ECIA

A Regional Response to Local needs

Travel Demand Forecasting Model for DMATS Area

Chandra Ravada

Topics

- **Modeling Process**

- **Data and Inputs**

- **Trip Generation**

- **Trip Distribution**

- **Traffic Assignment**

- **Calibration & Validation Process**
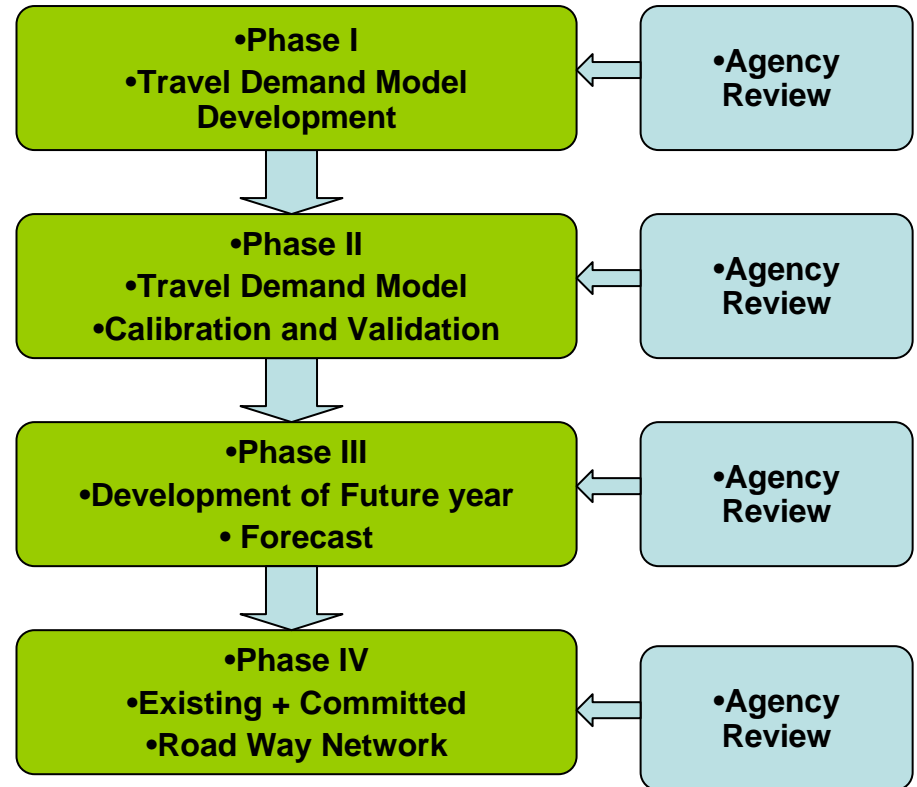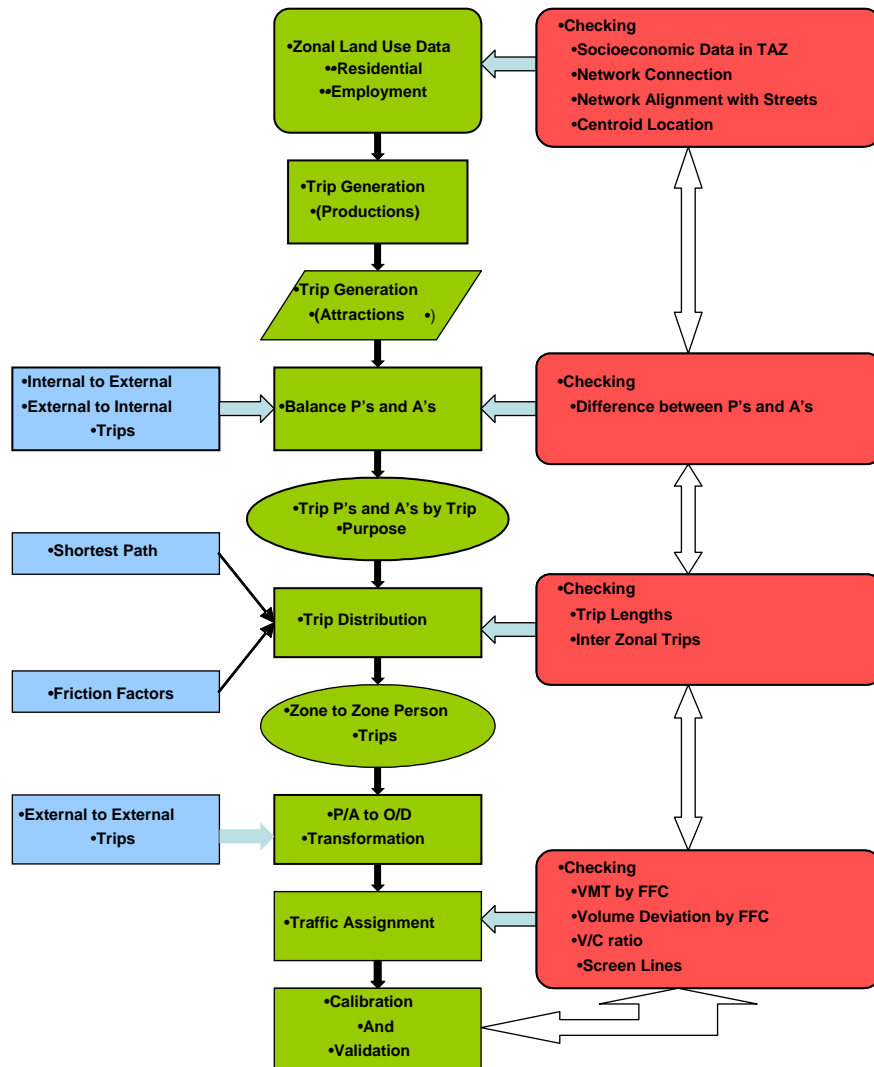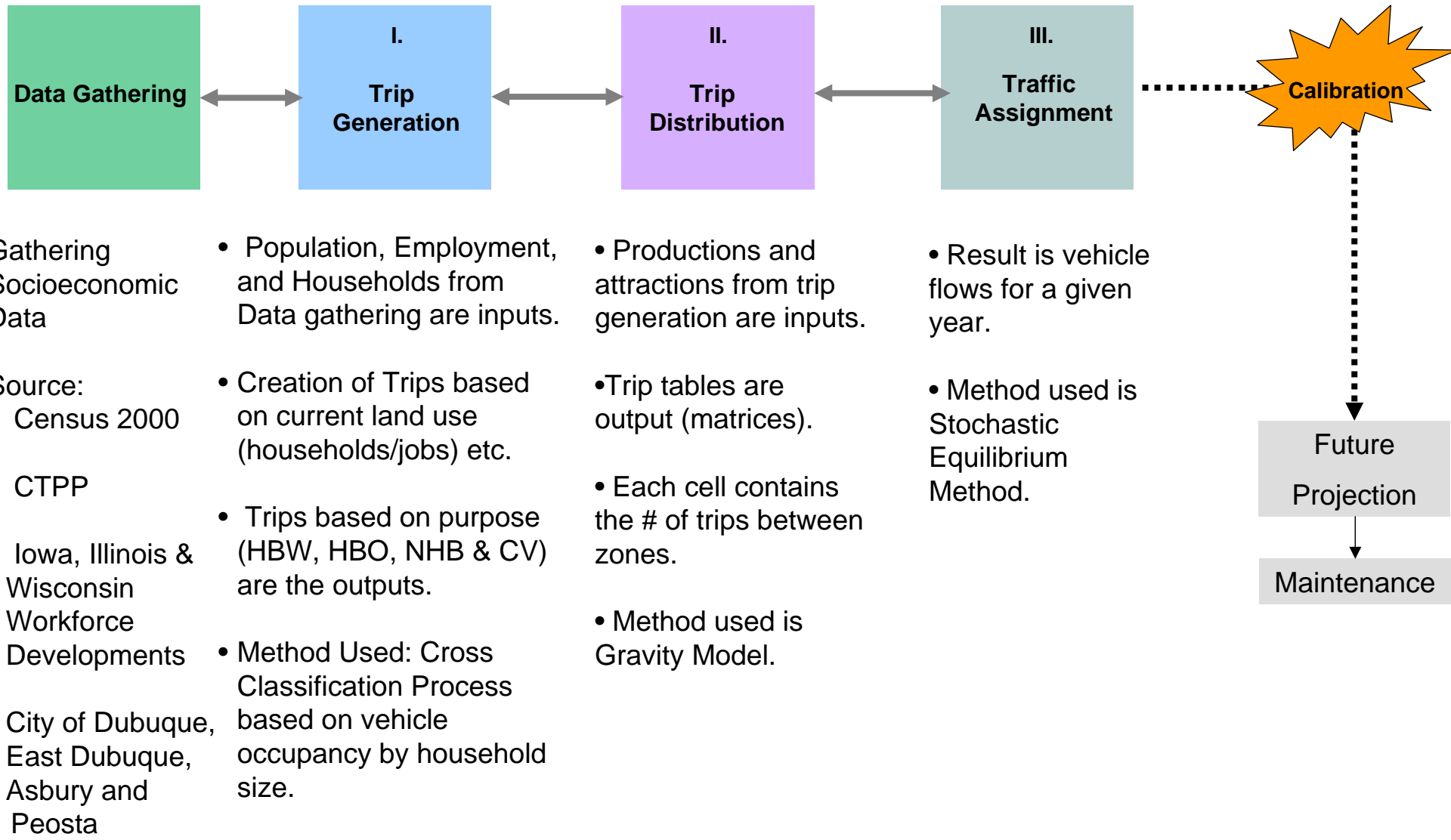
- **Post Process**

Topics

- **Modeling Process**

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- Trip Distribution

- Traffic Assignment

- Calibration & Validation Process

- Post Process

Modeling Process

Three Step Process

| Data Gathering | I. Trip Generation | II. Trip Distribution | III. Traffic Assignment | Calibration |

Gathering Socioeconomic Data

Source:
- Census 2000
- CTPP
- Iowa, Illinois & Wisconsin Workforce Developments
- City of Dubuque, East Dubuque, Asbury and Peosta

I. Trip Generation
- Population, Employment, and Households from Data gathering are inputs.
- Creation of Trips based on current land use (households/jobs) etc.
- Trips based on purpose (HBW, HBO, NHB & CV) are the outputs.
- Method Used: Cross Classification Process based on vehicle occupancy by household size.

II. Trip Distribution
- Productions and attractions from trip generation are inputs.
- Trip tables are output (matrices).
- Each cell contains the # of trips between zones.
- Method used is Gravity Model.

III. Traffic Assignment
- Result is vehicle flows for a given year.
- Method used is Stochastic Equilibrium Method.

Future Projection
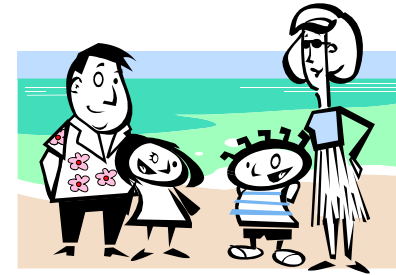
Maintenance

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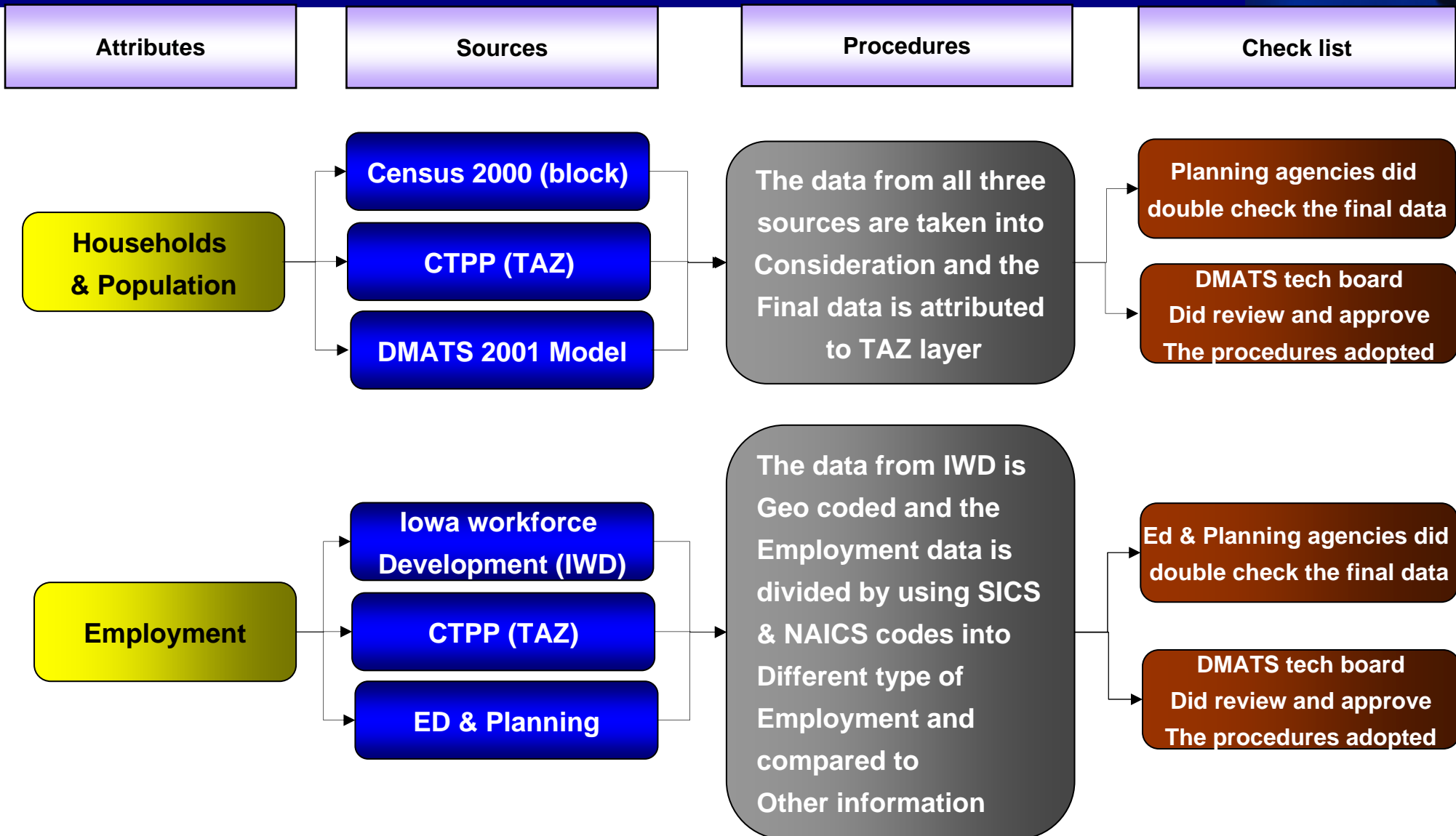- **Calibration & Validation Process**

- **Post Process**
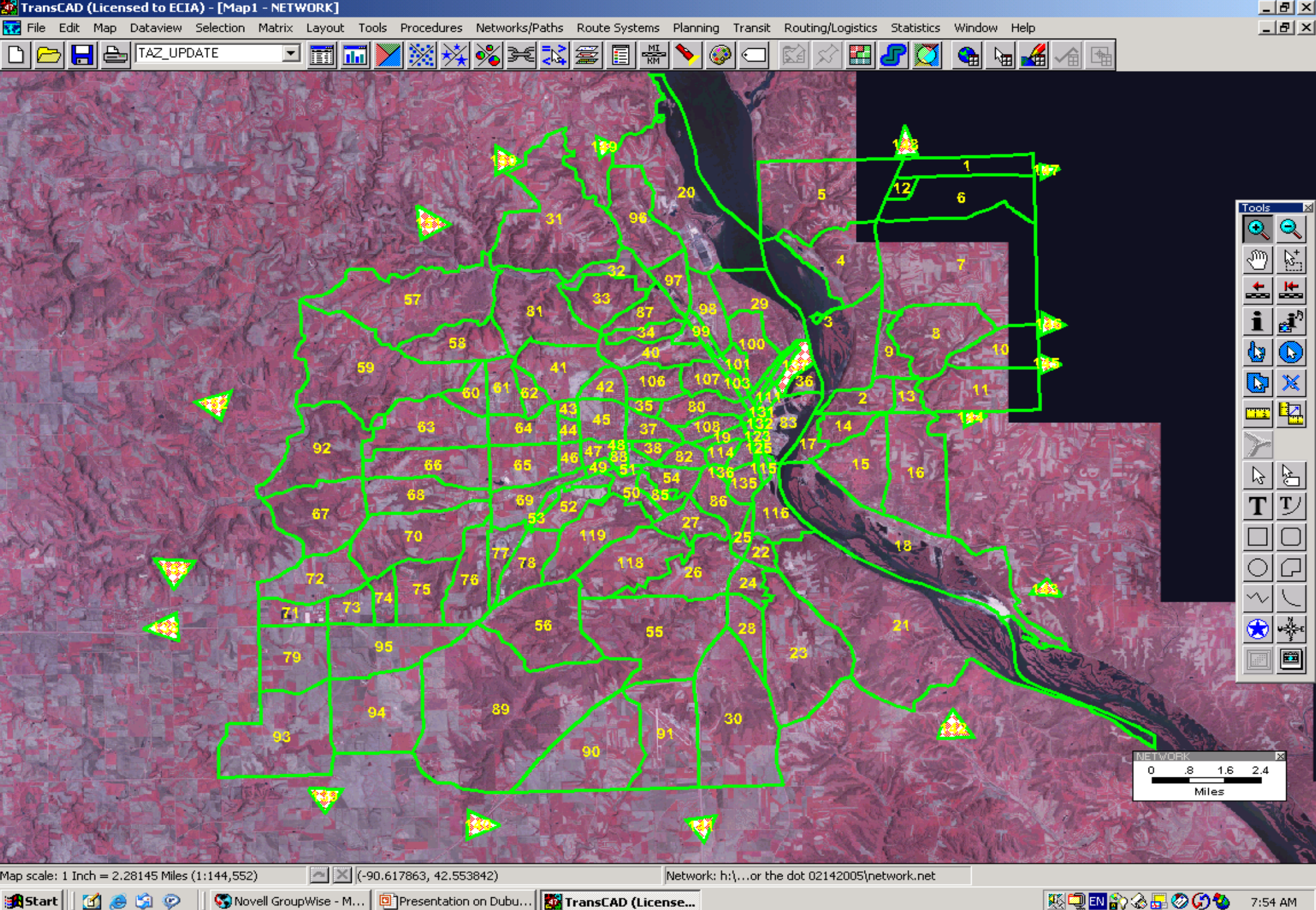
Attributes to TAZ Layer

- **Number of Households**

- **Non-retail Employment**

- **Retail Employment**

- **Service Employment**

- **Total Population**

Procedure for TAZ layer

Attributes	Sources	Procedures	Check list

Households & Population
- Census 2000 (block)
- CTPP (TAZ)
- DMATS 2001 Model

The data from all three sources are taken into Consideration and the Final data is attributed to TAZ layer

- Planning agencies did double check the final data
- DMATS tech board Did review and approve The procedures adopted

Employment
- Iowa workforce Development (IWD)
- CTPP (TAZ)
- ED & Planning

The data from IWD is Geo coded and the Employment data is divided by using SICS & NAICS codes into Different type of Employment and compared to Other information

- Ed & Planning agencies did double check the final data
- DMATS tech board Did review and approve The procedures adopted
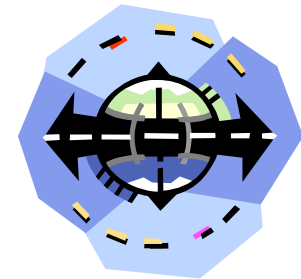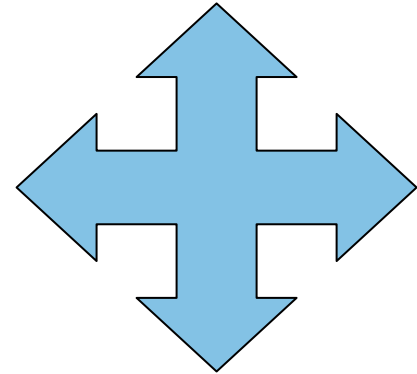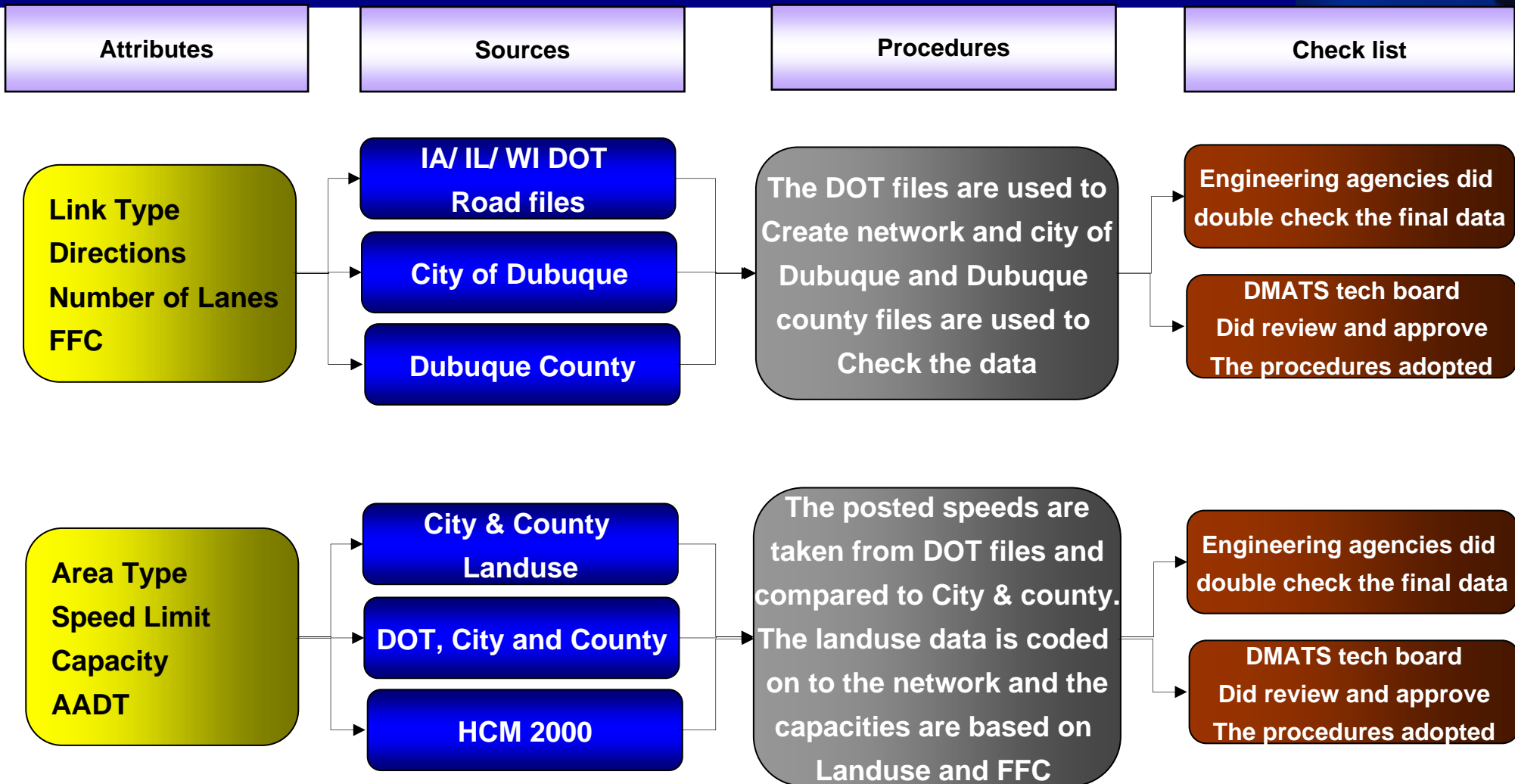
Attributes to Network Layer

- **Link Type**

- **Direction**

- **Number of Lanes**

- **Capacity**

- **FFC of the Roadway**

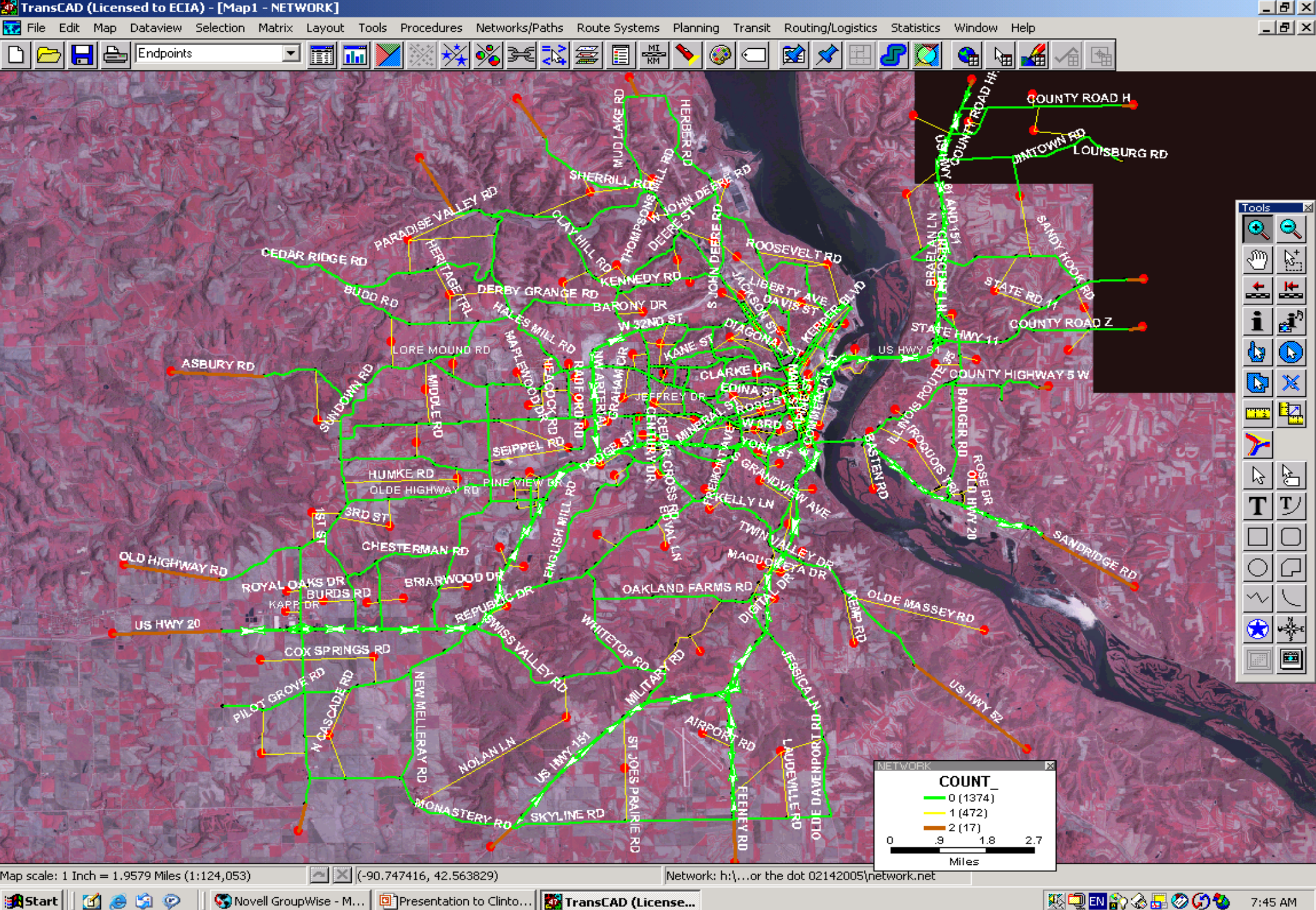- **Average Annual Daily Traffic**

- **Speed Limit**
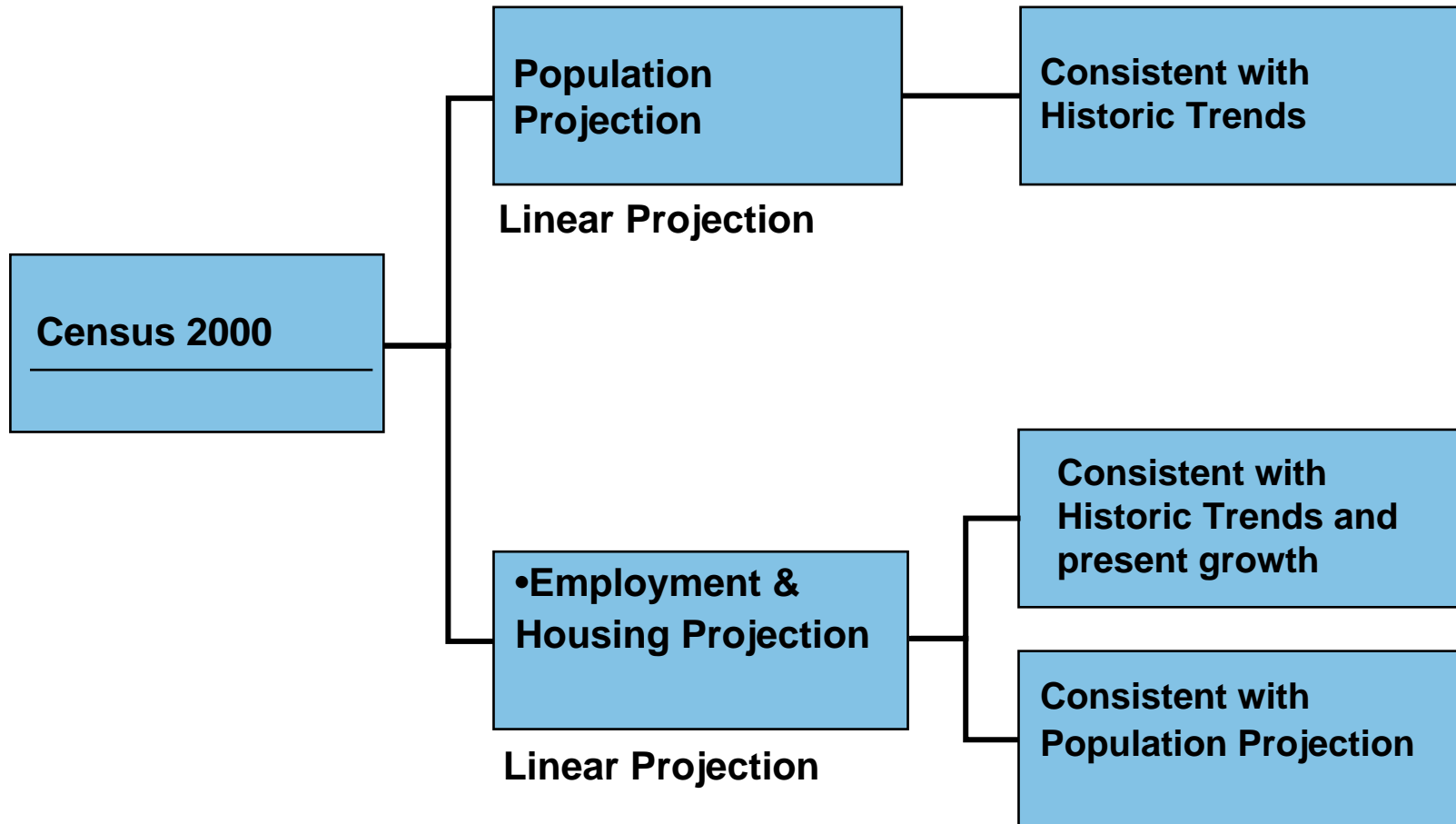
Procedure for Network layer

Attributes	Sources	Procedures	Check list

Link Type
Directions
Number of Lanes
FFC

- IA/ IL/ WI DOT Road files
- City of Dubuque
- Dubuque County

The DOT files are used to Create network and city of Dubuque and Dubuque county files are used to Check the data

- Engineering agencies did double check the final data
- DMATS tech board Did review and approve The procedures adopted

Area Type
Speed Limit
Capacity
AADT

- City & County Landuse
- DOT, City and County
- HCM 2000

The posted speeds are taken from DOT files and compared to City & county. The landuse data is coded on to the network and the capacities are based on Landuse and FFC

- Engineering agencies did double check the final data
- DMATS tech board Did review and approve The procedures adopted

The Network links and centroid connector locations are adjusted based on aerial photography.

2030 Socioeconomic data projections

Census 2000

Population Projection

Linear Projection

Consistent with Historic Trends

•Employment & Housing Projection

Linear Projection

Consistent with Historic Trends and present growth

Consistent with Population Projection

2030 Socioeconomic data projections

City of Dubuque

City of East Dubuque

City of Asbury

City of Peosta

Dubuque County

Jo Daviess County

Grant County

→ Census 2000

Based on Existing Land Use Plan

Based on Existing Annexation Plan

Based on Historical Trends and Existing Growth

Checking with ECIA projections

2030 Socioeconomic data projections

DMATS area Model

Percentage Change in Socioeconomic Data from 2000 to 2031

	Year		
	2000	**2030**	**% Change**
Population	77,018	105,564	37.06%
Households	29,910	42,927	43.52%
Employment	46,745	62,191	33.04%

Source: ECIA

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- **Traffic Assignment**

- **Calibration & Validation Process**

- **Post Process**

Trip Generation

Cross-Classification Rates for Productions

Purpose	Household Size	Autos Owned		
		1	2	3+
Home Based Work	1	0.64	0.78	0.46
Home Based Work	2	0.74	1.53	1.9
Home Based Work	3+	1.1	1.93	2.29
Home Based Other	1	1.97	2.49	1.84
Home Based Other	2	2.85	3.07	3.12
Home Based Other	3+	4.51	4.4	5.54

Trip Generation

Cross-Classification Rates for Attractions

Purpose	Variable	Rate
Home-Based Work	Total Employment	0.83
Home-Based Other	Dwelling Units	0
	Retail Employment	2.33
	Other Employment	1.63
	School Enrollment	0.8
	Population	0
Commercial Vehicles	Dwelling Units	0.357
	Retail Employment	0.263
	Other Employment	0.034
Internal-External	Dwelling Units	0.06
	Total Employment	0.259
	I-E Sum	1912

Source: ECIA, 2001 NHTS, Des Monies MPO Add on Survey

Trip Generation

Cross-Classification Rates for Non-Home Based Work (NHB)

Cross Classification Rates				
	Autos Owned			
Household Size	1	2	3+	
1	1.57	1.81	0.54	
2	1.83	2.14	1.83	
3+	5.96	2.47	3.01	
Linear Regression				
			Data	
		Rate	Column	
Population		0.322		
Total Employment		0.71		
Non-Home based	1	2.52	2.65	1.88
Non-Home based	2	3.1	3.07	2.78
Non-Home based	3+	4.97	3.24	3.97

Trip Generations (External Stations)

The *NCHRP Report No. 365* procedures were formatted to an Excel spreadsheet to calculate the percentage of through trips for the Dubuque Metropolitan Area TransCAD model.

Percentage of External - Internal & Internal - External Trips Formula

Attractions		Productions	
HBW	15%	HBW	1%
HBO	27%	HBO	23%
NHB	8%	NHB	17%

Source: NCHRP 365

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Trip Distribution

The gravity model for trip distribution is defined as follows:

where:

T$_{ij}$ is the number of trips from zone i to zone j

P$_i$ is the number of trip productions in zone i

A$_i$ is the number of trip attractions in zone j

F$_{ij}$ is the "friction factor" relating the spatial separation between zone i and zone j

K$_{ij}$ is an optional trip distribution adjustment factor for interchanges between zone i and zone j

Standard Gamma function with friction factors a = 1, b= 0.3 & c=0.01.

Traffic Assignment

Stochastic User Equilibrium (SUE) has been used to assign traffic.

SUE is a generalized form of User Equilibrium (UE) that assumes travelers do not have perfect information concerning network attributes and/or they perceive costs in different ways.

SUE permits use of less attractive as well as the most attractive routes. Less attractive routes will have lower utilization, but will not have zero flow as they do in UE.

Dubuque being a difficult terrain to travel do have some routes that are not attractive to travel but do have traffic on them. Staff felt comfortable in using SUE when compared to UE, All or nothing and STOCH methods to portrait travel patterns within the MPO area.

Iterations: 20, Alpha: 0.15 & Beta : 4.00

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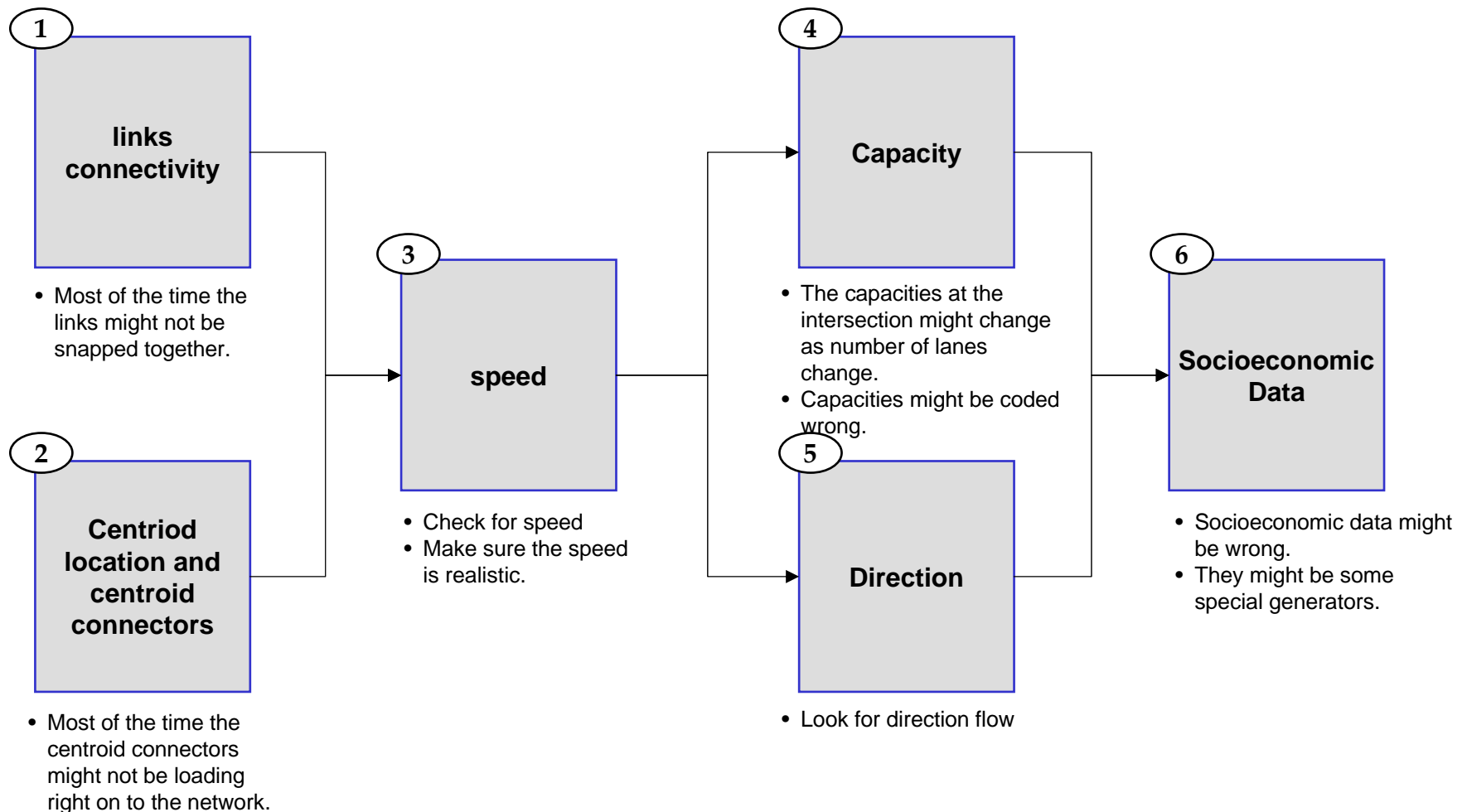
- **Post Process**

Calibration & Validation

Calibration: Calibration in the traditional four-step modeling process was accomplished by modifying model parameters until the models replicated the travel patterns exhibited by the O-D Survey.

Validation: Validation consisted of running the calibrated models with current socioeconomic data and comparing the simulated link volumes with ground counts.

Calibration & Validation Process

Summary of Calibration approach

1 links connectivity

- Most of the time the links might not be snapped together.

2 Centriod location and centroid connectors

- Most of the time the centroid connectors might not be loading right on to the network.

3 speed

- Check for speed
- Make sure the speed is realistic.

4 Capacity

- The capacities at the intersection might change as number of lanes change.
- Capacities might be coded wrong.

5 Direction

- Look for direction flow

6 Socioeconomic Data

- Socioeconomic data might be wrong.
- They might be some special generators.

Calibration & Validation Process

Calibration & Validation

Trip Generation

Trips per household by Region

Trips per Household by Purpose

Comparison of Production & Attraction

Calibration & Validation (Trip Generation)

Average Motorized Person Trips per Household by Region

Region	Survey Year	Population	Vehicle Trips/HH
Dubuque	2005 Model	77,018	*8.08*
HBW	2005 Model	77018	1.50
HBO	2005 Model	77,018	4.00
Reno, NV	1987	254,000	8.58
Vancouver, WA	1985	259,000	5.83
Charlotte, NC	1985	511,433	9.29

Average Motorized Person Trips per Household by Purpose

Purpose	Dubuque 2000 Model	Houston 1985 Models	Dallas/Ft. Worth 1984 Trvl Sur	Denver 1985 Trvl Sur	San Francisco 1985 Trvl Sur	Atlanta 1980 Trvl Sur	Delaware Valley 1986 Trvl Sur
HBW	1.50	1.71	2.29	1.96	1.89	1.95	2.27
HBO	4.00	4.80	4.32	3.40	4.49	4.45	4.19
NHB	2.58	2.96	2.07	1.97	2.35	1.87	1.64
Total	8.08	9.47	8.68	7.33	8.73	8.27	8.10

Comparison of Production and Attractions Before Balancing

Purpose	Productions	Attractions	Ratio	FHWA
HBW	42,117	40,668	3.44%	+/- 10%
HBO	102,893	101,892	0.97%	+/- 10%
NHB	69,134	69,134	0.00%	+/- 10%
CV	13,220	13,220	0.00%	+/- 10%
Total	227,364	224,914	1.08%	+/- 10%

• **The Average person trips per Household for DMATS area are 8.08 trips/HH.**

• **The recommended range for ratio between Productions and Attractions before balancing is +/- 10%.**

Calibration & Validation Process

Calibration & Validation

Trip Generation

- Trips per household by Region
- Trips per Household by Purpose
- Comparison of Production & Attraction
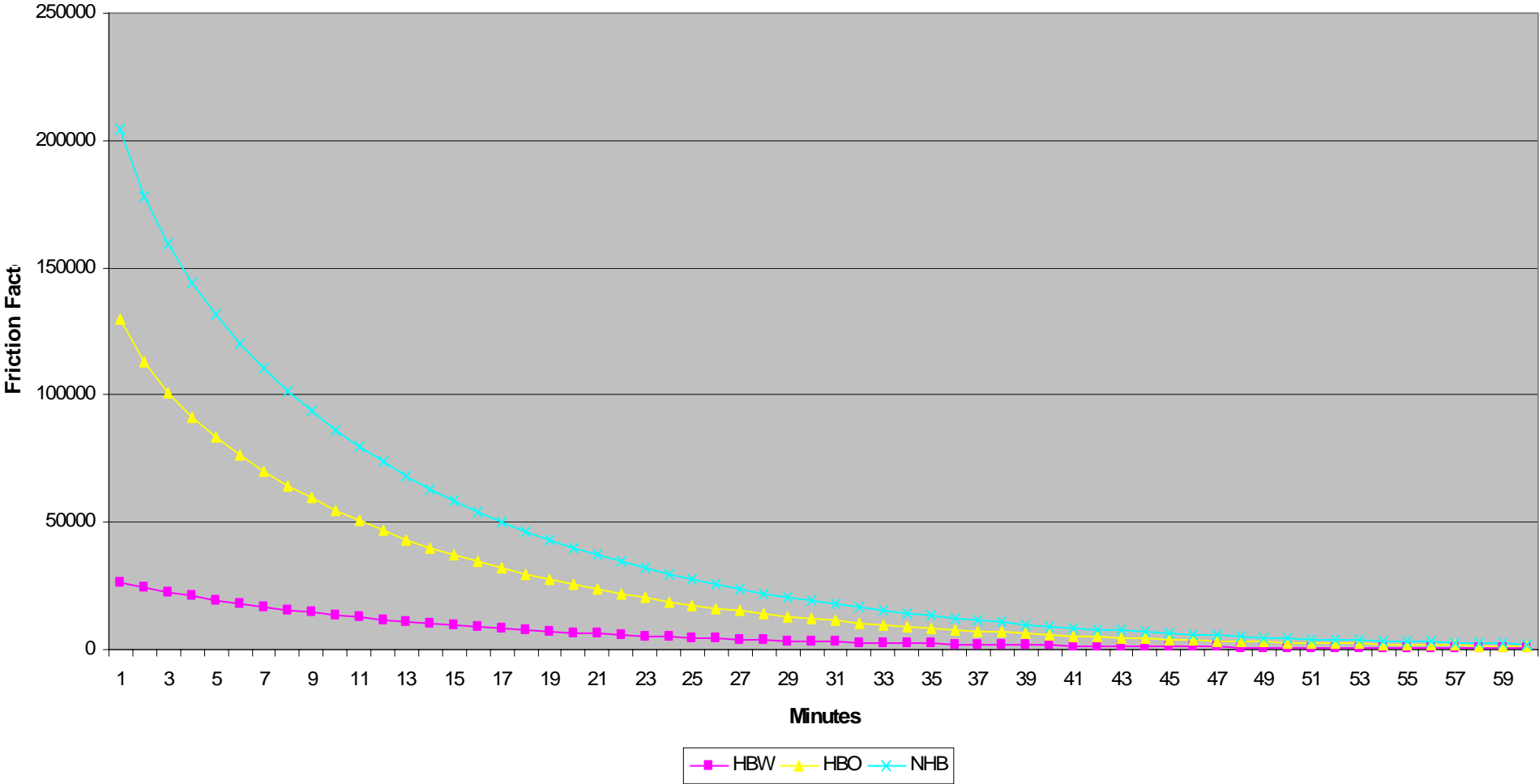
Trip Distribution

- Friction Factors
- K Factors
- Trip Length & Intrazonal Trips

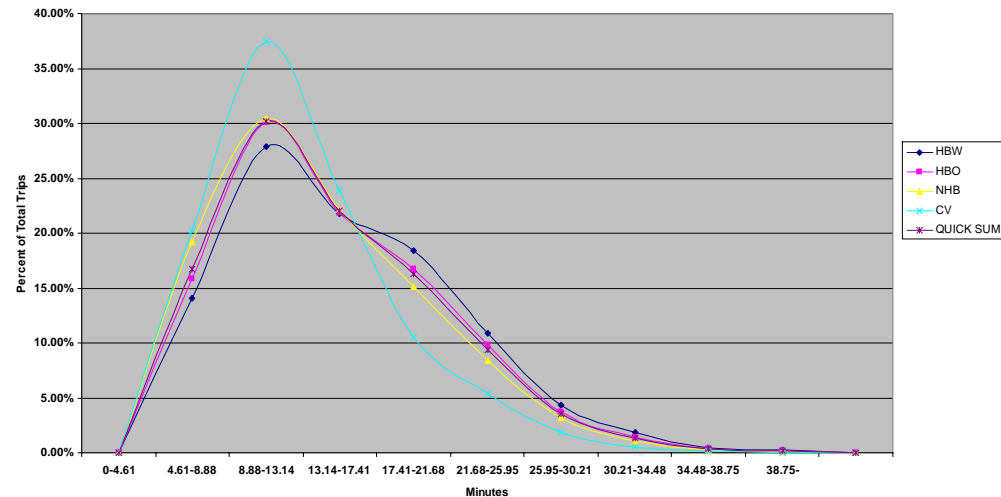# Calibration & Validation (Trip Distribution)

Friction Factors by Purpose

Calibration & Validation (Trip Productions)

Average Trip Length

Purpose	Time (Minutes)	Standards FHWA
HBW	11.71	11 - 15
HBO	11.14	9.5 - 13
NHB	10.48	9.5 – 12.5
CV	9.37	N/A
Quick Sum	10.87	N/A

Trip Length Distribution

Intrazonal Trip Percentages by Purpose

• The recommended range for Average trip length for small urban areas is 10 – 15 Minutes.

•The recommended range for % of internal trips is 0 - 5%.

Purpose	% of Internal Trips	Standards FHWA
HBW	1.53%	5.00%
HBO	1.64%	5.00%
NHB	2.50%	5.00%
CV	2.63%	5.00%
Total	1.93%	5.00%

Calibration & Validation Process

Calibration & Validation

Trip Generation	Trip Distribution	Traffic Assignment
Trips per household by Region	**Friction Factors**	**Federal Function Class (FFC)** • Volume Deviation by FFC • Vehicle Miles Traveled by FFC
Trips per Household by Purpose	**K Factors**	**Average Annual Daily Traffic (AADT)** •Volume Deviation by AADT • Vehicle Miles Travel by AADT
Comparison of Production & Attraction	**Trip Length & Intrazonal Trips**	**Volume Capacity Curve**
		Root Mean Square Error (RMSE)

Calibration & Validation (Trip Assignment)

Volume Deviation by Function Classification

Function Class	No of Counts	Count	Loaded	% Differnce	FHWA
		2005			
Principal Arterial	98	1,047,048	1,098,319	4.89%	<7%
Major Arterial	114	916,160	919,981	-0.42%	<10%
Minor Arterial	55	248,730	279,871	-12.52%	<15%
Collector & Local	17	54,710	46,614	14.80%	<25%
Total	284	2,273,884	2,344,785	-3.12%	N/A

Vehicle Miles Traveled (VMT) Deviation by Function Class

Function Class	No of Counts	VMT Count	VMT Loaded	% Difference
		2005		
Principal Arterial	98	272,642	284,262	4.26%
Major Arterial	112	124,372	126,650	-1.83%
Minor Arterial	55	59,397	61,118	-2.90%
Collector & Local	17	10,047	8,748	12.93%
Total	285	465,222	479,056	-2.97%

Calibration & Validation (Trip Assignment)

Volume Deviation by Average Annual Daily Traffic (AADT)

2000					
Link AADT	No of Counts	Count	Loaded	% Difference	FHWA
7000+	135	1,273,500	1,279,610	0.48%	+/- 10%
5000-7000	48	287,834	312,627	-8.61%	+/- 15%
3000-5000	44	171,830	189,098	-10.05%	+/- 25%
1000-3000	37	81,240	89,590	-10.28%	+/- 50%
Total	285	2,273,884	2,344,785	-3.12%	

Vehicle Miles Traveled (VMT) Deviation by AADT

2000 VMT				
Link AADT	No of Counts	Count	Loaded	% Difference
7000+	135	260,480	263,508	1.16%
5000-7000	48	52,679	58,936	-11.88%
3000-5000	44	47,967	49,242	-2.66%
1000-3000	37	21,763	22,734	-4.46%
Total	285	465,222	479,056	-2.97%

Calibration & Validation (Trip Assignment)
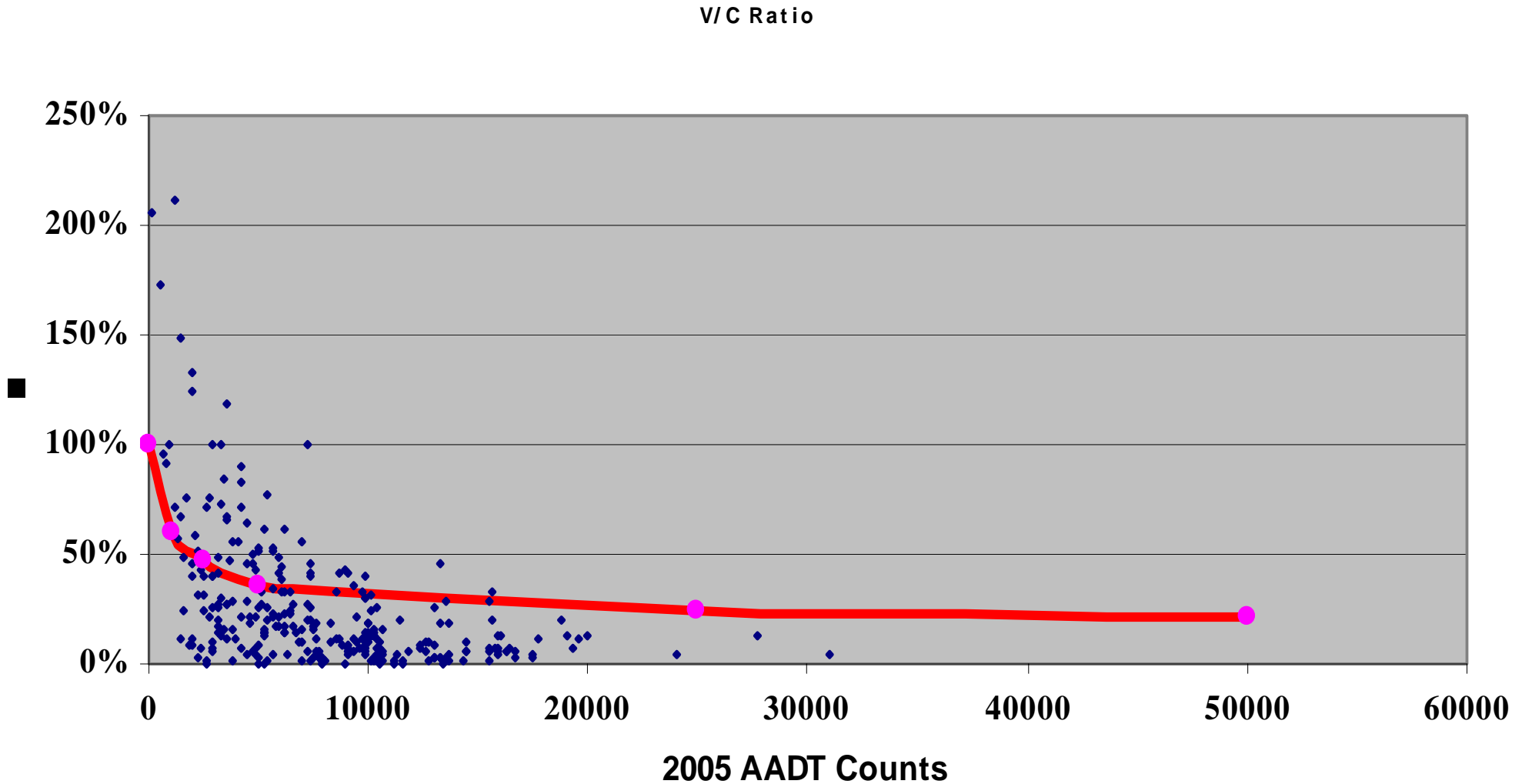
Calibration & Validation (Trip Assignment)

Root Mean Square Error(RMSE) by Function Class

Function Class	# of Counts	RMSE%	FHWA
Principal Arterial	98	15.09%	0-30%
Major Arterial	114	22.22%	0-30%
Minor Arterial	55	39.67%	0-30%
Collector & Local	17	42.47%	0-30%
Total	284	21.28%	0-30%

Root Mean Square Error(RMSE) by AADT

Function Class	# of Counts	RMSE%	FHWA
7000+	148	15.13%	0-30%
5000-7000	50	30.86%	0-30%
3000-5000	44	47.20%	0-30%
1000-3000	37	57.33%	0-30%
Total	284	21.28%	0-30%

Calibration & Validation Process

Calibration & Validation

Trip Generation	Trip Distribution	Traffic Assignment	Screenline Process
Trips per household by Region	**Friction Factors**	**Federal Function Class (FFC)** • Volume Deviation by FFC • Vehicle Miles Traveled by FFC	**Percentage of Volume Deviation**
Trips per Household by Purpose	**K Factors**	**Average Annual Daily Traffic (AADT)** • Volume Deviation by AADT • Vehicle Miles Travel by AADT	
Comparison of Production & Attraction	**Trip Length & Intrazonal Trips**	**Volume Capacity Curve**	
		Root Mean Square Error (RMSE)	

Calibration & Validation (Screen lines)

Deviation of Screenline Volume

Screenline	Base Year Volume	Assigned Volume	Percent Deviation (Deviation/Count)	Model/ Count
1	45,400	45,656	1.60%	0.98
2	28,510	29,990	5.19%	1.05
3	55,400	48,304	12.81%	0.87
4	100,300	100,918	0.62%	1.01
5	43,950	42,190	4.00%	0.96
6	44,500	44,312	0.42%	1.00
7	68,900	63,011	8.55%	0.91
8	54,100	61,143	13.02%	1.13

Deviation of Screenline Volumes

Screenline Vehicle Miles Traveled

Screenline	Base Year VMT	Assigned VMT	VMT Model/ Count
1	22220	21473	0.97
2	10542	11207	1.06
3	18036	17484	0.97
4	18354	16245	0.89
5	33687	34589	1.03
6	19219	18808	0.98
7	16329	14110	0.86
8	19836.7	22811	1.15

•**All Screen lines are within the percentage curve.**

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- **Post Process**

Post Process

| Model Updates	Process	Check
Traffic Studies	• Staff will be requested by Planning & engineering agencies to check Traffic Studies submitted by consultants by using the model	• **Data validity** • **Methodology for future projections** • **Update model with approved traffic study**
New Developments	• The local planning agencies and ED groups do provide staff with future developments that are happening in the area	• **Staff calculates trips using standards for the new developments and update model with new developments.**
Traffic Counts	• Staff do traffic counts on regular bases within the MPO area • Staff conducts special traffic counts for corridor studies	• **Staff make sure the raw traffic counts are converted into AADT by IADOT staff.** • **Staff will recalibrate the model basing on the new information.**
Landuse Maps	• Staff will be provided with new landuse maps by planning agencies in the MPO area.	• **Staff develops trips basing on the landuse and update the model**
Improvements	• Staff are updated by engineering staff with new road improvements (extra Lane/ traffic Signal coordination etc) in the area.	• **Staff will make the necessary capacity changes and adjust travel time basing on the improvements made.**

Corridor Studies

- Request do come from consultancy firms for traffic projections for the corridor
- Staff work with engineering, planning & Ed agencies in the area and make sure all development is taking into considerations and will calibrate the model based on the most recent AADT data.
- Staff release the data to the consultant and work with consultant upon request to look at the corridor and make sure both parties are on same page..

IA 32 NW Arterial
IA 32 SW Arterial
US 20 corridor
East West corridor

Consultancy Firms

Higher Usage

Model
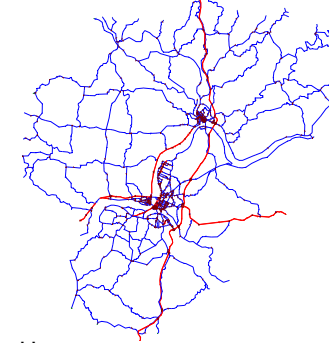
Medium Usage

Medium Usage

City & county

ED Groups

Traffic Studies

- Staff works with city and County staff to double check the traffic study data and future projections.

Sams Club
Hill street Condominiums

Future Projections

- Staff work with ED groups to check future developments and their impact.
- Staff do provide future projections in socioeconomic data for specific zones.

•Questions ?