Post-Construction Evaluation of Forecast Accuracy

December 8, 2008

Pavithra Parthasarathi
David Levinson
University of Minnesota

Presentation Outline

Research objectives

Data collection

Analysis of forecast data

Identifying reasons for forecast inaccuracy

Conclusions

Questions?

Research Objectives

- Evaluate the accuracies of MnDOT demand forecasts

  Identify and estimate the inaccuracies in roadway traffic forecasts

- Identify reasons for presence of inaccuracies
- Provide recommendations

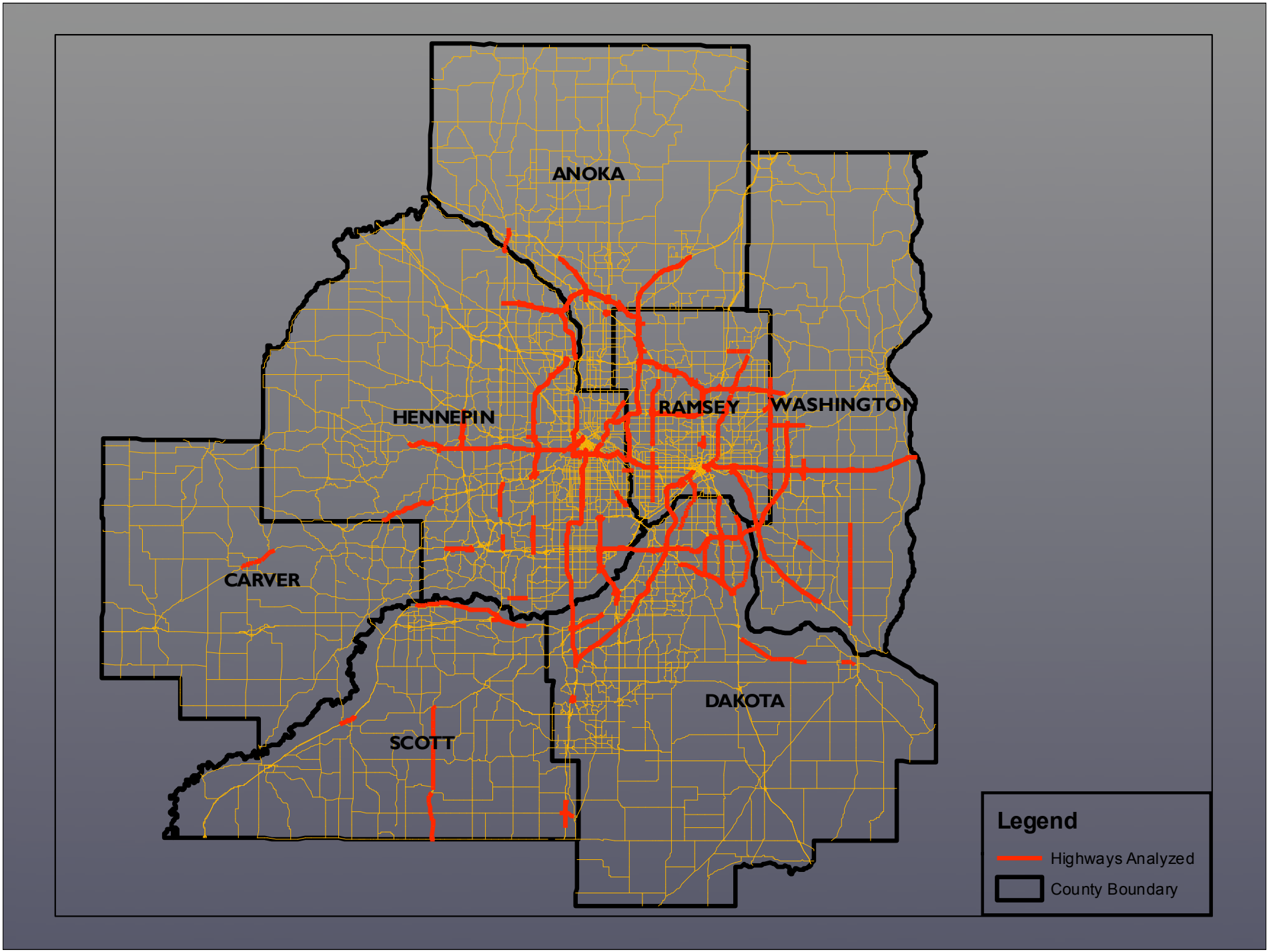
Data Collection

- 9 months of project time
- 211 project reports scanned
- 108 reports used in the final database

  5,158 roadway segments with forecast data

  2, 984 of 5,158 roadway segments have actual traffic data (AADT)

- The same information was collected from all forecast reports to ensure consistency


ANOKA
HENNEPIN
RAMSEY
WASHINGTON
CARVER
DAKOTA
SCOTT
Legend
Highways Analyzed
County Boundary

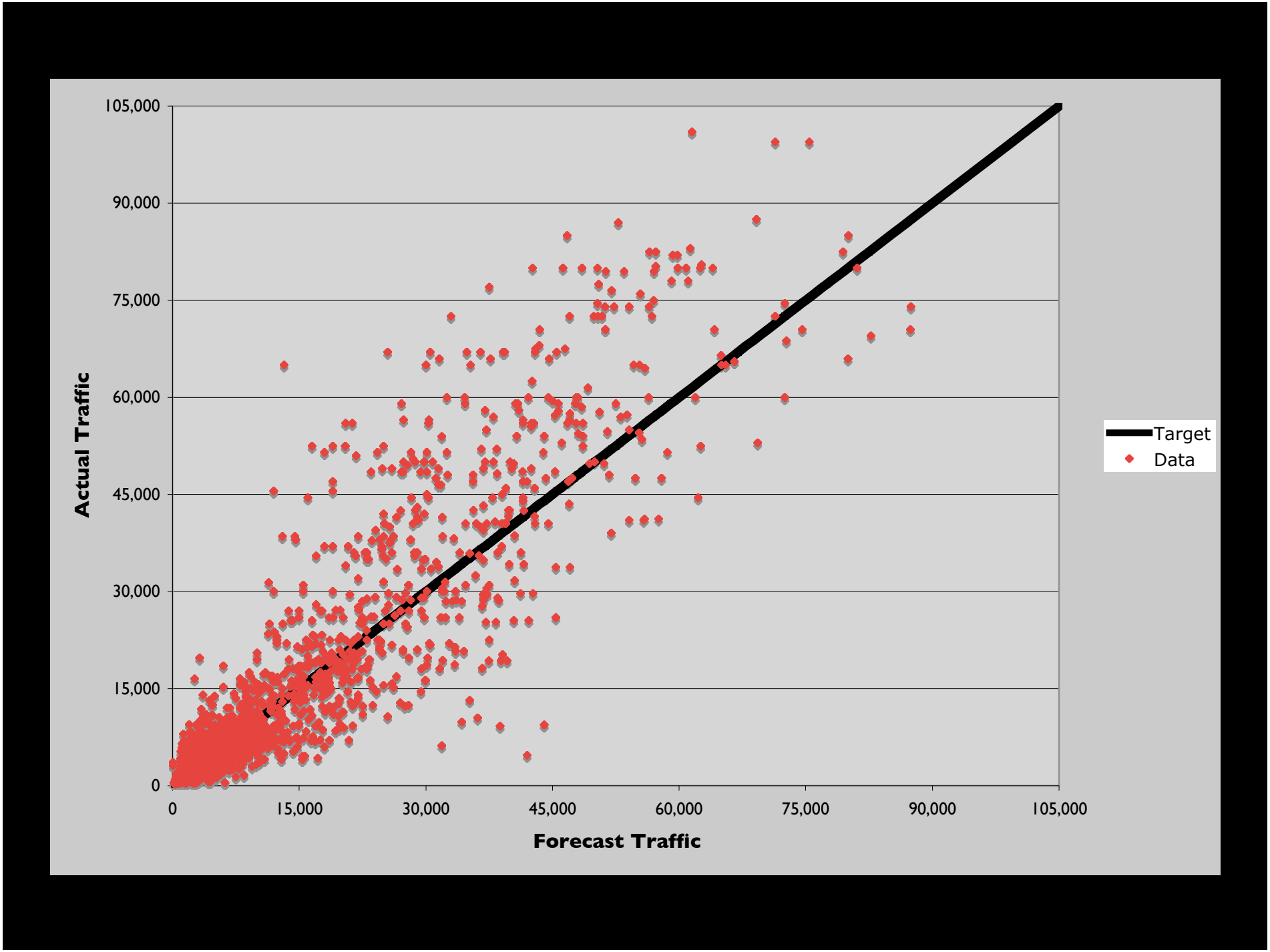
Analysis of forecast data

Illustrative Analysis

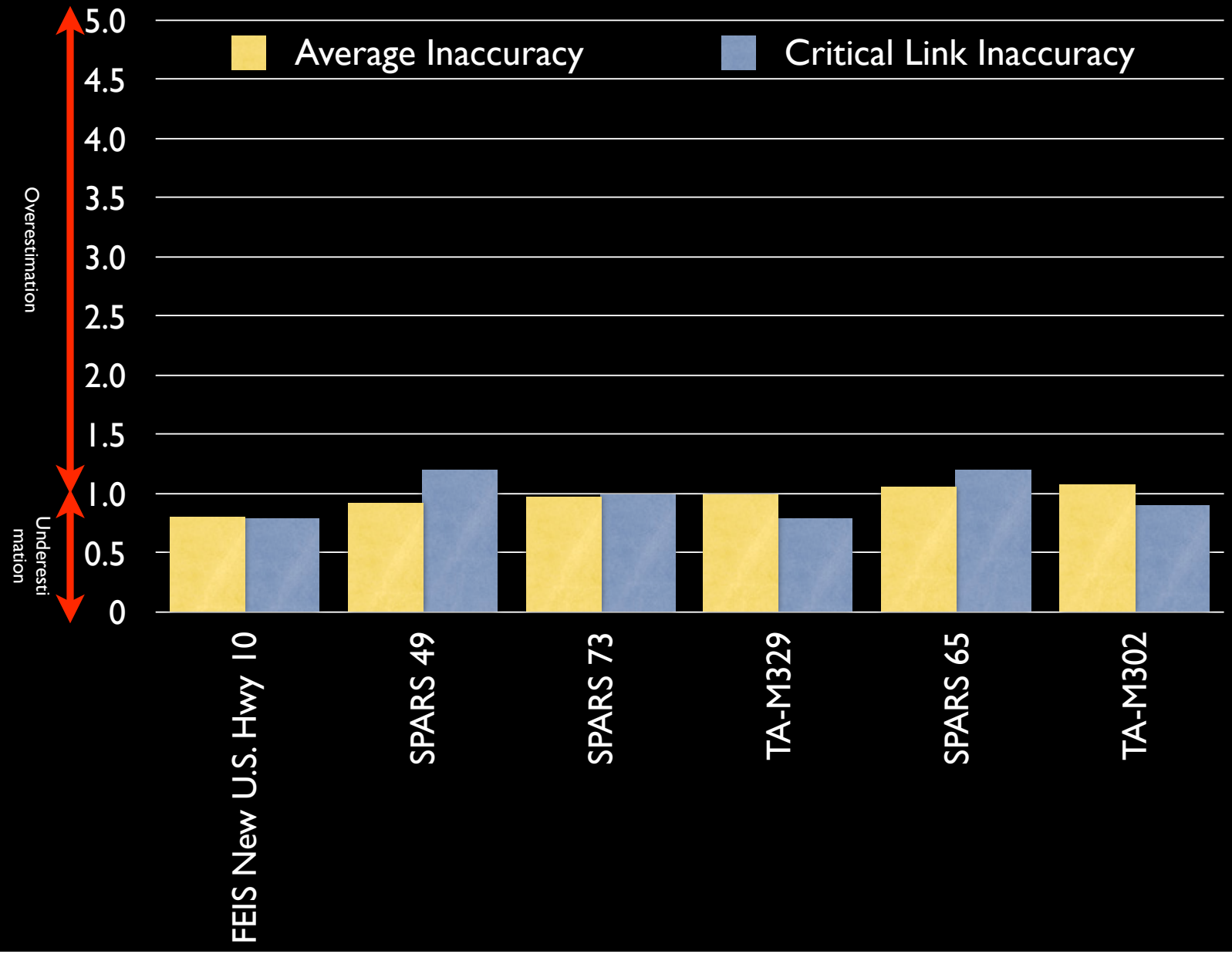
Macro-level analysis

$$\text{Inaccuracy} = \frac{\text{Forecast Traffic}}{\text{Actual Traffic}}$$

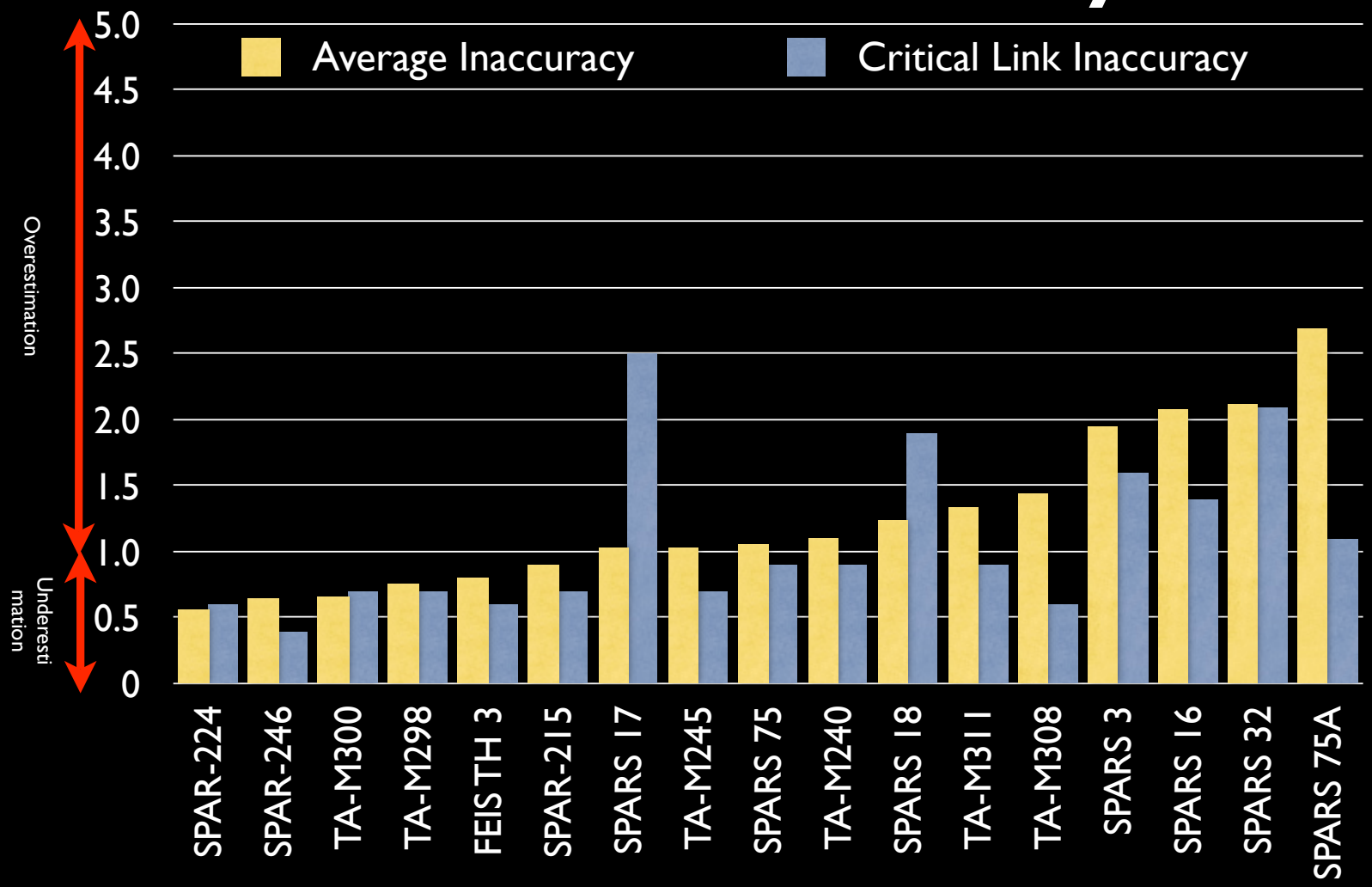
Inaccuracy estimated by different categories to better understand the data


105,000
90,000
75,000
60,000
45,000
30,000
15,000
0
Actual Traffic
0
15,000
30,000
45,000
60,000
75,000
90,000
105,000
Forecast Traffic
Target
Data

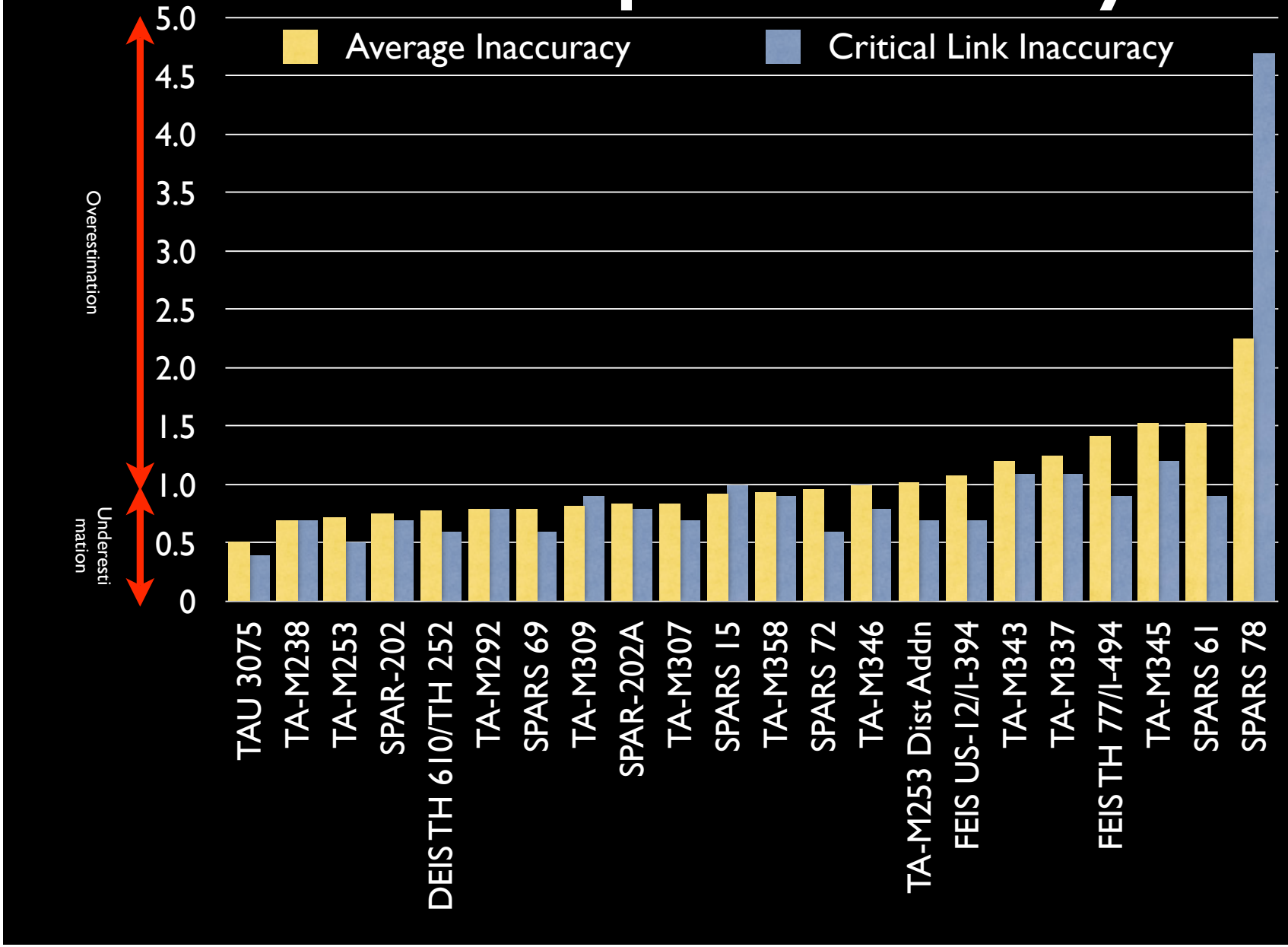
Anoka County



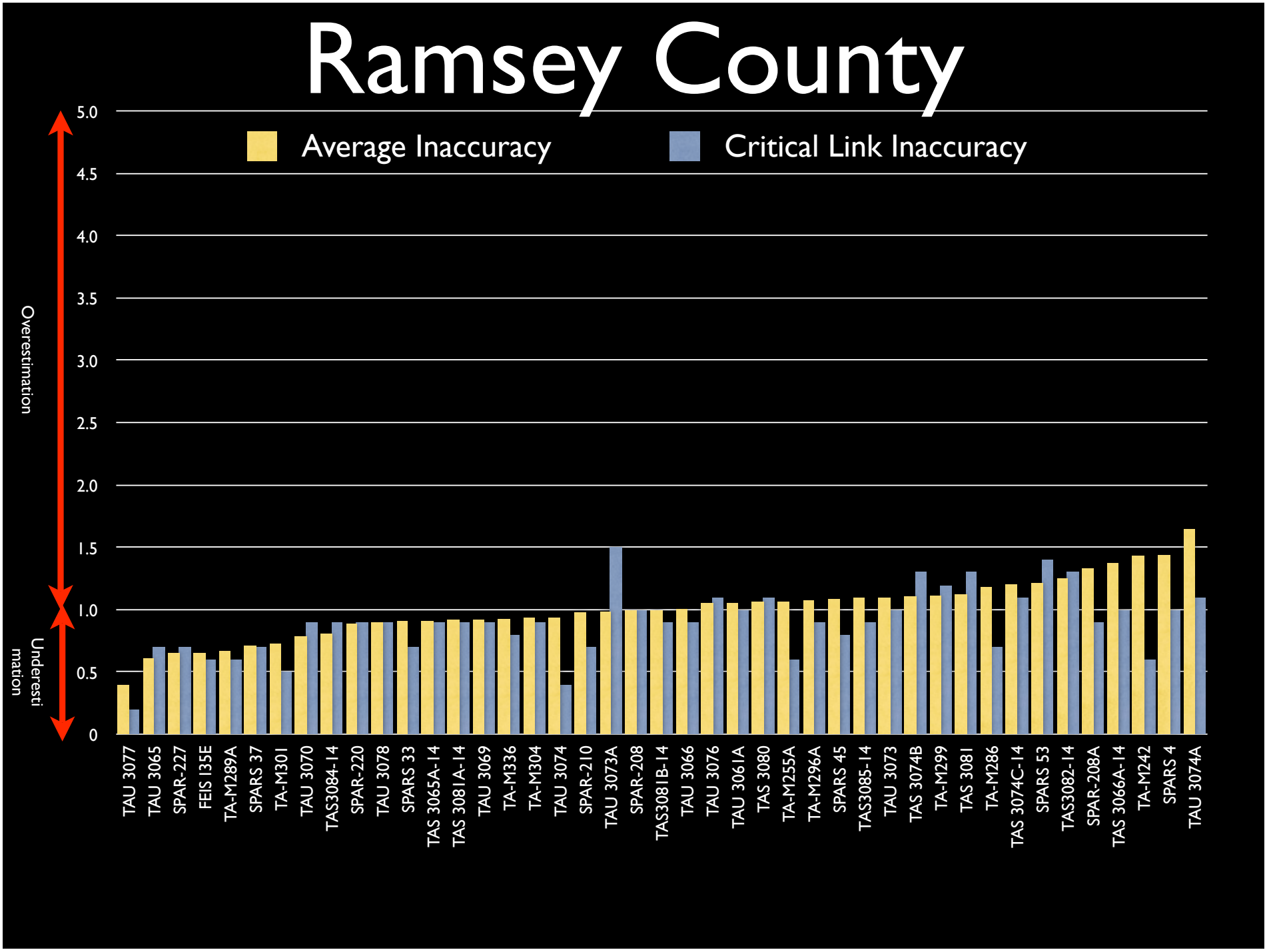
Dakota County



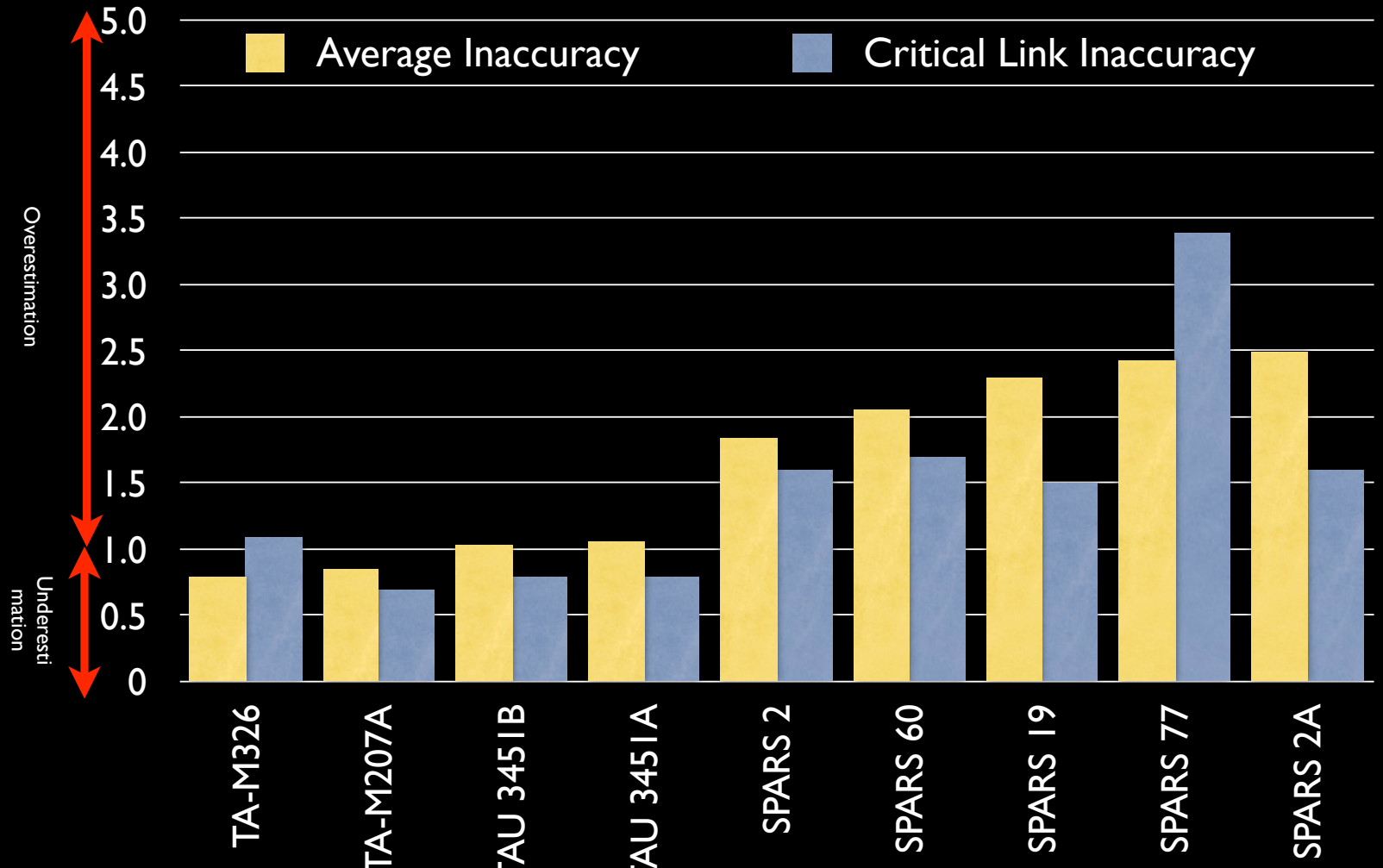
Hennepin County



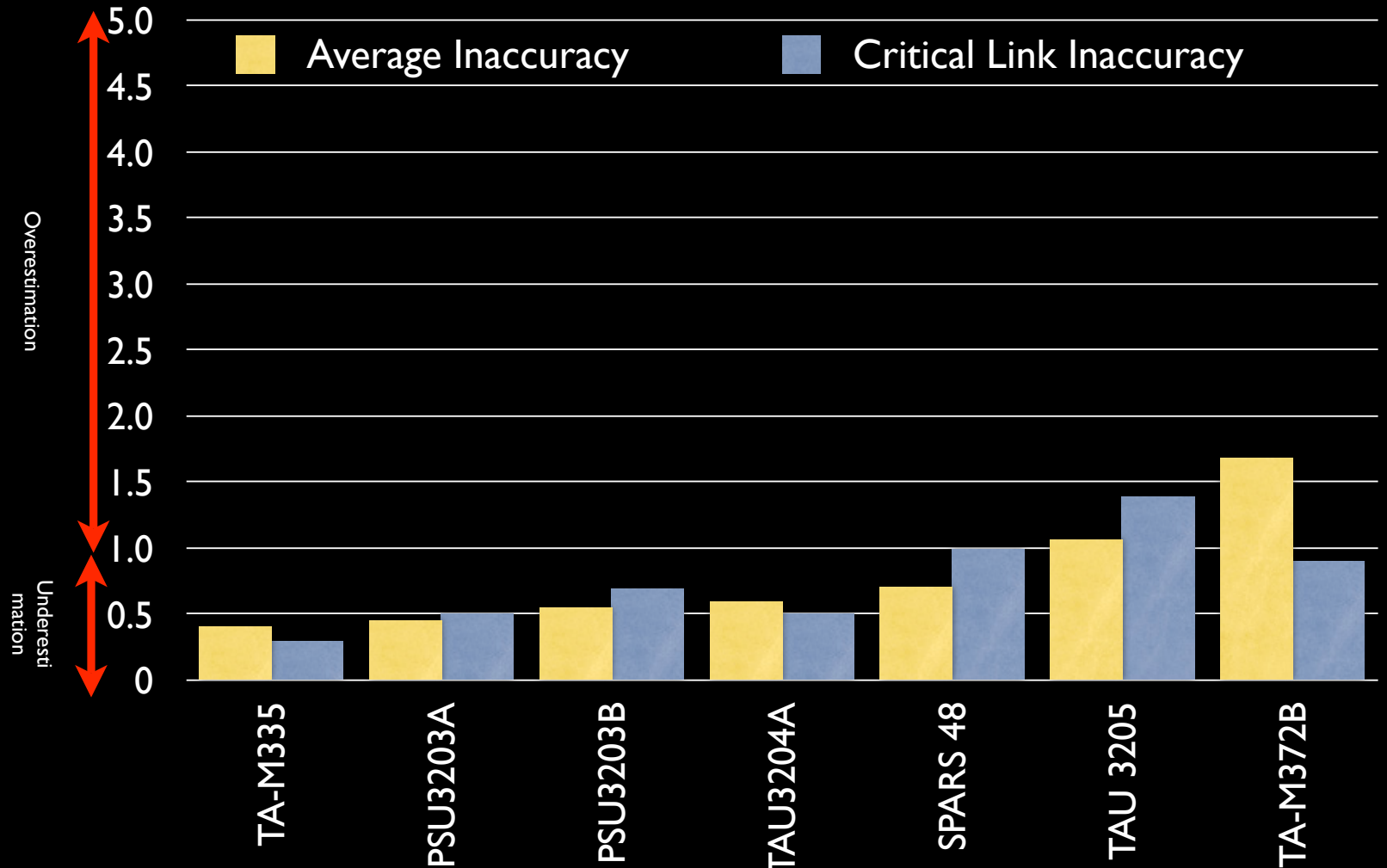
Ramsey County



Washington County



Carver & Scott County



Statistics

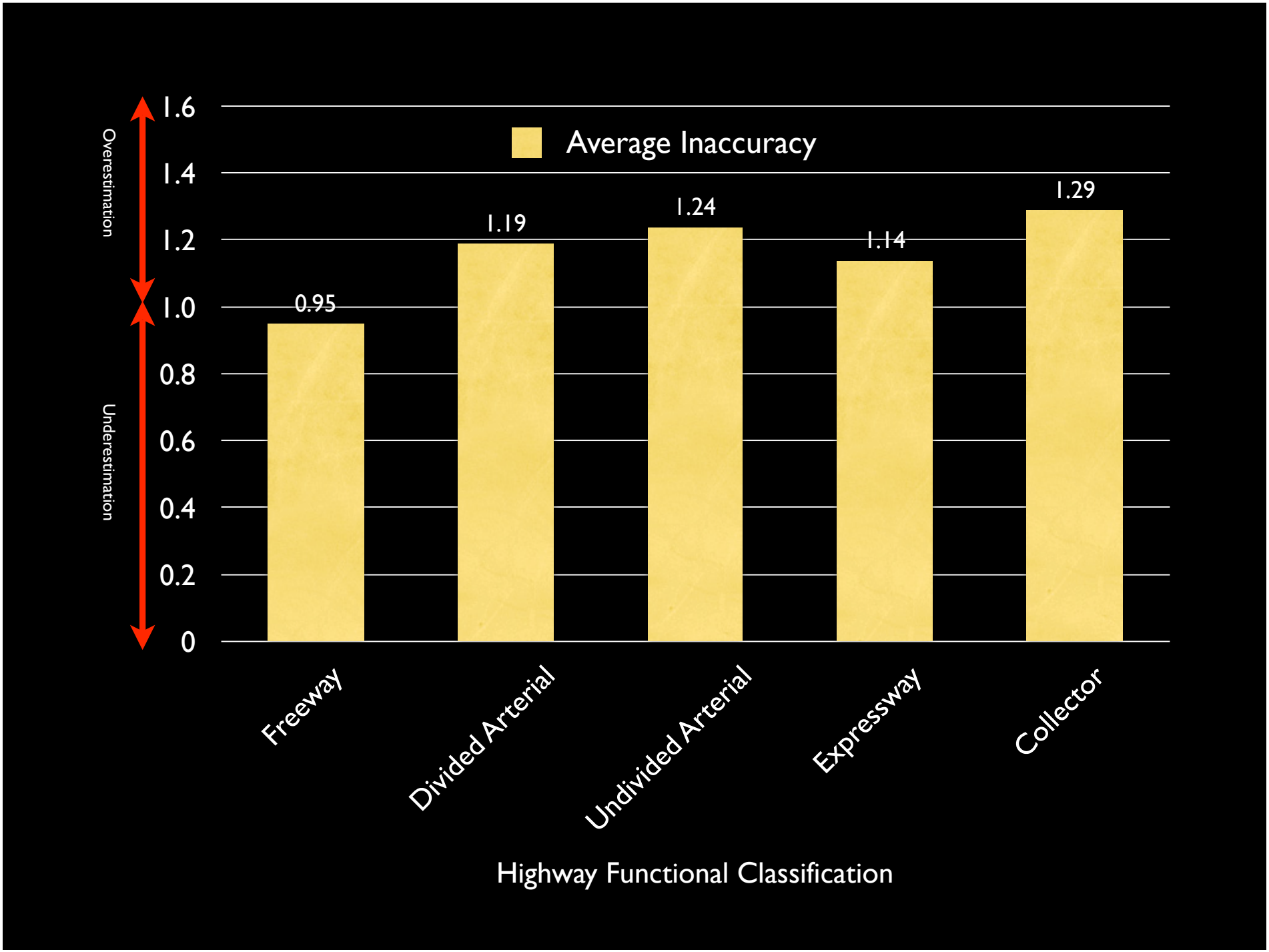
Inaccuracy Ratio = Forecast Traffic / Actual Traffic	Overestimation (Inaccuracy ratio>1.0)	Underestimation (Inaccuracy ratio<1.0)	Exact(Inaccuracy ratio=1.0)
Average Inaccuracy	48%	48%	4% (within +/-0.5%)
Critical Link Inaccuracy	27%	65%	8% (within +/-5.0%)

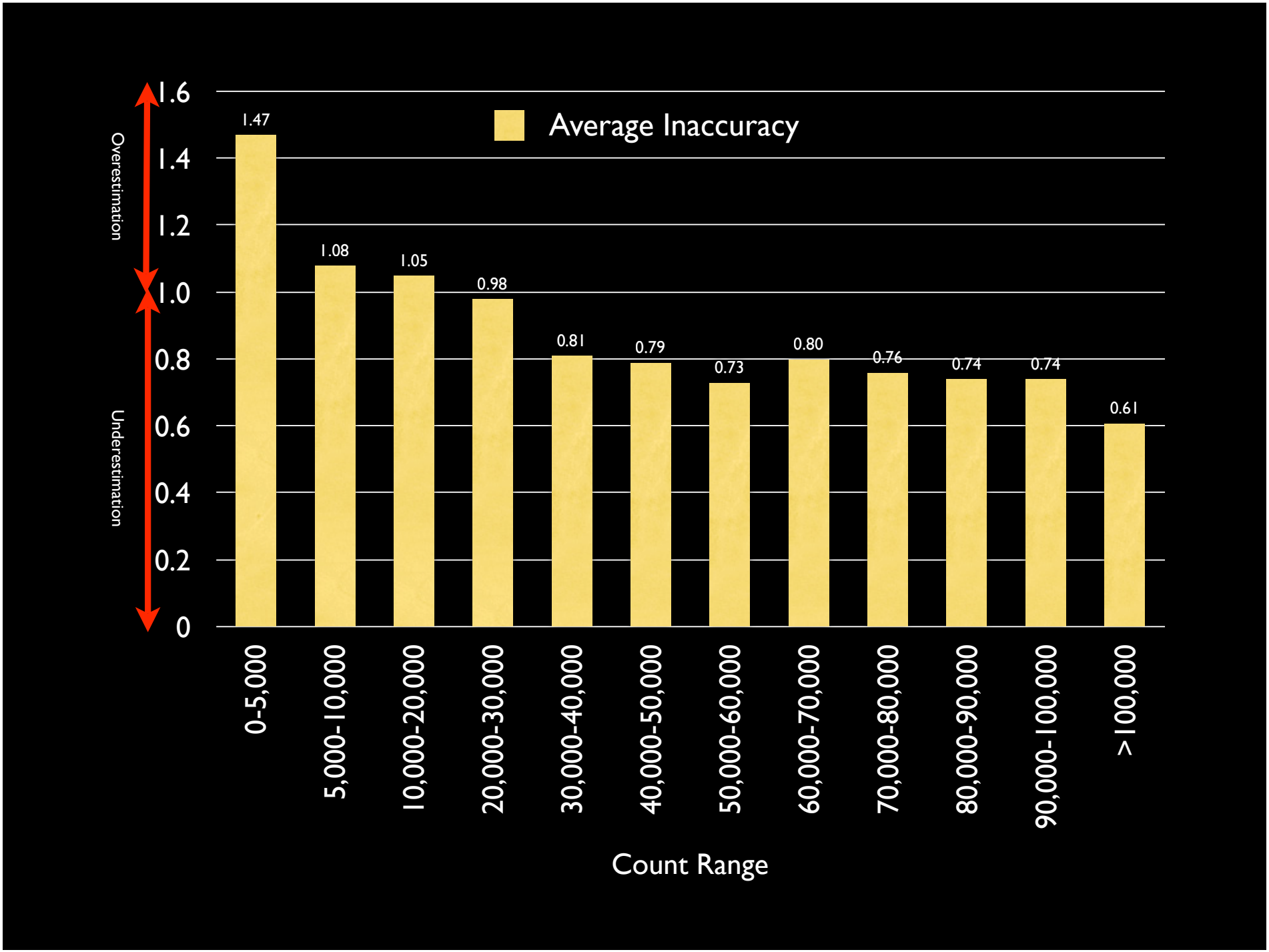
Note - The above statistics are based on data from the 108 project reports in the database

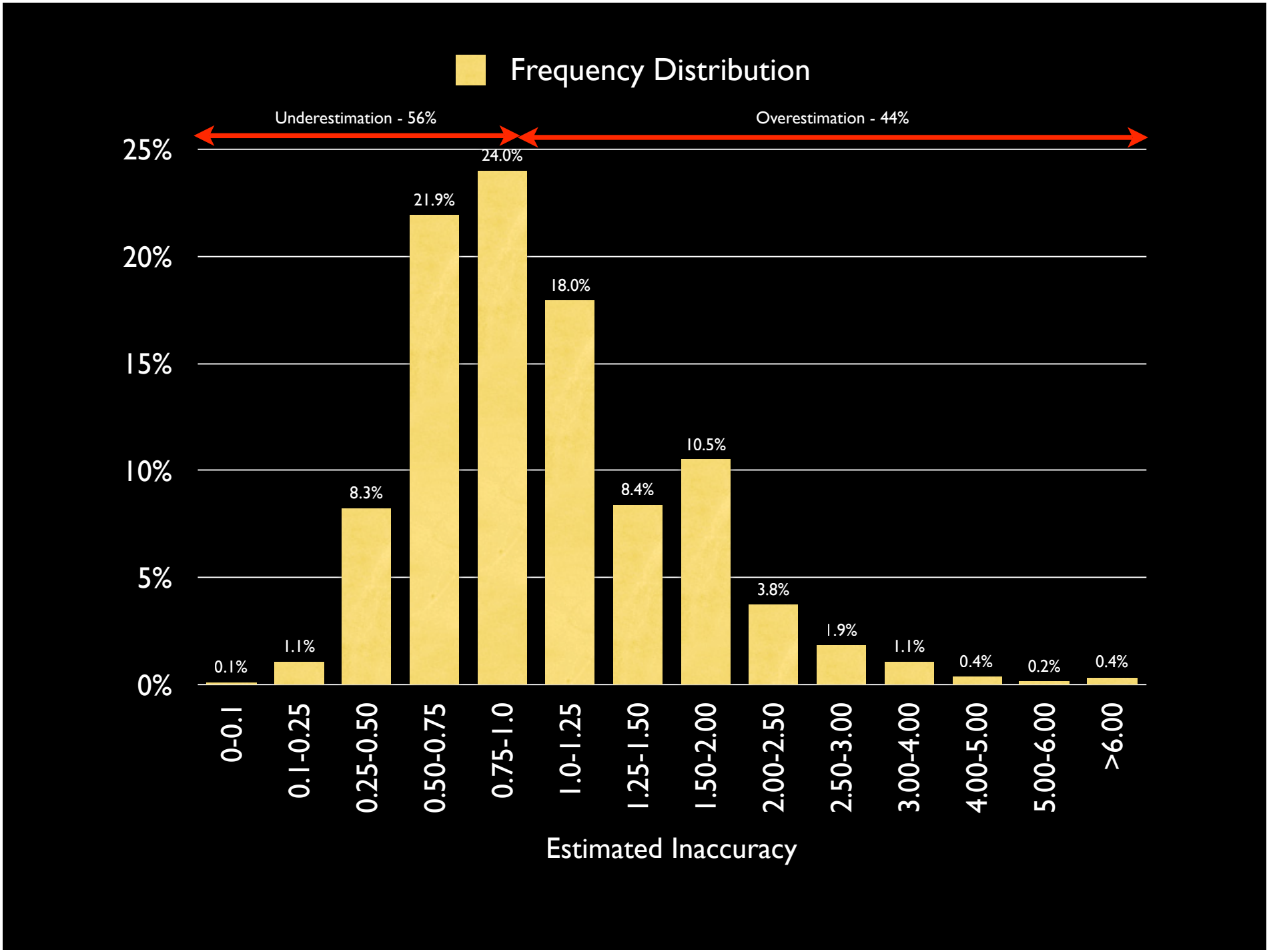
Statistics

Project Type	Frequency	Average Inaccuracy	Maximum Inaccuracy	Minimum Inaccuracy
Existing Roadways	77%	1.20	8.94	0.01
New Roadways	23%	0.95	5.00	0.16

Note - The above statistics are based on data from the 108 project reports in the database
Roadways classified as existing or new facility based on the status at the time of report preparation


Average Inaccuracy
Overestimation
Underestimation
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
0.95
1.19
1.24
1.14
1.29
Freeway
Divided Arterial
Undivided Arterial
Expressway
Collector
Highway Functional Classification


Average Inaccuracy
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
Overestimation
Underestimation
1.47
1.08
1.05
0.98
0.81
0.79
0.73
0.80
0.76
0.74
0.74
0.61
0-5,000
5,000-10,000
10,000-20,000
20,000-30,000
30,000-40,000
40,000-50,000
50,000-60,000
60,000-70,000
70,000-80,000
80,000-90,000
90,000-100,000
>100,000
Count Range


Frequency Distribution
Underestimation - 56%
Overestimation - 44%
25%
20%
15%
10%
5%
0%
0.1%
1.1%
8.3%
21.9%
24.0%
18.0%
8.4%
10.5%
3.8%
1.9%
1.1%
0.4%
0.2%
0.4%
0-0.1
0.1-0.25
0.25-0.50
0.50-0.75
0.75-1.0
1.0-1.25
1.25-1.50
1.50-2.00
2.00-2.50
2.50-3.00
3.00-4.00
4.00-5.00
5.00-6.00
>6.00
Estimated Inaccuracy

Summary

- No clear trend seen in the estimation of average inaccuracy by project

  Trend of underestimation seen in the estimation of inaccuracy on critical links

- Higher functional classification roads and higher volume roadways seem more prone to underestimation

Quantitative Analysis

- To identify the factors influencing forecast inaccuracy
  - Only main roadways included
  - Other roadways in the project not included
  - Additional information collected for the main roadways used in the analysis

- Ordinary Least Square Regression Model

  $I = f(N, H, F, V, D, T, S)$ where,

  I = Inaccuracy ratio

  N = Number of years between report year and forecast year

  H = Highway type - radial or lateral

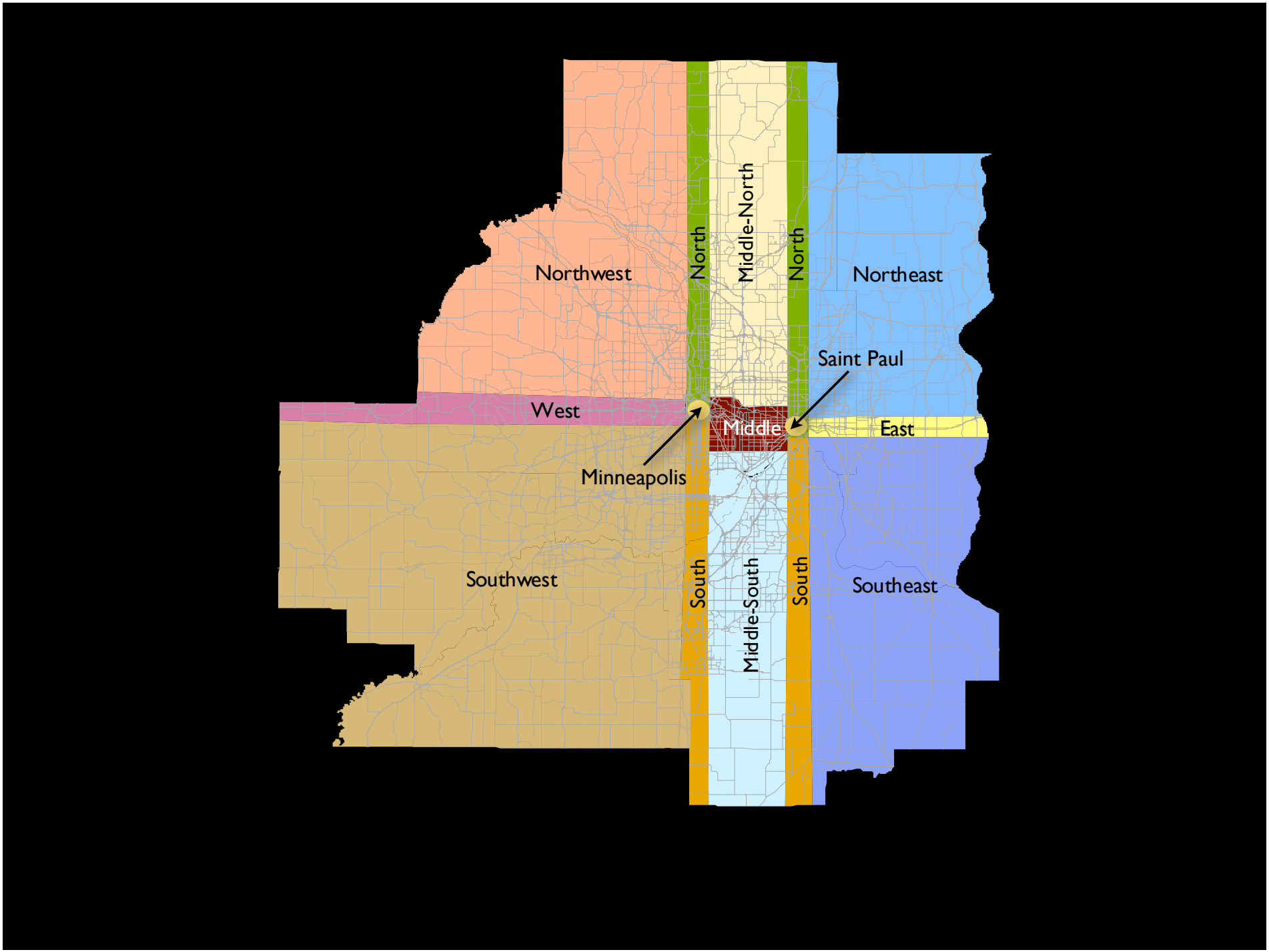
  F = Functional classification

  V = Project VKT or VMT

  D = Segment direction

  T = Decade of report preparation

  S = Roadway status - existing or new


Northwest
North
Middle-North
North
Northeast
Saint Paul
West
Middle
East
Minneapolis
Southwest
South
Middle-South
South
Southeast

Dependent Variable = Forecast Traffic/Actual Traffic				
Variable	Coefficient	Std. Error	t	P>|t|
Number of years	-0.034	0.004	-9.560	0.000
Project VMT	0.000	0.000	-1.430	0.153
Radial highway type	-0.108	0.033	-3.330	0.001
Collector	-0.112	0.226	-0.500	0.619
Divided Arterial	0.047	0.057	0.830	0.407
Expressway	0.097	0.043	2.270	0.024
Undivided Arterial	0.031	0.049	0.640	0.523
East	0.264	0.082	3.230	0.001
Middle North	-0.036	0.073	-0.490	0.624
Middle South	-0.348	0.105	-3.320	0.001
North	-0.113	0.072	-1.560	0.119
Northeast	0.552	0.077	7.200	0.000
Northwest	-0.193	0.087	-2.220	0.027
South	-0.056	0.071	-0.780	0.434
Southeast	0.358	0.070	5.140	0.000
Southwest	-0.162	0.079	-2.050	0.041
West	-0.154	0.083	-1.860	0.063
Rept year between 1970-1980	0.111	0.042	2.610	0.009
Rept year between 1980-1990	0.064	0.047	1.350	0.177
Rept year after 1990	0.278	0.220	1.260	0.207
New Facilities	-0.125	0.039	-3.220	0.001
constant	1.639	0.088	18.630	0.000
Number of obs	1275			
R-squared	0.251			
Adj R-squared	0.238			
Root MSE	0.503			
Positive & significant - Overestimation; Negative & significant - Underestimation				

Qualitative Analysis

- Conducted interviews with modelers in the Twin Cities
  - Modeling experience varied among the interviewees
  - Seven interviews conducted in May - June 2008
  - Interviews conducted in-person, via email or over the phone

Goal was to obtain perspectives and useful insights on modeling in the Twin Cities

To understand the reasons for inaccuracy in traffic forecasts

Standard set of 5 questions asked of all the interviewees

1. Your understanding of possible sources of error in the Twin Cities models?

2. With the current expertise in modeling that we have, what could have be done differently with the model development in 1970s, 1980s?

3. How does the Twin Cities model compare with other models that you have worked with or had an opportunity to look at?

4. How would you respond to criticisms against modeling?

5. Have there been instances of political compulsions influencing the model forecasting in the Twin Cities?

Stated reasons for inaccuracy

Inability of model to understand and predict societal changes

- Labor force participation of women
- Increases in mobility and auto ownership
- Increasing influence of internet & technology

Model Inputs

- Population - Employment inputs
- Network inputs

Technical limitations inherent in previous models

- Fewer people involved in modeling

Lack of a good understanding of trip distribution

Use of a fixed percentage of daily traffic for peak periods

Inability of the model to handle peak spreading

Over importance to home-based work (HBW) trips

Too much emphasis to assignments on principal arterials

Handling of special generators

ex. Mall of America

Political compulsions NOT too much of an issue in the Twin Cities

Private consultants likely to face more pressure from clients

Public agencies more likely to face a “push” to use existing or expected trends

Comparison of demographic forecasts

Average Inaccuracy estimated using 1975 Metropolitan council forecasts			
County	1980 Population	1990 Population	2000 Population
Anoka	1.08	1.01	0.93
Carver	1.02	1.19	1.04
Dakota	1.17	1.19	1.19
Hennepin	1.10	1.08	1.06
Ramsey	1.12	1.17	1.22
Scott	1.02	1.04	0.89
Washington	1.11	1.27	1.22
Total 7-county	1.11	1.12	1.10

TBI data

TBI Data	1949	1958	1970	1982	1990	2000	1990 - 1970	2000 - 1970
HBW Average Trip Length: Miles	na	na	6.57	8.11	9.2	11.4	40%	74%
HBW Average Trip Time: Minutes	na	na	19.8	na	21.2	25.6	7%	29%
Trips Per Capita	1.78	2.45	2.72	3.37	3.9	4.2	43%	54%
Trips Per Household	na	7.52	8.88	9.08	10.12	10.3	14%	16%
Persons Per Household	na	na	3.27	2.68	2.56	2.46	-22%	-25%
Workers Per Household	na	na	1.3	1.38	1.42	na	9%	na
Auto Occupancy: HBW	1.12	1.12	1.19	1.15	1.07	1.05	-10%	-12%
Auto Occupancy: Overall	1.55	1.57	1.5	1.3	1.29	1.35	-14%	-10%
Percentage of Women in Labor Force*	na	na	48.8%	60.0%	67.8%	72.5%	39%	49%

*Source: 2005 Twin Cities Transportation System Performance Audit

Network Inputs

New facilities identified in the 1976 Regional Development Framework (RDF) and expected to be completed by 1990			
Highways	From	To	Year Built
I-35E	West Seventh Street	I-94	1984-1991
I-35E	I-35	State Highway 110	1981-1985
I-94 (Minneapolis)	US 12	57th Ave N	1980-1982
I-494	State Highway 5	I-494	1982-1986
US 10	Ramsey Co Rd J	State Highway 47	1990
US 169/212	I-494	State Highway 41	1994-1996
US 169 (W River Rd)	86th Ave N	Northtown Corridor	1983
US 169/ State 101 (Shakopee Bypass)	US 169	State Highway 13	1976-1980
Co Rd 18 (Hennepin)	5th Street S	Minnetonka Blvd	1994
Co Rd 62 (Hennepin)	Co Rd 18	I-494	1985-1986
Northtown Corridor	US 169	I-94	Not built yet
Northtown River Crossing	US 10	US 169	1998
LaFayette Expressway (52)	I-494/State Highway 110	State Highway 55/52	1985-1994
I-335	I-94	I-35W	Control Section eliminated in 1979

Recommendations

Forecasting is a complicated long-term process

It is difficult to anticipate changes and control for errors

Better record keeping and data archiving procedures extremely essential

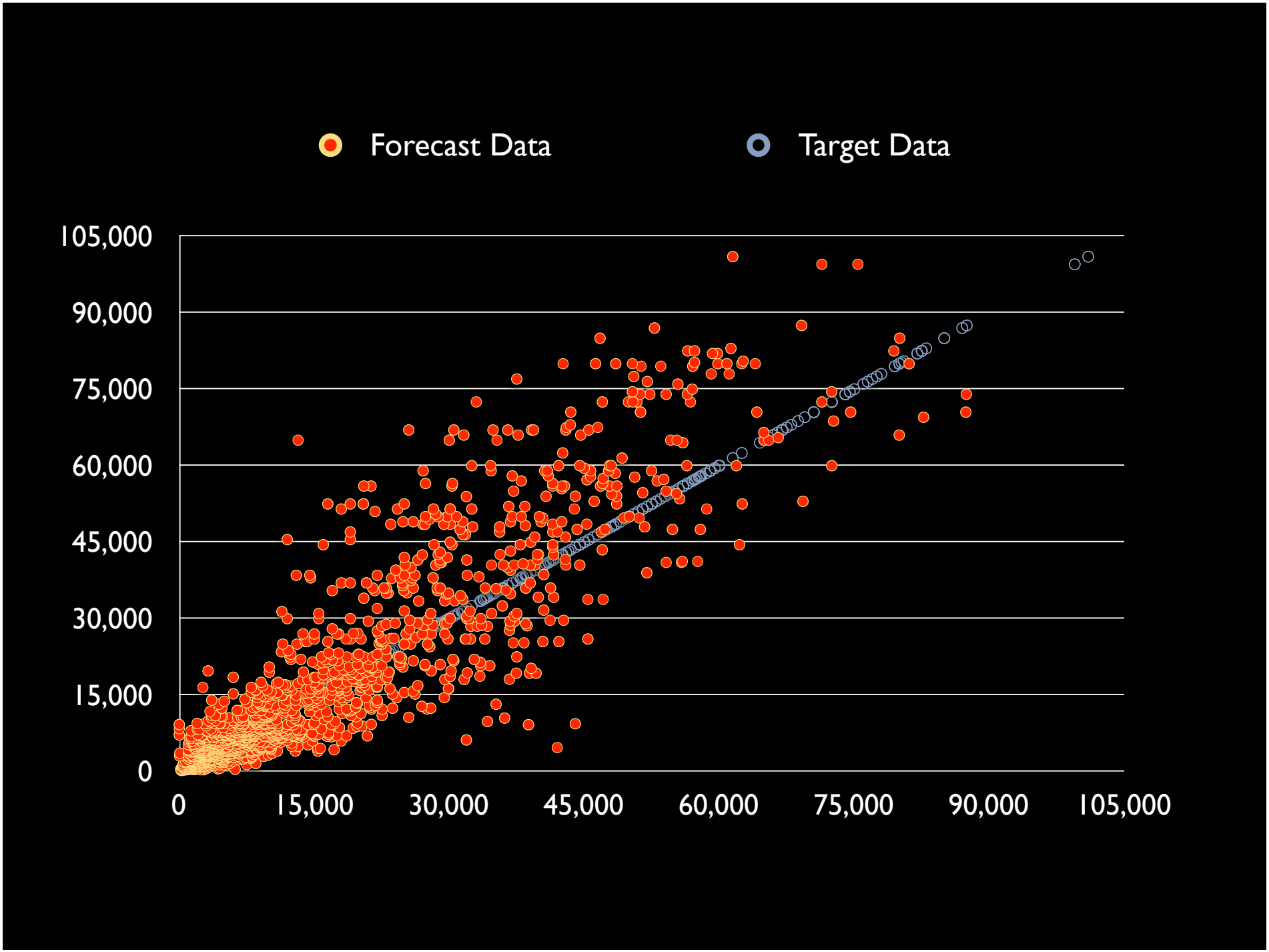
Better understanding and incorporation of fundamental societal changes is important

- Blindly following existing trends might not be the best approach

- Lesser importance needs to be given to the use of absolute numbers in forecasts
  - Use of ranges
  - Acknowledgement of uncertainties
- Non-modelers
  - Essential to understand the science, limitations and applicability of traffic forecasts

Questions?

Dependent variable: Inaccuracy Ratio = Forecast Traffic/ Actual Traffic				
Variable	Coefficient	Std. Error	t	P>|t|
Number of years	-0.029	0.004	-8.100	0.000
Project VKT	0.000	0.000	-1.550	0.121
Radial Highway Type	-0.059	0.039	-1.520	0.128
Collector	0.027	0.282	0.100	0.922
Divided Arterial	0.051	0.069	0.730	0.463
Expressway	0.128	0.052	2.460	0.014
Undivided Arterial	0.148	0.054	2.740	0.006
East	0.181	0.098	1.850	0.065
Middle-North	-0.059	0.087	-0.680	0.494
Middle-South	-0.395	0.120	-3.280	0.001
North	-0.127	0.080	-1.580	0.115
Northeast	0.492	0.092	5.360	0.000
Northwest	-0.184	0.098	-1.860	0.062
South	0.034	0.077	0.450	0.653
Southeast	0.324	0.083	3.920	0.000
Southwest	-0.197	0.090	-2.190	0.029
West	-0.333	0.086	-3.880	0.000
cons	1.552	0.095	16.400	0.000
Number of obs	1358			
R-squared	0.161			
Adj R-squared	0.151			
Root MSE	0.638			
Positive & significant - Overestimation; Negative & significant - Underestimation				


Forecast Data
Target Data
105,000
90,000
75,000
60,000
45,000
30,000
15,000
0
0
15,000
30,000
45,000
60,000
75,000
90,000
105,000