

# **The Synthetic Representation of Local Transit Services in the California Statewide Travel Demand Modeling Framework**

**CSTDM 09 Tier 2 Training Workshop**

**March 8, 2011**

# Aim of the study

**To develop a robust methodology for the synthetic representation of local transit services in the State of California to use in the CSTDM Statewide Modeling Framework.**

# Objectives

## Models

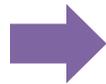
Short Distance  
Personal Travel  
Model  
(SDPM)

Long Distance  
Personal Travel  
Model  
(LDPM)

Short Distance  
Commercial  
Vehicle Model  
(SDCVM)

Long Dist. Comm.  
Veh. Model  
(LDCVM)

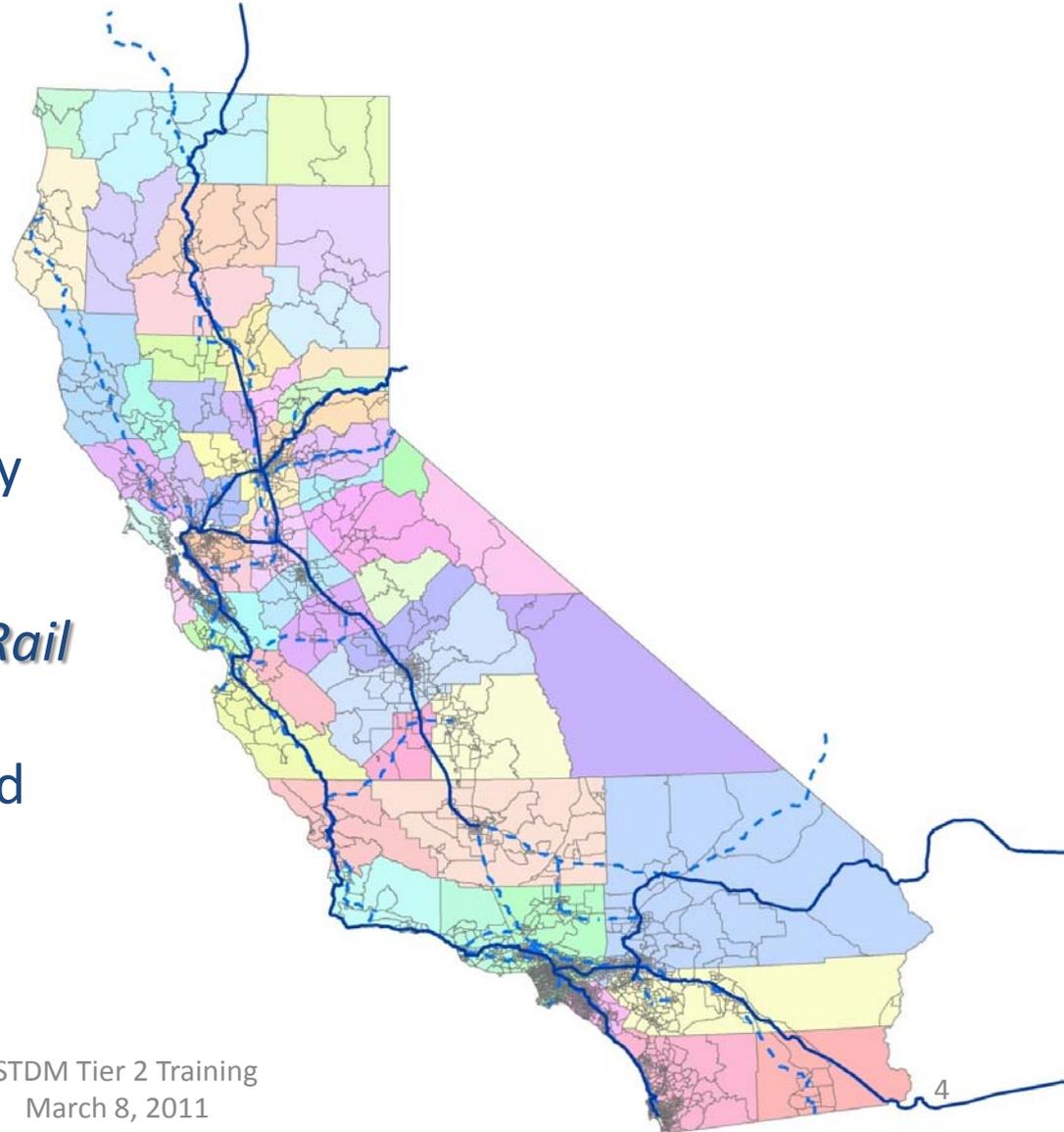
External Travel  
Model  
(ETM)



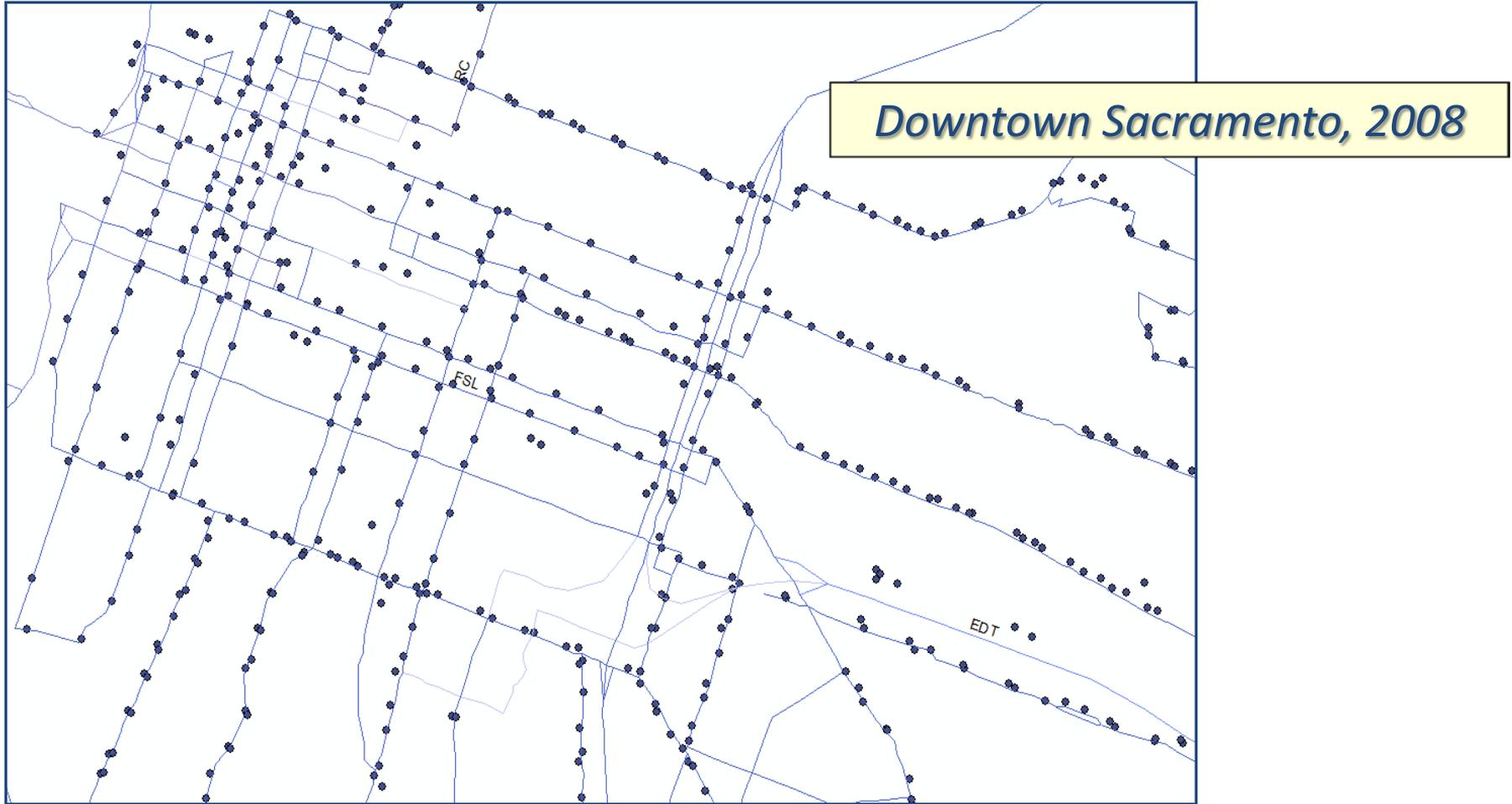
- To provide a *realistic representation of local transit* in the Short Distance PT Model (*component of the CSTDM*)
- To avoid the explicit coding of all local transit lines in the State
- To reduce the efforts required for the update of the PT network, when defining future scenarios in the CSTDM

# Public Transportation in the CSTDM

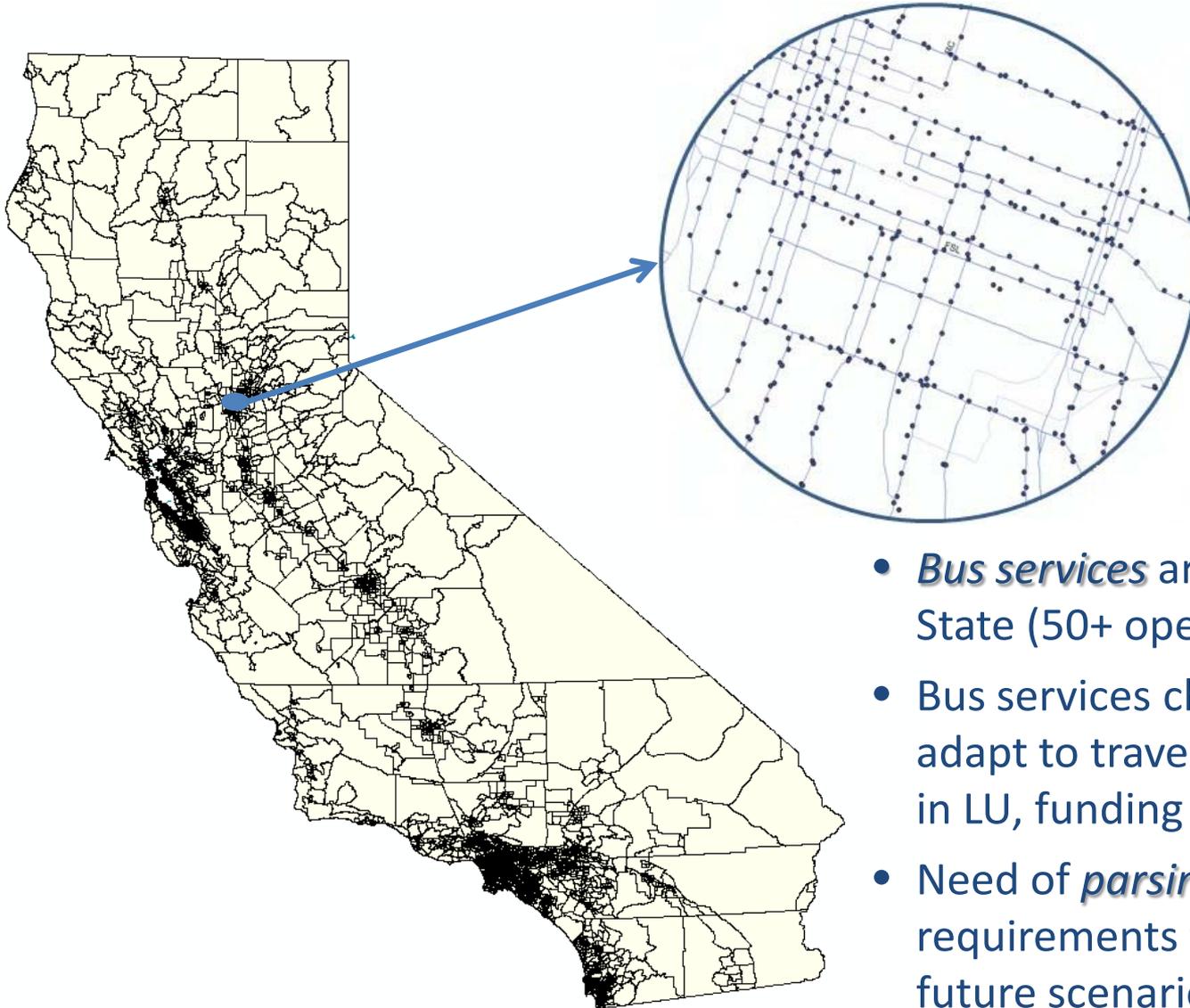
- *Limited railway services in California:*
  - 3 IC railways
  - 4 commuter railways
  - Some light rail and subway systems
- *Limited modifications in the Rail network* – due to large investments for railways, fixed routes (tracks) and high sunk costs



# Bus Services in California



# Bus Services in California (2)



- *Bus services* are quite common in the State (50+ operators, 1500+ bus lines)
- Bus services change frequently to adapt to travelers' demand, changes in LU, funding and subsidies
- Need of *parsimony* in reducing the requirements for network updates for future scenarios.

# Local Transit services

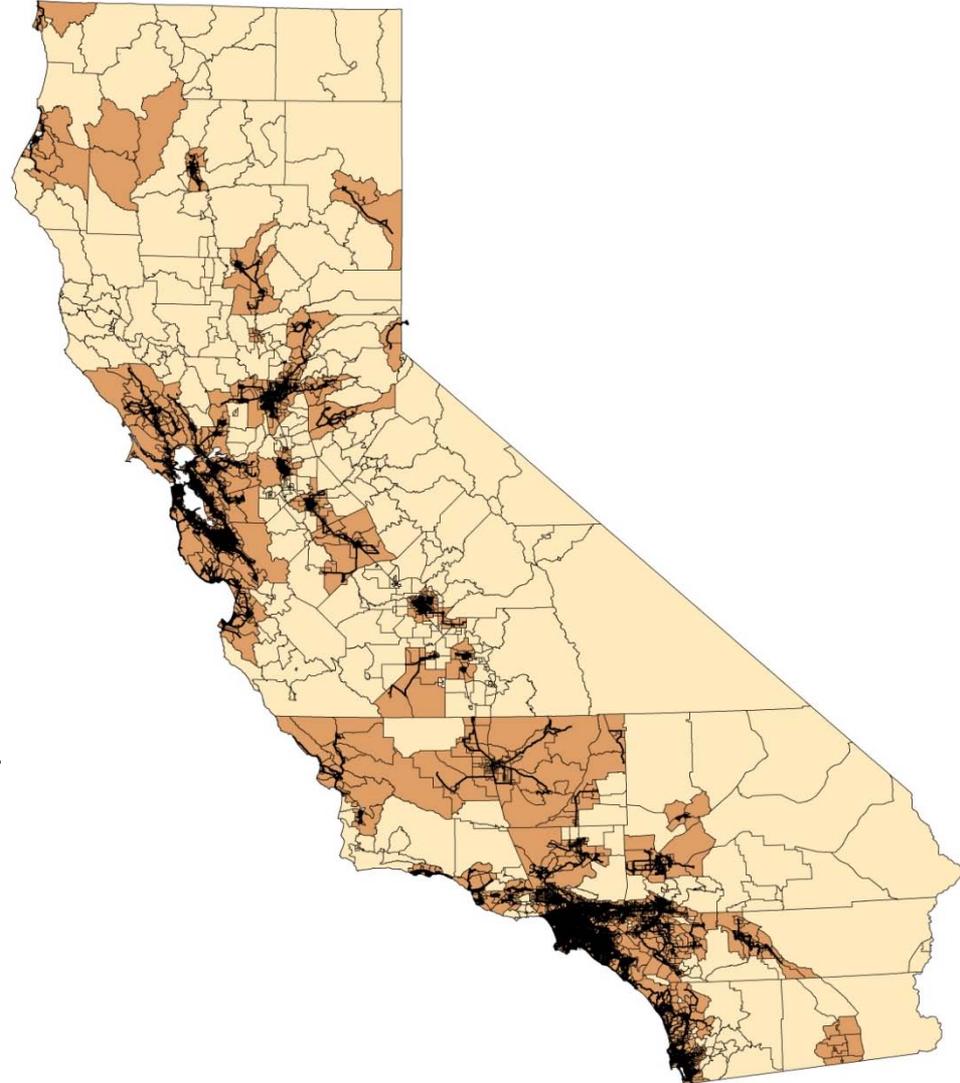
- In a Statewide model, there is *limited convenience in explicitly coding* every bus line in the State
- Very high ***costs of development*** and implementation of the model
- Difficulties in keeping the *network updated* (***cost of maintenance***) with modifications introduced by local operators
- Not justified by the ***scale of the project*** and the ***limited mode share*** for PT in California (→ *limited relevance in CSTDM project*)

# Local Transit in the CSTDM framework

- Local bus attributes expressed as *function of other variables* in the model.
- Based on a *service variable*, as well as *network* and *zonal properties*.
- Model based on the estimation of two functions for *In Vehicle Time (IVT)* and *Out-of-Vehicle time (OVT)* for local transit.
- *IVT* and *OVT functions* estimated using *observed data*.
- Model represents the dependence of public transportation characteristics from features of the *road network* (*distances, average speed*) and the *land use* (*densities, job locations*).

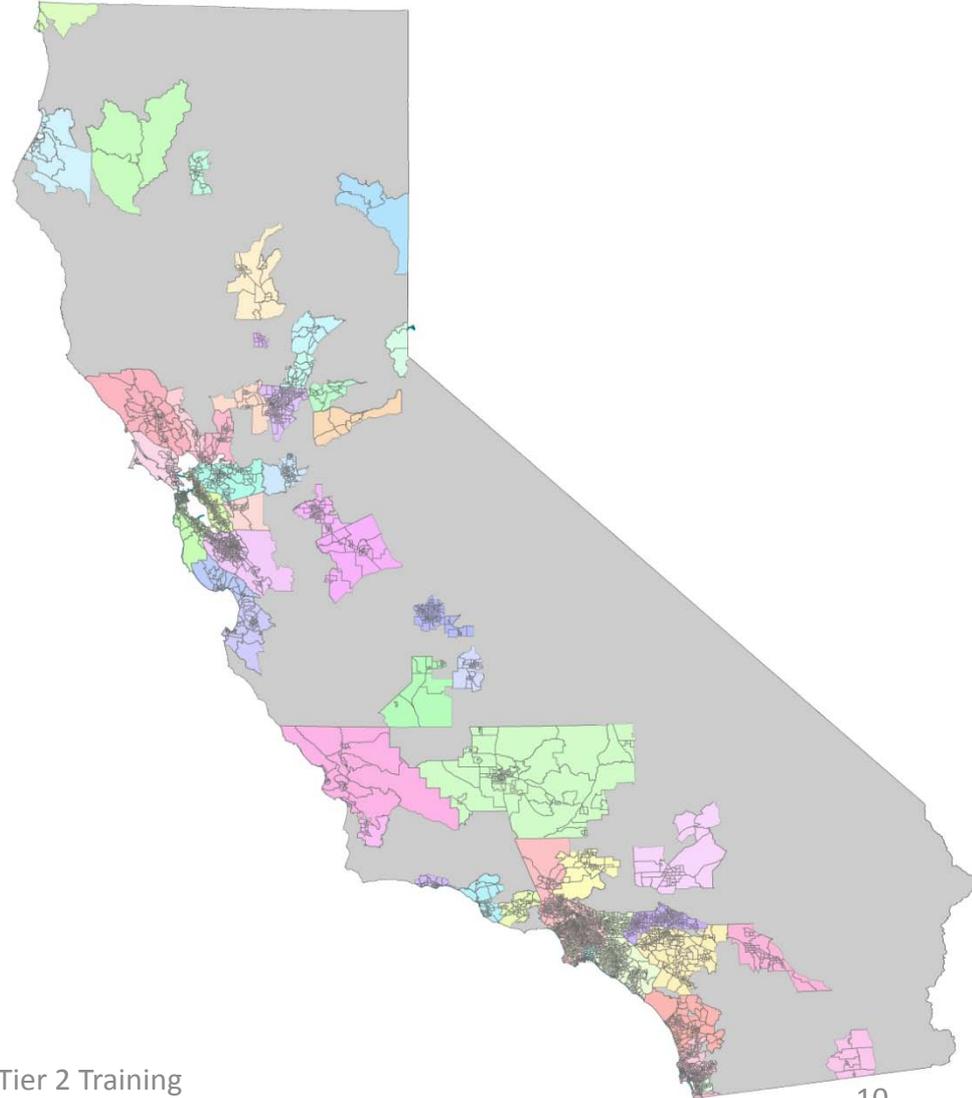
# Local Transit in the CSTDM framework (2)

- Four key inputs are used:
  - **Transfer Area:** area in which a person can travel
  - **Service Area:** area where transit services are generally operated by one operator
  - **Level of Service:** it represents the quality of local bus services in each service area
  - **Fare:** value (in dollars) paid by the travelers to use the transit services
- Division of the State of California in 32 **Catchment Areas:** area of influence (catchment) of bus operators and the easiness to transfer from a bus line to another

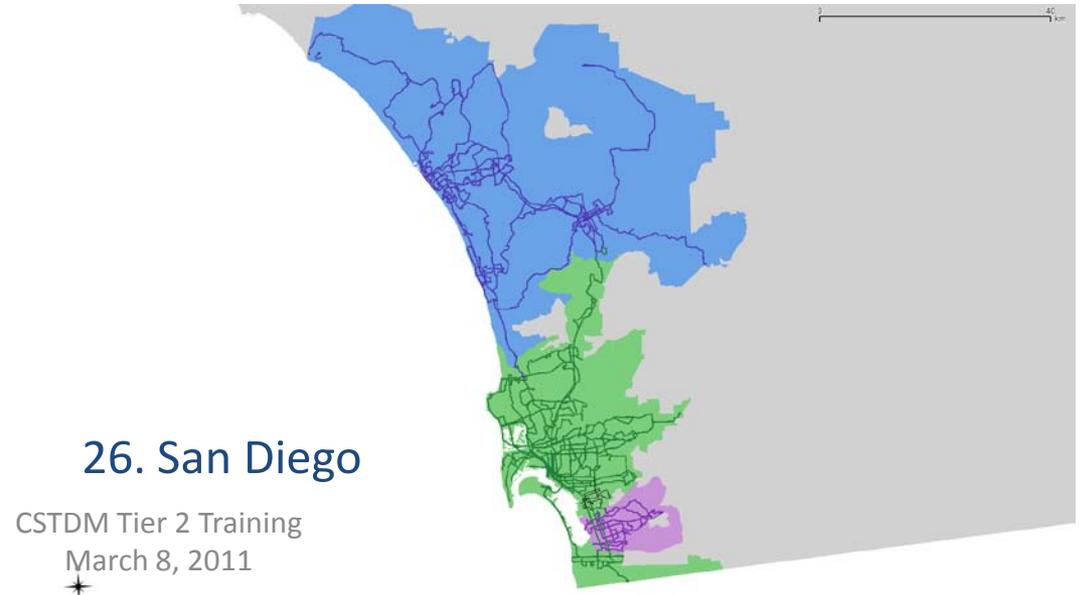
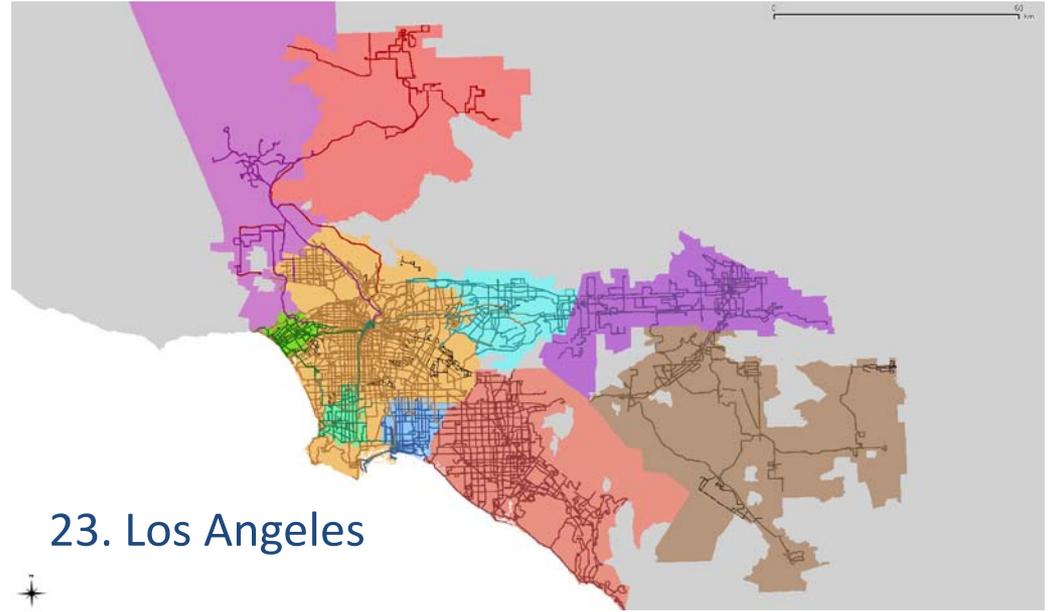
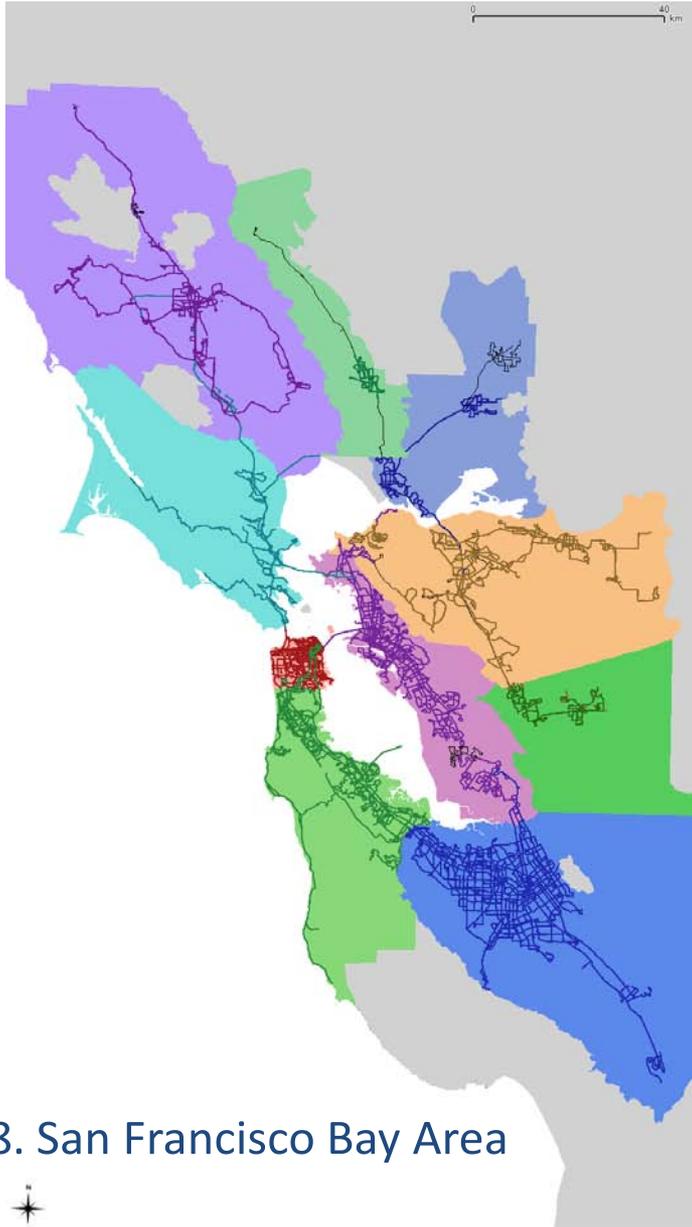


# The catchment areas

- The catchment areas account for the different *levels of service* and the easiness to transfer from one line to another
- Each TAZ is assigned to a catchment area, if at least one of the following conditions is true:
  - the proximity from the centroid to the closest bus lines < 3mi, *or*
  - at least one bus line passes through the TAZ
- Some TAZs are not served by any local transit service



# The catchment areas (2)



# Estimation of the model: Data

- IVT and OVT functions are estimated using observed data collected from the Google internet platform
- Total sample size: *91,074 records* collected for inter-zonal trips in *29 service areas* in the State of California
- Data referred to the four time periods (AM peak, Midday, PM peak, Off peak)
- Extraction of records from Google with the required information (IVT, OVT, catchment area, locations of origins and destinations, time of the day)
- Data merged with information available from other sources (Caltrans, other CSTDM components) to create the datasets for the estimation of the IVT and OVT functions

# Local Transit Functions: In Vehicle Time (IVT)

- *IVT* depends on:
  - *speed of private vehicles* that share the road
  - *HOV3 congested speed (HOV lanes, where available, can be used by buses)*
  - *level of service LOS* (investments in the transit system and local conditions)
  - *time of the day*

PEAK IVT MODEL		N= 50727				
		Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.	
HOV3_Time	2.8921040	.01478	.88182	195.69460	.00000	
HOV3_2	-.0174477	.00040	-.13566	-43.99996	.00000	
LOSHOV3	.0057270	.00011	.20607	52.59453	.00000	
R		Adjusted R Square		Std. Error of the Estimate		
0.95682	<b>0.915505304</b>	0.9155	14.44533			

OFF-PEAK IVT Model		N= 40347				
		Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.	
HOV3_Time	2.7813943	.01734	.82159	160.42225	.00000	
HOV3_2	-.0029318	.00055	-.01913	-5.29485	.00000	
LOSHOV3	.0046781	.00013	.15756	35.90664	.00000	
R		Adjusted R Square		Std. Error of the Estimate		
0.953631	<b>0.9094125</b>	0.909406	13.63288			

# Local Transit Functions: Out of Vehicle Time (OVT)

- *OVT* depends on:
  - *population and employment densities* at origin and destination
  - *HOV3 distance* between origin and destination (*HOV lanes*, where available, can be used by buses)
  - *level of service LOS* (investments in the transit system and local conditions)
  - *time of the day*

PEAK OVT MODEL		N= 49263				
Model	Unstandardized Coefficients		Standardized Coefficients.			Sig.
	B	Std. Error	Beta	t		
SQLOS	3.219780	0.018315	0.8152	175.796	0	
LOSDIST	0.006140	9.9E-05	0.1972	62.042	0	
SQP2EDENS	-0.016737	0.000669	-0.082	-25.020	2.66E-137	
R	0.916336		Adjusted R Square	0.839663	Std. Error of the Estimate	16.2413
		<b>R Square</b>				<b>0.839672</b>

OFF-PEAK OVT MODEL		N= 39467				
Model	Unstandardized Coefficients		Standardized Coefficients			Sig.
	B	Std. Error	Beta	t		
SQLOS	3.087907	0.0215319	0.7659	143.410	0	
LOSDIST	0.007235	0.0001239	0.2105	58.351	0	
SQP2EDENS	-0.007630	0.0007448	-0.0396	-10.244	1.34E-24	
R	0.9108550		Adjusted R Square	0.8296439	Std. Error of the Estimate	16.78981
		<b>R Square</b>				<b>0.829656</b>

# Implementation in the CUBE script

```
Cube (Licensed to University of California, Davis) - [AMMAT00A.S (E:\CSTM2009\CSTDM2009\APPLICATIONS)]
File Scenario Edit Run Search Insert Tools Other Apps Window Help

CSTM2009.cot
Scenarios
  Base
    Year2000
    Year2008

Applications
  CSTDM2009
    Highway Assignment and S
    Public Transport
    Transit Sims
      OFF_PEAK
      AM_Peak
      MIDDAY
      PM_Peak

Data
  Inputs
  Outputs
  Reports

Keys
Key Value
Scen. Name Year2000
YEAR 2000

FILE MATI[1] = "{SCENARIO_DIR}\SKIMS\TRANSIT\AMPEAK\W-RAIL_W_AMPEAK_SKIMS_{YEAR}.MAT"
FILE MATI[2] = "{SCENARIO_DIR}\SKIMS\TRANSIT\AMPEAK\D-RAIL_D_AMPEAK_SKIMS_{YEAR}.MAT"
FILE MATI[3] = "{SCENARIO_DIR}\SKIMS\TRANSIT\AMPEAK\D-RAIL_W_AMPEAK_SKIMS_{YEAR}.MAT"
FILE MATI[4] = "{SCENARIO_DIR}\SKIMS\TRANSIT\AMPEAK\W-RAIL_D_AMPEAK_SKIMS_{YEAR}.MAT"
FILE MATI[5] = "{SCENARIO_DIR}\SKIMS\Auto\SKIMS_AMPEAK_{YEAR}.MAT"
FILE ZDATI[1] = "{SCENARIO_DIR}\Controls\LocalBus_{YEAR}.dbf"
FILE ZDATI[2] = "{SCENARIO_DIR}\Controls\Zonal properties_{YEAR}.dbf"

;Output files

FILEO MATO[1] = "{SCENARIO_DIR}\SKIMS\TRANSIT\AMPEAK\W_W_AMPEAK_GC_{YEAR}.MAT",
NO=1-5, NAME=WRT,WRT,TRW,TRT,TTT
FILEO MATO[2] = "{SCENARIO_DIR}\SKIMS\TRANSIT\AMPEAK\D_W_AMPEAK_GC_{YEAR}.MAT",
NO=6-7, NAME=DRW,DRT
FILEO MATO[3] = "{SCENARIO_DIR}\SKIMS\TRANSIT\AMPEAK\W_D_AMPEAK_GC_{YEAR}.MAT",
NO=8-9, NAME=WRD,TRD
FILEO MATO[4] = "{SCENARIO_DIR}\SKIMS\TRANSIT\AMPEAK\COSTS_AMPEAK_{YEAR}.MAT",
NO=10-18, NAME=WU_TIVT,WU_TOVT,WU_TFARE,DM_TIVT,DM_TOVT,DM_TFARE,WD_TIVT,WD_TOVT,WD_TFARE

CATCHI=z1.1.CATCHMENT
OPERAI=z1.1.OPERATOR
LOSI=1.0*z1.1.LOS ;GC: LOS are constant but different functions are used for the different time periods
DENSI=(z1.2.POPDENS+2*z1.2.EMPDENS)
FAREI=z1.1.FARE
IF (DENSI > 250000)
  DENSI = 250000
ENDIF

JLOOP

CATCHJ=z1.1.CATCHMENT[J]
OPERAJ=z1.1.OPERATOR[J]
LOSJ=1.0*z1.1.LOS[J] ;GC: LOS are constant but different functions are used for the different time periods
DENSJ=(z1.2.POPDENS[J]+2*z1.2.EMPDENS[J])
IF (DENSJ > 250000)
  DENSJ = 250000
ENDIF

FAREJ=z1.1.FARE[J]

LOS= (LOSI + LOSJ + MAX(LOSI,LOSJ))/3 ; KJS: If between two systems, use 2/3 of LOS for worse system

IF ((CATCHI<>CATCHJ) || (CATCHI=0) || (CATCHJ=0)) .mi.5.7>9999|||
  TIVT=9999 ; Transit in Vehicle Time
  TOVT=9999 ; Transit out vehicle time
  TFARE=9999 ; Transit Fare
ELSE
  TIVT=2.8921040*mi.5.7 - 0.0174477*(mi.5.7^2) + 0.0057270*mi.5.7*LOS
  TOVT=3.2197805*SQRT(LOS) + 0.0061401*mi.5.8*LOS - 0.0167375*(SQRT(DENSI)+SQRT(DENSJ))
  TOVT = MAX(TOVT, 5)
  TFARE= FAREI
ENDIF

IF (mi.5.7>65) ;GC: solution to "cap" the IVT quadratic function for longer trips
  TIVT=2.8921040*65 + (2.8921040/4)*(mi.5.7-65) - 0.0174477*(65*65) + 0.0057270*mi.5.7*LOS
  TOVT=TOVT
ENDIF

IF (OPERAI<>OPERAJ) ; between two operators
  TIVT=TOVT
```

# The control file for catchment areas and fares in CUBE

TAZ	COUNTY	OPERATOR	CATCHMENT	LOS	FARE
100	Del Norte	1	1	200	1.12
101	Del Norte	1	1	200	1.12
102	Del Norte	1	1	200	1.12
103	Del Norte	1	1	200	1.12
104	Del Norte	0	0	9999	9999
105	Humboldt	2	2	200	1.35
106	Humboldt	2	2	200	1.35
107	Humboldt	2	2	200	1.35
108	Humboldt	2	2	200	1.35
109	Humboldt	0	0	9999	9999
110	Humboldt	2	2	200	1.35
111	Humboldt	2	2	200	1.35
112	Humboldt	2	2	200	1.35
113	Humboldt	2	2	200	1.35
114	Humboldt	2	2	200	1.35
115	Humboldt	2	2	200	1.35
116	Humboldt	2	2	200	1.35
117	Humboldt	0	0	9999	9999
118	Humboldt	0	0	9999	9999
119	Humboldt	0	0	9999	9999
120	Humboldt	2	2	200	1.35
121	Humboldt	2	2	200	1.35
122	Lassen	0	0	9999	9999
123	Lassen	0	0	9999	9999
124	Lassen	3	3	200	0.75
125	Lassen	3	3	200	0.75
126	Lassen	3	3	200	0.75
127	Lassen	3	3	200	0.75
128	Modoc	0	0	9999	9999

*No need for explicit coding* of updates in the local transit networks.

CSTDM runs the local transit model with 4 script files (the same for all scenarios).



The file *LocalBus\_{year}.dbf* provides information for *catchment areas*, *LOS* and *fares* for each scenario.

The model allows *policy testing* on local transit system in future scenarios.

Documentation available on  
[//ultrans.its.ucdavis.edu/resource/186](http://ultrans.its.ucdavis.edu/resource/186)



**For any question, please contact:**

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