager PT Line Format'
10. Click 'All Done'

76

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PT Line Manager

The public transit line manager shows the transit files that are available for editing as well as the transit lines that are currently in the file.

1. Set the TRN Layer to the 'Active' or top most layer 
2. Click Line Manager.
3. Click New in Line Options.
4. Type in the Name (Red Flash)
5. Click OK.
   - The dialog box closes and we now have created a transit line.

77

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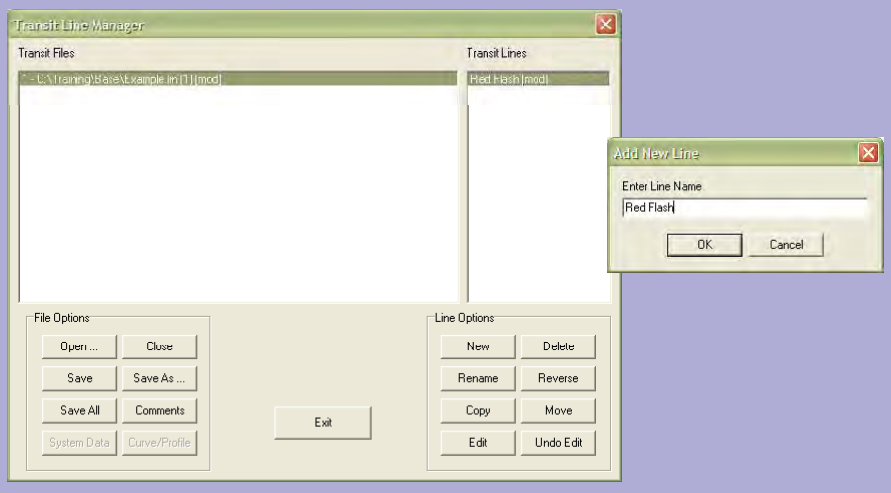
PT Line Manager Dialog



78

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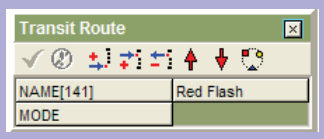
Preparing to Edit the PT Line

1. With Red Flash highlighted, click on Edit. 
   - The transit line coding dialog opens.
2. Click on the 'zoom to node' icon
3. Enter node 791.
4. Set Window Width to 25000
5. Click OK.
6. Select 'Post > One-Way Arrow'
7. Post all node numbers



79

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Editing a PT Line

1. Click on the Route Edit button on the dialog
   - If you move the cursor over the map, you should now have a cross-hair.
2. Click on Node 797
3. Click on Node 791 to create the next Transit Stop. The Route is extended the route to that node.
4. Alt+Click on Node 784 to simply extend the route to this node. No Transit Stop is created.
5. Continue the Route into Downtown
6. Press ESC to exit Route Creation Mode
7. Click the 'Green Check-Mark' to save the updates

80

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Editing PT Line Parameters

1. Fully enlarge the PT Rote Edit Dialog Window
   - Each Node in the Route is present
   - Non-Stop Nodes are designated by a '-' sign. No boarding or alighting will be allowed.
2. In the 'Mode' variable, enter mode number (1)
3. Click on the 'Insert Row' Button
   - The dialog lists all possible line parameters that may be used
4. Double-Click 'Headway[1]'
5. Double-Click 'Color'
6. Click 'Cancel'
7. Enter a Color Code (3)
8. Enter a Headway Time (10)
9. Save the Changes

81

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Viewing PT Lines

1. Click the Transit Line Manager Button
2. Click 'Save All' to save edits.
3. Click 'Exit'
4. Select 'Transit > Show Stop/Non-Stop Nodes'
5. Check the two check boxes and accept the default colors and sizes. Click OK.
6. The transit line now shows where it runs, where it stops and where it does not stop.

82

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More PT Line Editing

- Code another bus line named 'Blue Dragon'
  - mode=1, headway[1]=15, color=1
- Modify an existing transit line.

83

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Coding PT Mode Data

1. In Transit Line Manager, Click Open
2. Create a new transit file (TransitSystemData.pts)
3. Click on 'System Data'
4. Set access mode definitions:
   - Mode=1, Name="NatRail", Longname="NationalRailways"
   - Mode=2, Name="RegRail", Longname="RegionalRailways"
   - Mode=3, Name="ExpBus", Longname="ExpressBuses"
   - Mode=4, Name="LocBus", Longname="LocalBuses"
   - Mode=33, Name="Walk", Longname="walk access connectors"
   - Mode=34, Name="Xwlk", Longname="walk transfer connectors"

84

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Code PT Waiting Data

1. In the Transit Line Manager, Click 'Curve/Profile'
2. Click 'Add Curve'
3. Enter the Name (Short, Short Wait)
4. Enter the Curve Definition (1-0.5,15-5.0,100-10.0)
5. Click the Green Check to Save
6. Add a second Curve
   - WAITCRVDEF=2, Name="Long-wait", Curve=1-0.5,15-7.5,100-20.0
7. Close the Curve Definition Window
8. Click 'Save All'
9. Click 'Exit'

85

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Viewing PT Coding in Cube Town

1. Network Building
2. Skimming
3. Mode Split
4. Assignment

86