TMIP
Better Methods. Better Outcomes.

TMIP Webinar Series

Agency Experience using Activity-Based Models

Session 3:

DRCOG Experience

Date:

December 13, 2012

Speakers:

Erik Sabina (DRCOG)

Tom Rossi (Cambridge Systematics)

U.S. Department of Transportation
Federal Highway Administration

Disclaimer

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When and Where we Started

- **2001 - running a basic trip-based model in MinUTP**
- **Place-based household survey from 1996/7**
- **One modeler on staff (me)**
- **2004 – completed transfer to TransCAD**
- **2005 – completed ABM visioning exercise**
- **Began ABM project in December, 2005**
  - One operational ABM at that time – SFCTA
  - NYMTC and MORPC almost complete
  - SACOG about to start work

Vision Phase purposes

- Build support from customers of the existing model
- And from potential customers of a better model
- Learn about next-generation model design

We held a big open house

120 attendees, including planners, engineers, elected official, and members of the general public

At the Denver Public Library in February, 2003

METRO VISION RESOURCE CENTER

DRCOG

DENVER REGIONAL COUNCIL OF GOVERNMENTS

Integrated Regional Model Project Open House

The Denver Regional Council of Governments and its Denver Regional Model provide the "numbers" behind many decisions about land use and transportation that affect life in our region. Using census and survey numbers, a model provides a representation of what impact a future project will have on its surroundings and the region.

It's time for DRCOG to update its current models to better support regional decision-making. Come see how the current models operate, and give input as to how you think they should work in the future. Lend your vision to the Integrated Regional Model Project!

Integrated Regional Model Project Open House
Wednesday, Feb 26, 4-7 p.m.
Denver Central Public Library
Conference Rooms A & B, Lower Level
10 W. 14th Ave. Parkway, Denver

For more information, call 303-480-6789 or e-mail esabina@drcog.org.

A joint project of the Denver Regional Council of Governments, the Regional Transportation District and the Colorado Department of Transportation.

We established three panels

- **An expert panel**
  - Keith Lawton
  - Keith Killough
  - Paul Waddell
  - Michael Morris
  - Frank Spielberg
  - Michael Replogle
  - Eric Miller
- **Technical Panel**
- **Policy Panel**

We established three panels

- **A Technical Panel**
  - Local government
  - State DOT
  - Regional Transportation District
  - Environmental groups
  - Economists
  - Academics
  - Partner MPOs

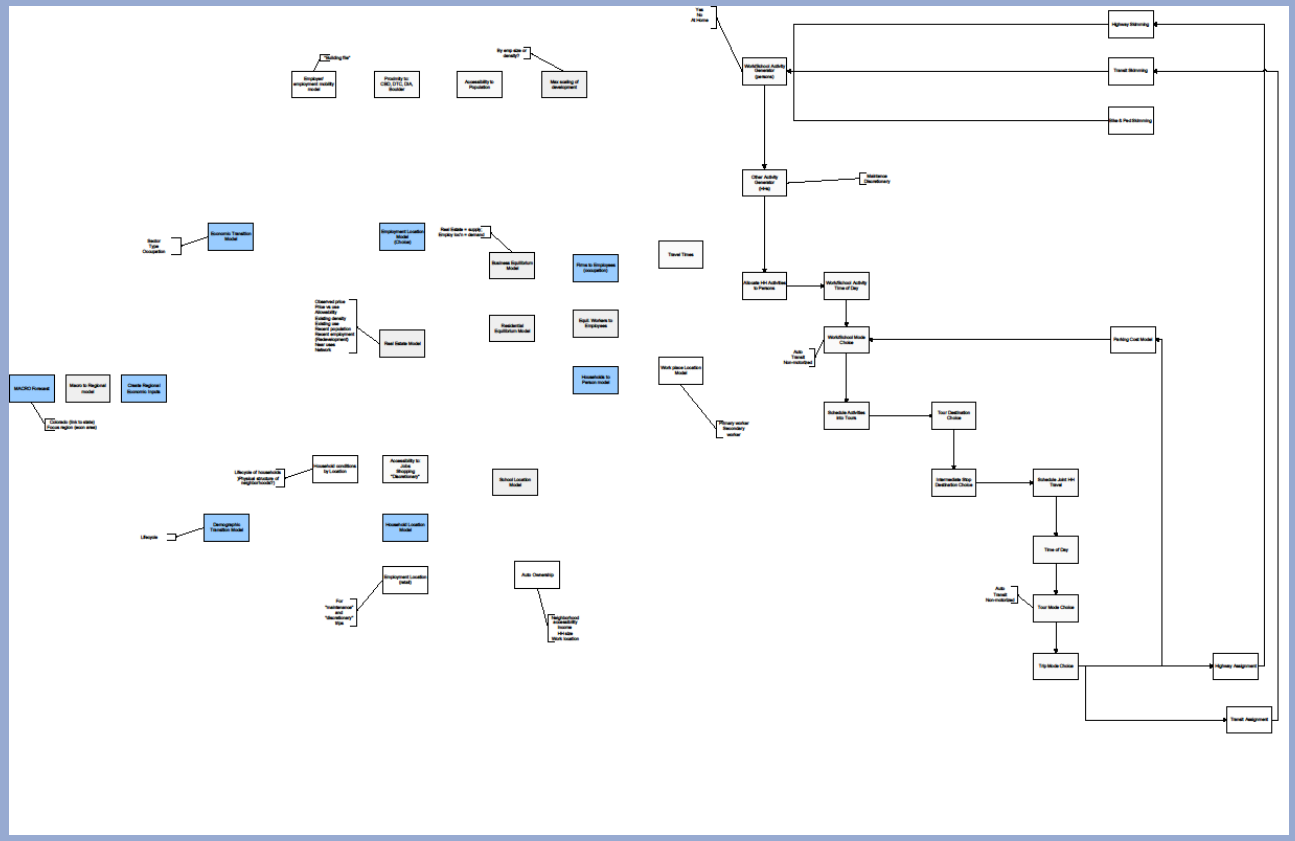
We established three panels

- **A Policy Panel**
  - Elected officials
  - Senior appointed officials
  - Senior chamber of commerce officials
  - Motor carrier representatives
  - Home builders associations

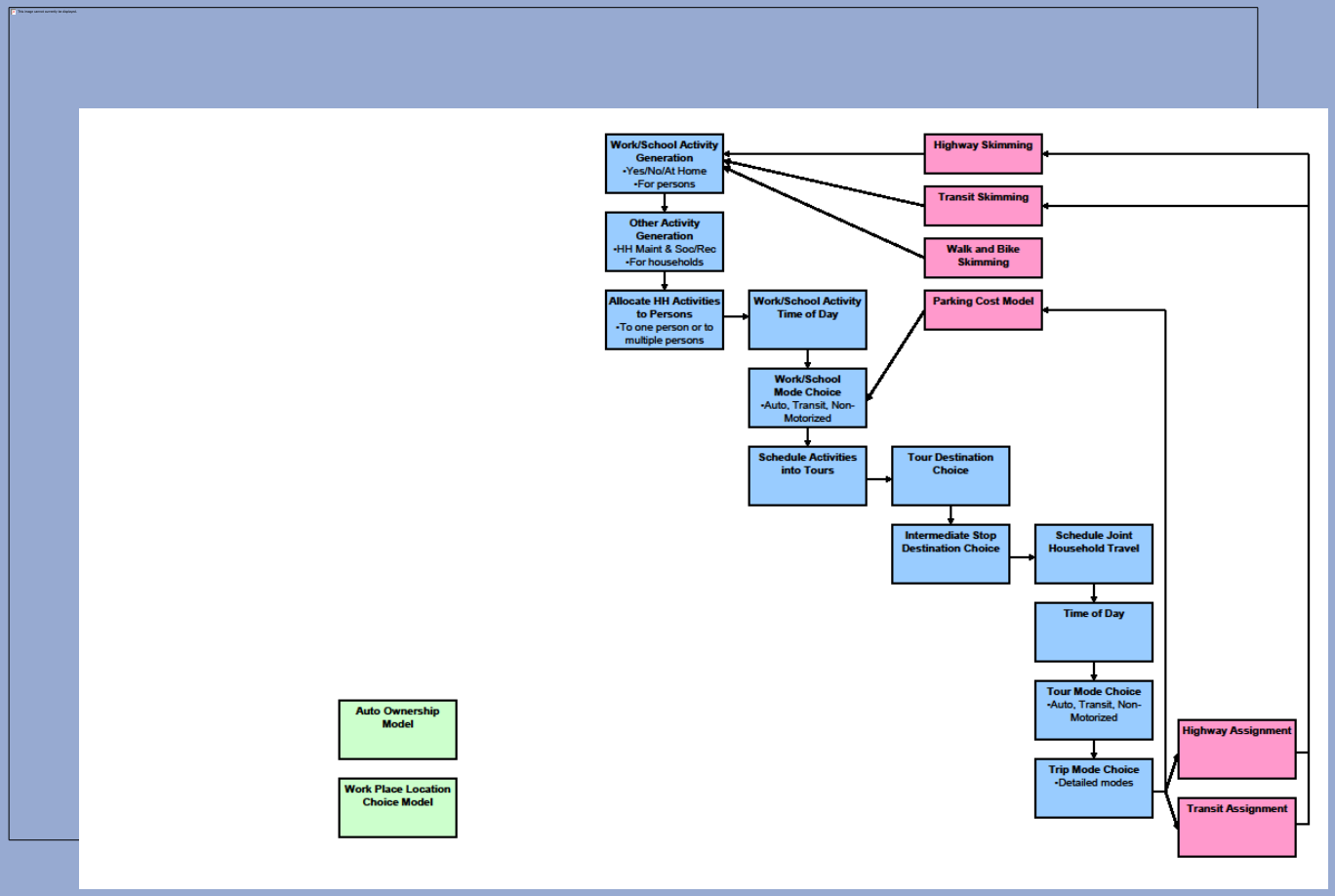
Vision Phase thoughts

- We weren't sure how far to take this dialogue (we were kind of new at it)
- Talk through customers' policy needs
- Figure out how to explain this stuff in plain English
- My opinion – disaggregate ABMs are much better for almost any kind of challenging analysis

Lots of box-arrow diagrams



Lots of box-arrow diagrams



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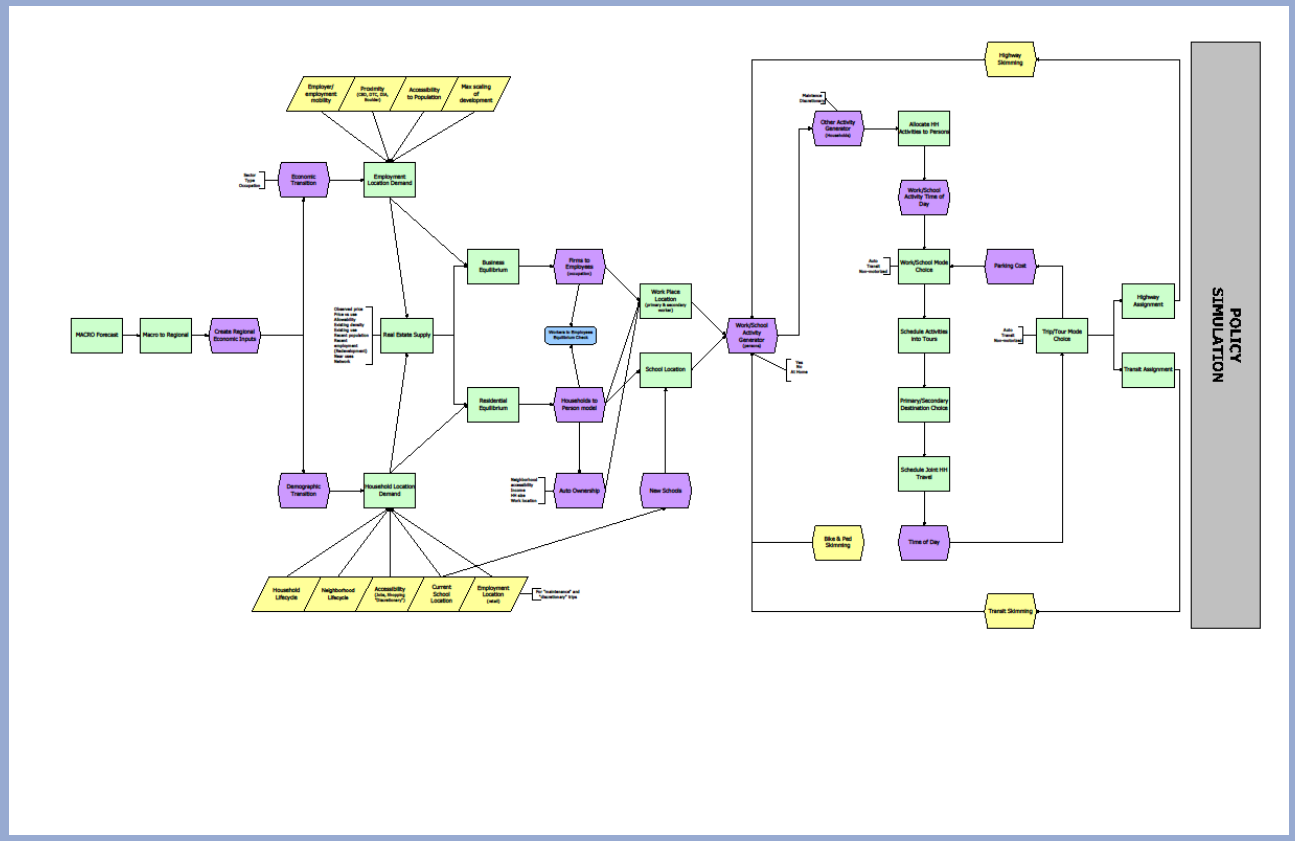

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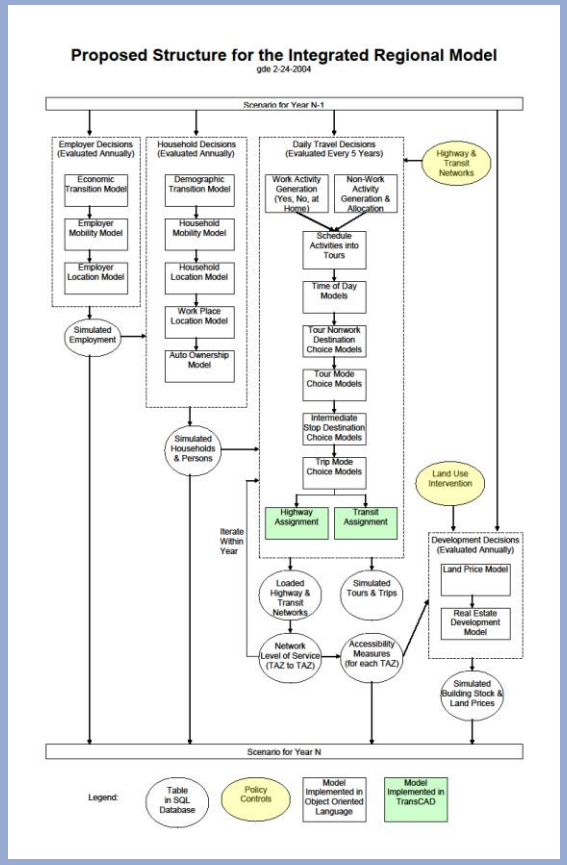
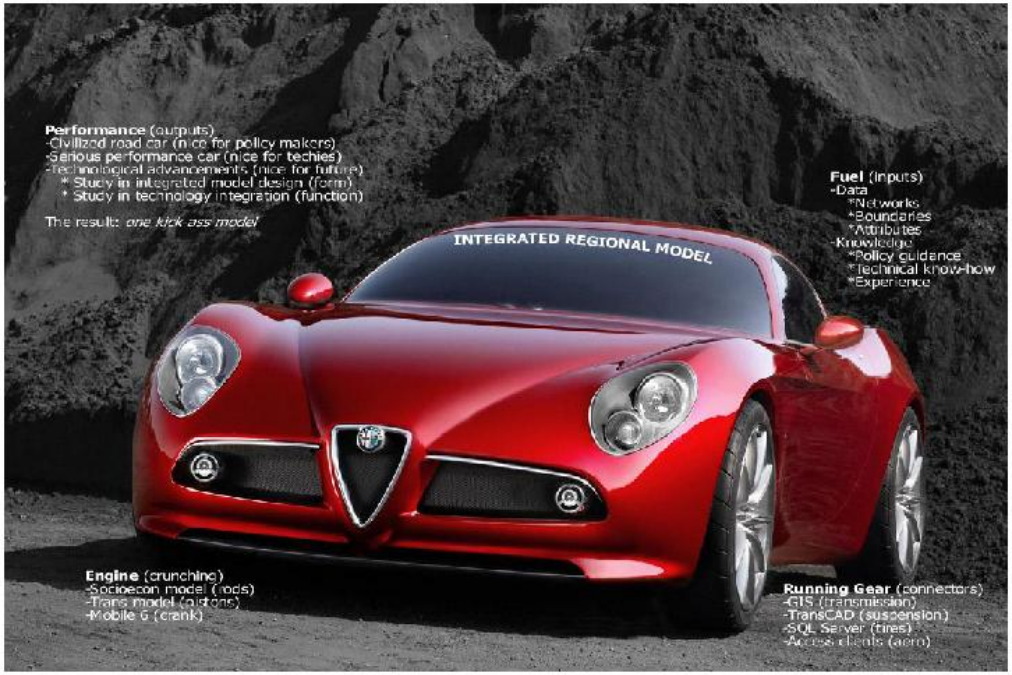


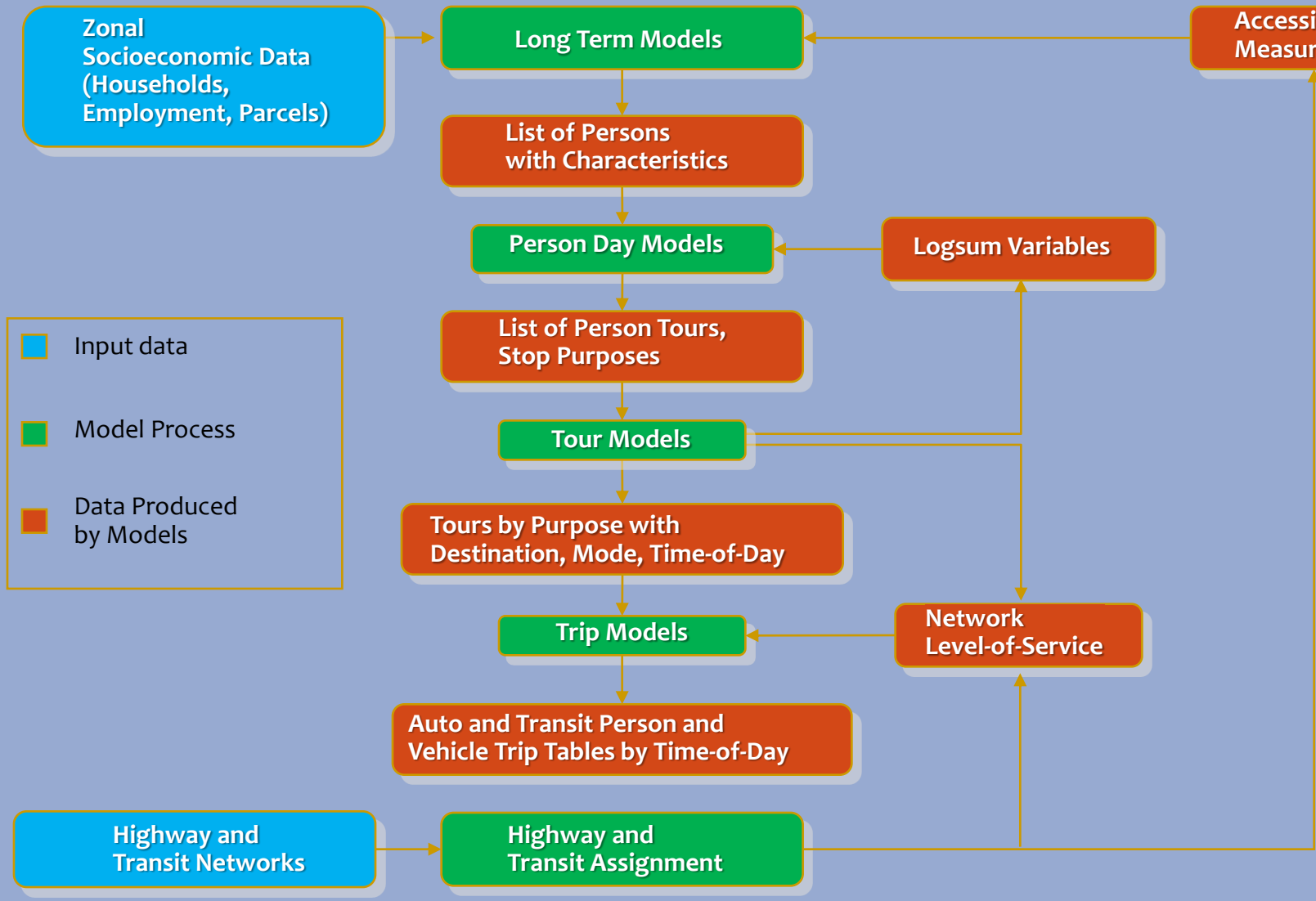
And a more creative depiction



DRCOG's Focus Model

- Based on daily activity pattern approach, originally conceived by Bowman/Ben-Akiva (and evolving/branching in the past 15-20 years)
- Similar to Sacramento model developed circa 2005

Focus Model Structure



Focus Model Components

1. **Population Synthesizer**
   - Network Skims
   - Aggregate Mode/Destination Choice Logsum Generator
   - Mode Choice Logsum Generator
2. **Regular Workplace Location Choice**
3. **Regular School Location Choice**
4. **Auto Availability**
   - Intermediate Stop Logsum Generator
5. **Daily Activity Pattern Choice**
   - Exact Number of Tours Choice
   - Work Tour Destination Type Choice Model
   - Work-Based Subtour Generation Choice
6. **Tour Primary Destination Choice**
7. **Tour Main Mode Choice**
8. **Tour Time of Day Choice**
9. **Intermediate Stop Generation Choice**
10. **Intermediate Stop Location Choice**
11. **Trip Mode Choice**
12. **Trip Departure Time Choice**
13. **Highway & Transit Assignment**

Modeling Activity Patterns

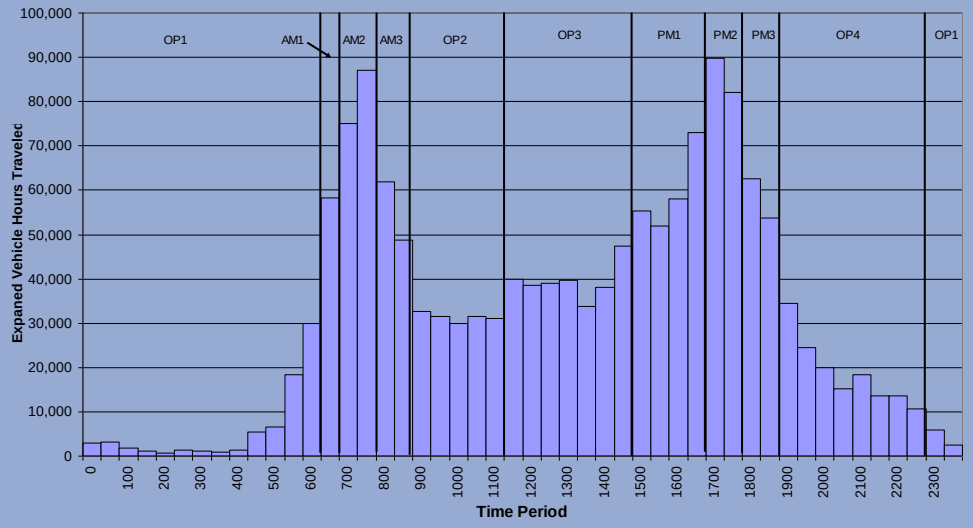
- **Daily activity pattern and exact number of tours models**
  - Variation on the Bowman and Ben-Akiva approach
  - Multinomial logit models
  - Eight person types
  - Predicts number of tours by purpose, and the occurrence of additional stops by purpose
  - Seven activity purposes (work, school, escort, eat meal, shopping, social/rec, personal business)

Modeling Activity Patterns in Focus

- **Intermediate stop frequency**
  - Predicts number of stops by purpose on each tour
  - Multinomial logit model
- **Subtour frequency**
  - Predicts number of work-based subtours by purpose
  - Multinomial logit model

Focus Time of Day Models

- **Hour level resolution**
- **Tour time-of-day**
  - Predicts start and end of tour primary activity
  - Higher priority tours run first, block out times of day not available to lower priority tours
- **Trip time-of-day**
  - Predicts departure time from each stop
  - In-transit time known, so serves as departure time and duration model

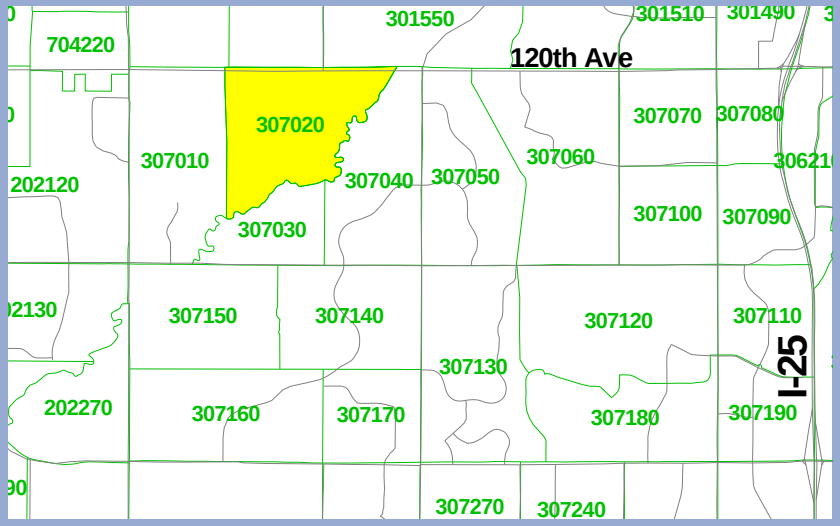


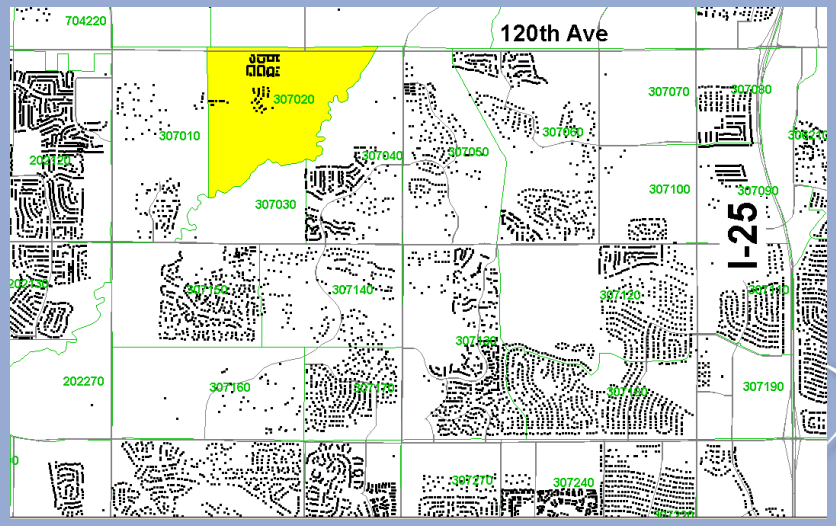
Key Functional Aspects of Focus

- Estimated on the 1996/7 data, calibrated against 2005 aggregate observations (traffic counts, transit ridership, etc.), back-validated against 1997 aggregate observations
- All trips in tours, including work-based subtours

Location Choices in Focus

- **Point-based land use**
- **Location choices conducted at the TAZ level, with Monte Carlo simulation to select point locations inside the TAZ**





Mode Choice Modeling in Focus

- **Eight modes**
  - Transit-walk, transit-auto, drive alone, shared ride 2, shared ride 3+, walk, bike, school bus
- **Bike/walk modeling**
  - Point-based land use crucial to permitting this capability
  - No bike/ped networks or assignment as yet (exploring feasibility of building such networks)

Component Integration in Focus

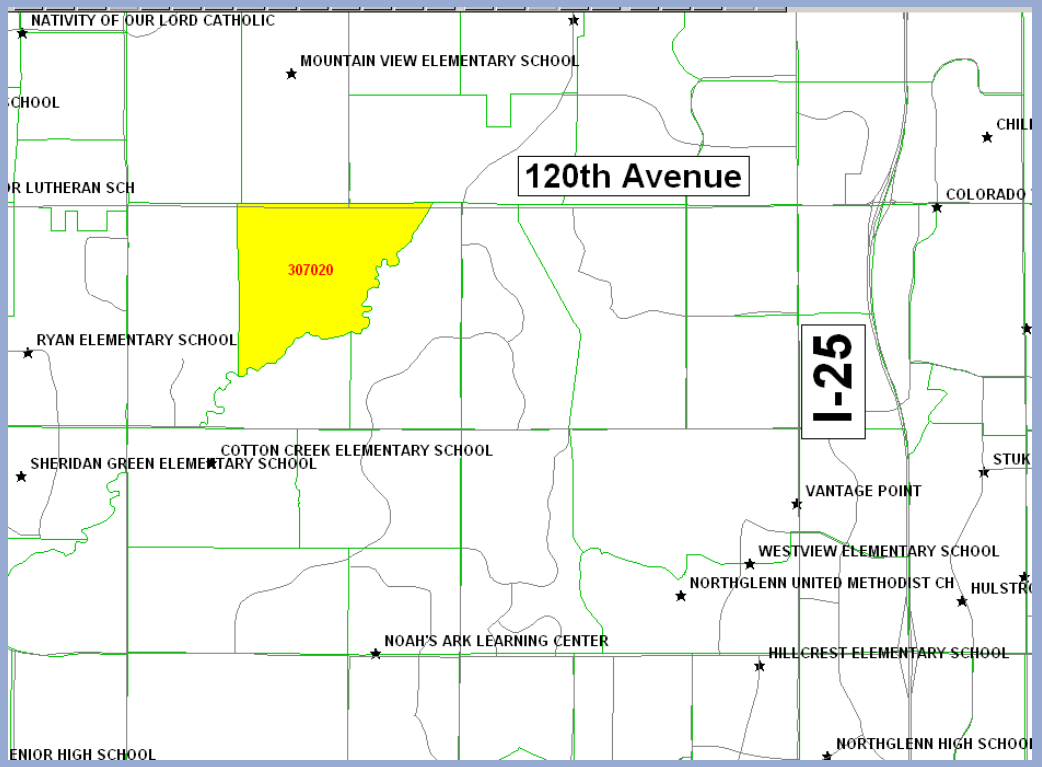
- **Logsums of various types used for accessibility variables "upstream" of the tour mode choice model**
- **Generalized cost variables used downstream of tour mode choice**
  - Structure from tour mode choice utility
  - Improves sensitivity consistency of model

Key Functional Aspects of Focus

- **Presently using PopSyn for synthetic population (Bowman and Sun), generously donated by Atlanta Regional Commission**
- **IE/EI/EE/airport/commercial vehicle trips are all still handled by the trip-based model**
  - The whole old trip-based model runs inside the tour-based model

Tricky Variables to Create for Future Years

- **Intersection density**
- **Locations of all schools (preschool, k-8, high school, university)**



How did we build it?

- **Roughly 50% DRCOG, 50% consultant**
- **Estimation data**
  - DRCOG did all initial data development

Estimation data development

Team Member Assigned	Status Not Started	In Process	Done	Parsons Check if Complete	
					Development and Transportation Geography
Jeremy			x		x/y point for each household, for all households in the region.
Jeremy			x		x/y point for each job, for all jobs in the region.
Shahida			x		x/y point for each local/limited stop
Shahida			x		x/y point for each express/regional stop
Shahida			x		x/y point for each rail stop
					Transit Access
Shahida			x		Number of local/limited bus stops in each TAZ.
Shahida			x		Number of express/regional bus stops in each TAZ
Shahida			x		Number of rail stops in each TAZ
Josh			x		Distance from each household x/y point to nearest local/limited stop, all points in our region
Josh			x		Distance from each household x/y point to nearest express/regional stop, all points in our re
Josh			x		Distance from each household x/y point to nearest rail stop, all points in our regional data
Josh			x		Distance from each job x/y point to nearest local/limited stop, all points in our regional data
Josh			x		Distance from each job x/y point to nearest express/regional stop, all points in our regional d
Josh			x		Distance from each job x/y point to nearest rail stop, all points in our regional data
Josh			x		Distance from each TBI x/y place point to nearest local/limited stop, all TBI places
Josh			x		Distance from each TBI x/y place point to nearest express/regional stop, all TBI places
Josh			x		Distance from each TBI x/y place point to nearest rail stop, all TBI places
					Parking
Shannon			x		Raw number long-term paid spaces in each TAZ. Method: all lot spaces.
Shannon			x		indoor spaces (in buildings, etc.)
Shannon			x		outdoor spaces (surface lots.)
Shannon			x		Raw average daily cost for paid spaces in each TAZ. Method: from our data, but we really d
Shannon			x		Raw number of Monthly paid spaces in each TAZ. Method: from out data.
Shannon			x		Raw average daily cost for monthly paid spaces in each TAZ.
Shannon			x		Raw number of daily/hourly rate paid spaces in each TAZ. Method: from out data.
Shannon			x		Raw average daily cost for daily/hourly paid spaces in each TAZ. Method: from data.

With some side-trips

TRANSIT PATH-BUILDING: "TO MULTIPATH OR NOT TO MULTIPATH"

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November 15, 2007

Word Count:

Text:	4,371
Tables (3):	750
Figures (8):	2,000
Total	7,121

How did we build it?

- **Roughly 50% DRCOG, 50% consultant**
- **Estimation data**
  - DRCOG did all initial data development
  - Consultant team formatted for Alogit input

Formatted for Alogit

Data Dictionary

```
SAMPLENU  'Household ID #'/
PERSON    'Person # within HH'/
MODELEXP  'Expansion Factor'/
PERSTYPE  'Person type'
GEND      'Gender'/
AGE       'Age  (years)'/
TRIPS     '# trips in person-day'/
DRLIC     'Driver's license status'/
TRPASS    'Transit Pass type'/
EMPSTAT   'Employment status'/
STUSTAT   'Student status'/
STUGRADE  'Grade of enrollment'/
PEOPLE    '# People in HH'/
VISITORS  '# Visitors at HH'/
VEHICLES  '# Vehicles at HH'/
HHINC     'Income Range'/
HOUSTYPE  'Housing Type'/
SAMPTYPE  'Survey Sample Type'/
INPERSON  'Provided own data?'/
USEDIARY  'Recorded travel on diary?'
HHFTW     'Household (inc. visitors) # full time workers'/
HHPTW     'Household (inc. visitors) # part time workers'/
HHNWA     'Household (inc. visitors) # non-working adults under 65'/
HHRET     'Household (inc. visitors) # non-workers adults over 65'/
HHUNI     'Household (inc. visitors) # university students'/
HHDAS     'Household (inc. visitors) # driving age high-school students'/
HH515     'Household (inc. visitors) # children age 5-15'/
HHCU5     'Household (inc. visitors) # children age 0-4'/
HAREATYP  'Residence area type'/
HTAZ2006  'Residence TAZ# in 2006 system'/
HXCOORD   'Residence X coordinate'/
HYCOORD   'Residence Y coordinate'/
WAREATYP  'Usual workplace area type'/
WTAZ2006  'Usual workplace TAZ# in 2006 system'/
WXCOORD   'Usual workplace X coordinate'/
WYCOORD   'Usual workplace Y coordinate'/
SAREATYP  'Usual school location area type'/
STAZ2006  'Usual school taz # in 2006 system'/
SXCOORD   'Usual school coordinate'/
SYCOORD   'Usual school Y coordinate'/
HBTOURS   '# home-based tours made'/
WBTOURS   '# work-based subtours made'/
TRIPS     '#trips made'/
FACTLOC   'location type of days first activity'/
LACTLOC   'location type of days last activity'/
WRKTOURS  '# of work tours'/
SCHTOURS  '# of school tours'/
ESCTOURS  '# of serve passenger tours'/
PRBTOURS  '# of personal business tours'/
SHPTOURS  '# of shopping tours'/
MEATOURS  '# of meal tours'/
RECTOURS  '# of social/recreation tours'/
WRKSTOPS  '# of work stops'/
SCHSTOPS  '# of school stops'/
ESCSTOPS  '# of serve passenger stops'/
PRBSTOPS  '# of personal business stops'/
SHPSTOPS  '# of shopping stops'/
MEASTOPS  '# of meal stops'/
RECSTOPS  '# of social/recreation stops'/
```

Consultants led model design

Figure 1.1. Model Process Flow Chart

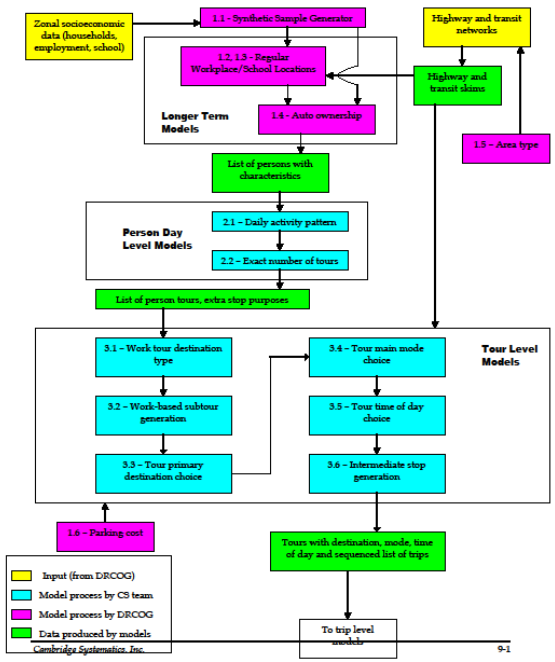
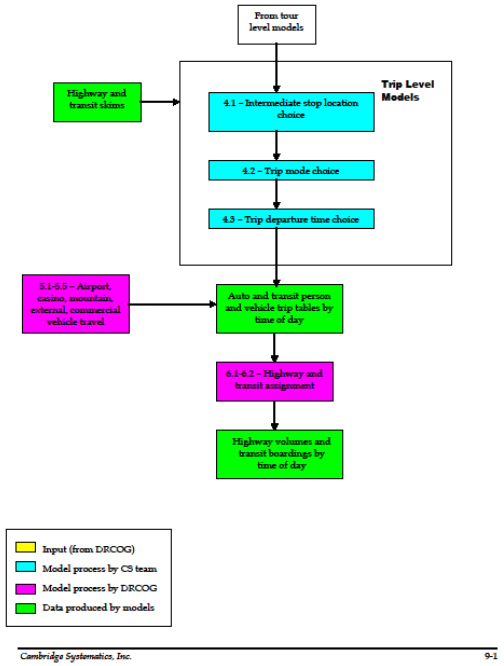


Figure 1.1. Model Process Flow Chart (continued)



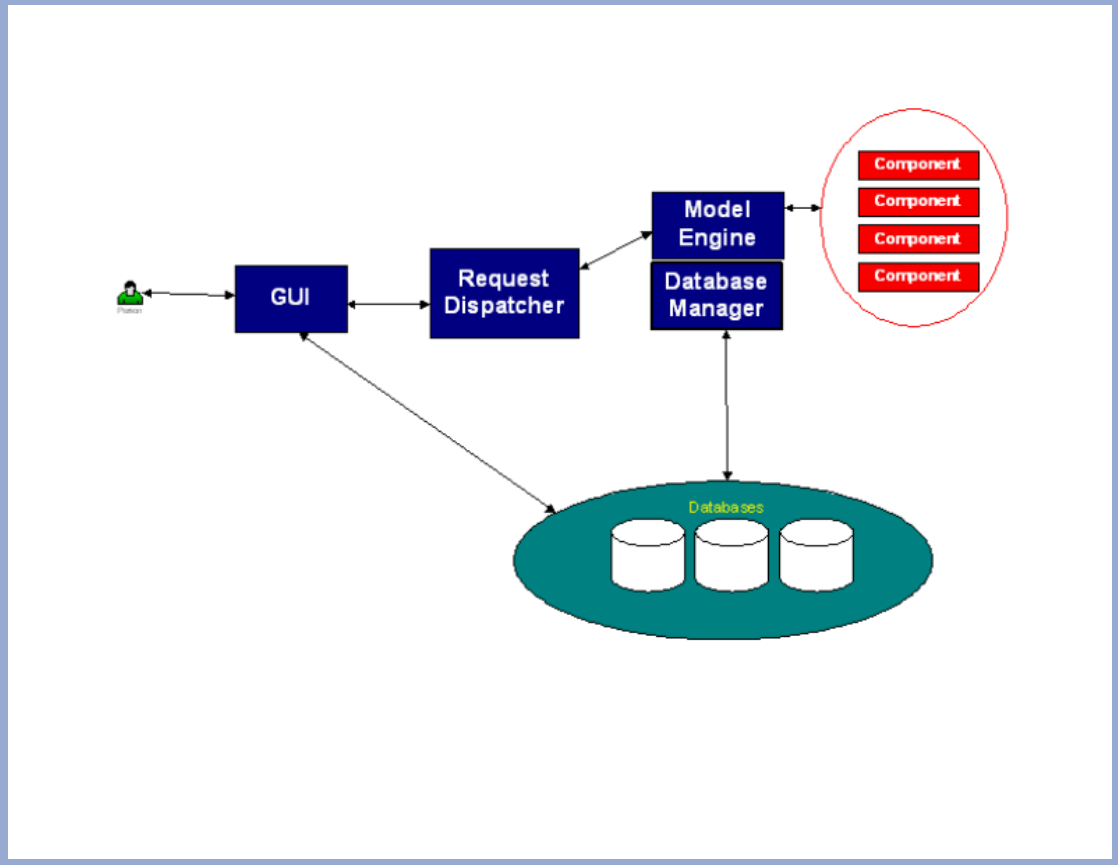
How did we build it?

- **Roughly 50% DRCOG, 50% consultant**
- **Estimation data**
  - DRCOG did all initial data development
  - Consultant team formatted for Alogit input
- **DRCOG estimated workplace and school location, auto availability**
- **Consultant team estimated all other components**

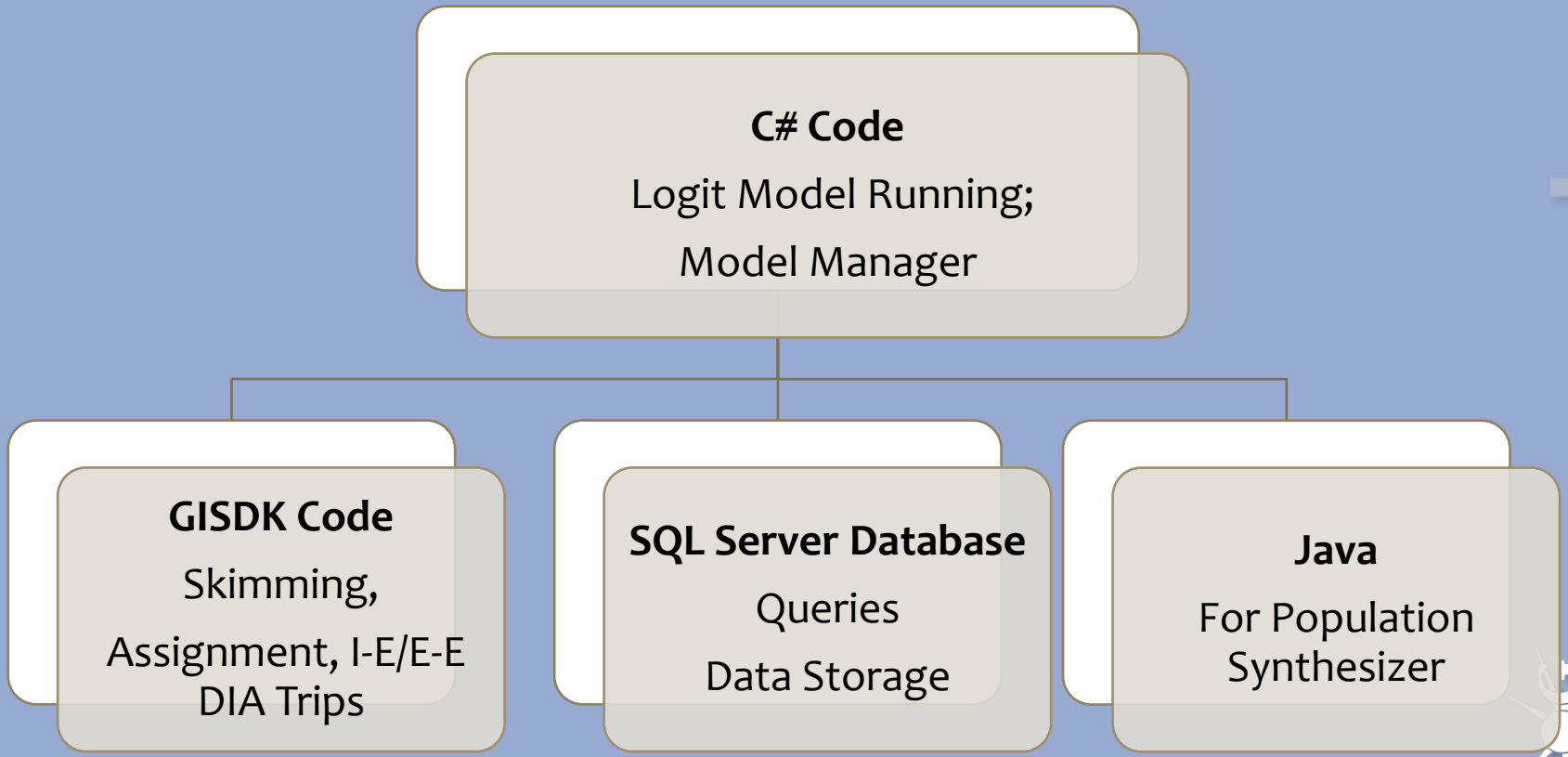
How did we build it?

- **DRCOG did 80% of software**
  - Final development steps were a consultant/DRCOG team effort – worked great!
  - Consultant SW specialists critical at the end
- **Contract structure – consultants responsible for final delivery of some components**
  - DRCOG responsible for others

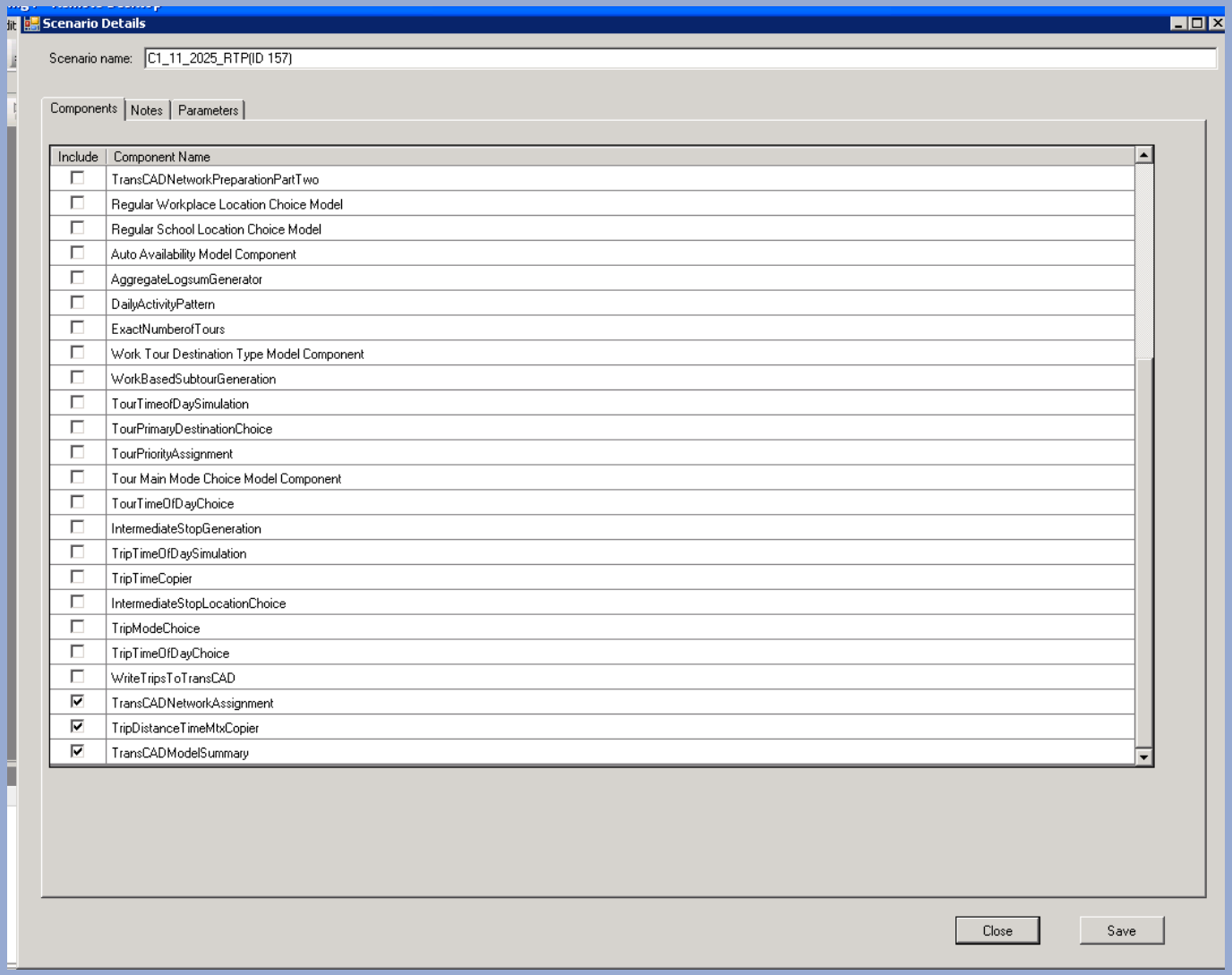
Software architecture



Code Types used in Model



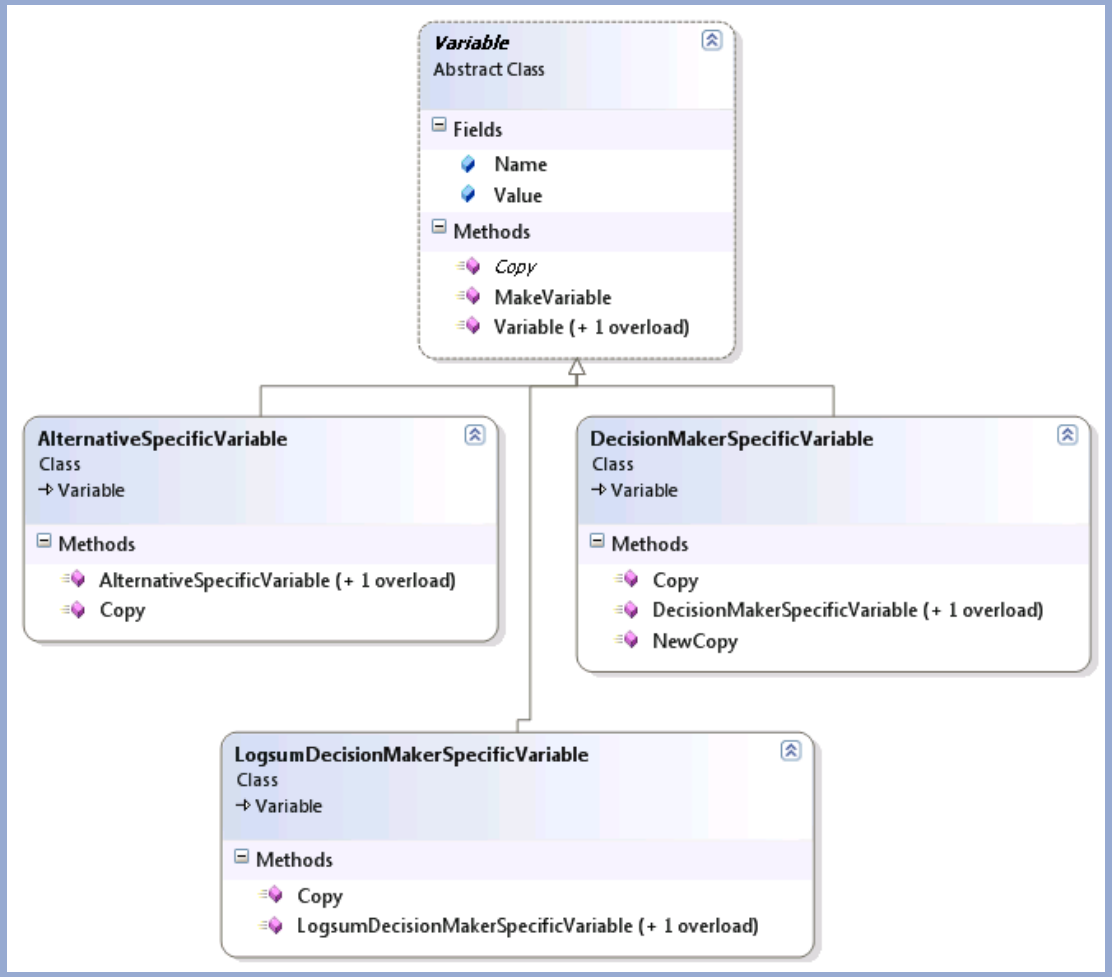
A bit of the user interface



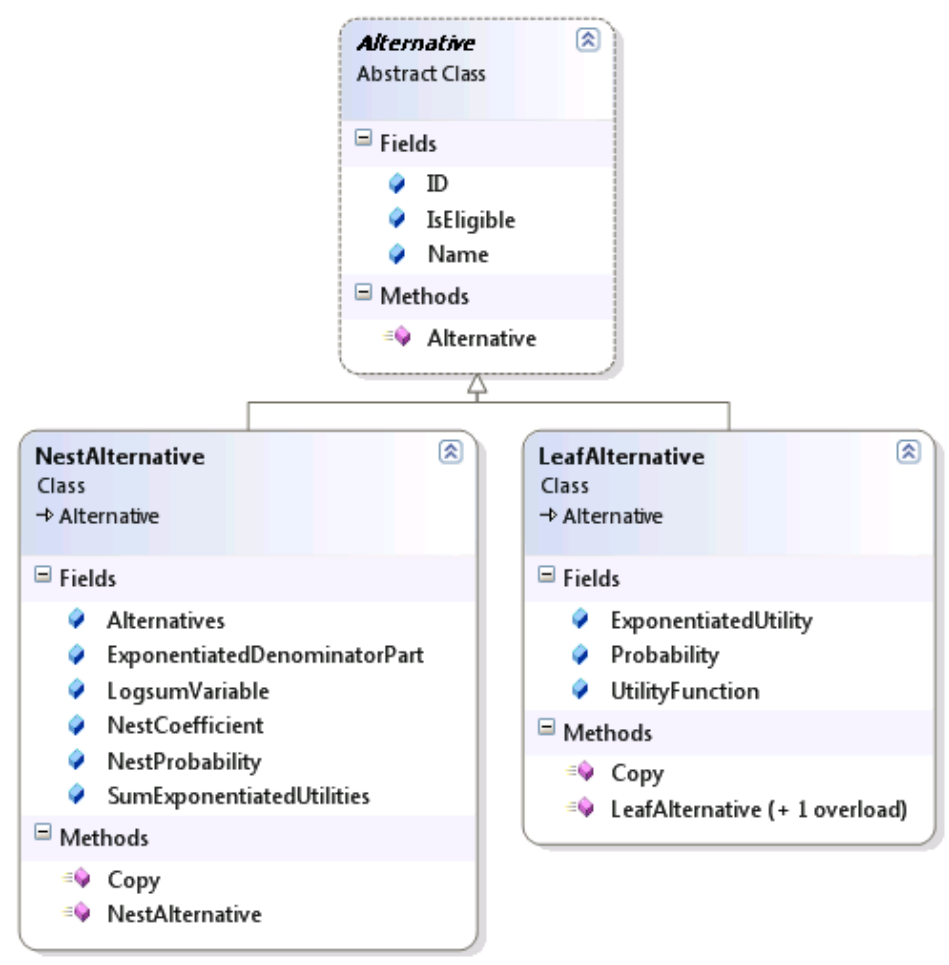
Standard Choice Component Elements

- PrepareModel()
- ReadData()
- Run()
- WriteData()

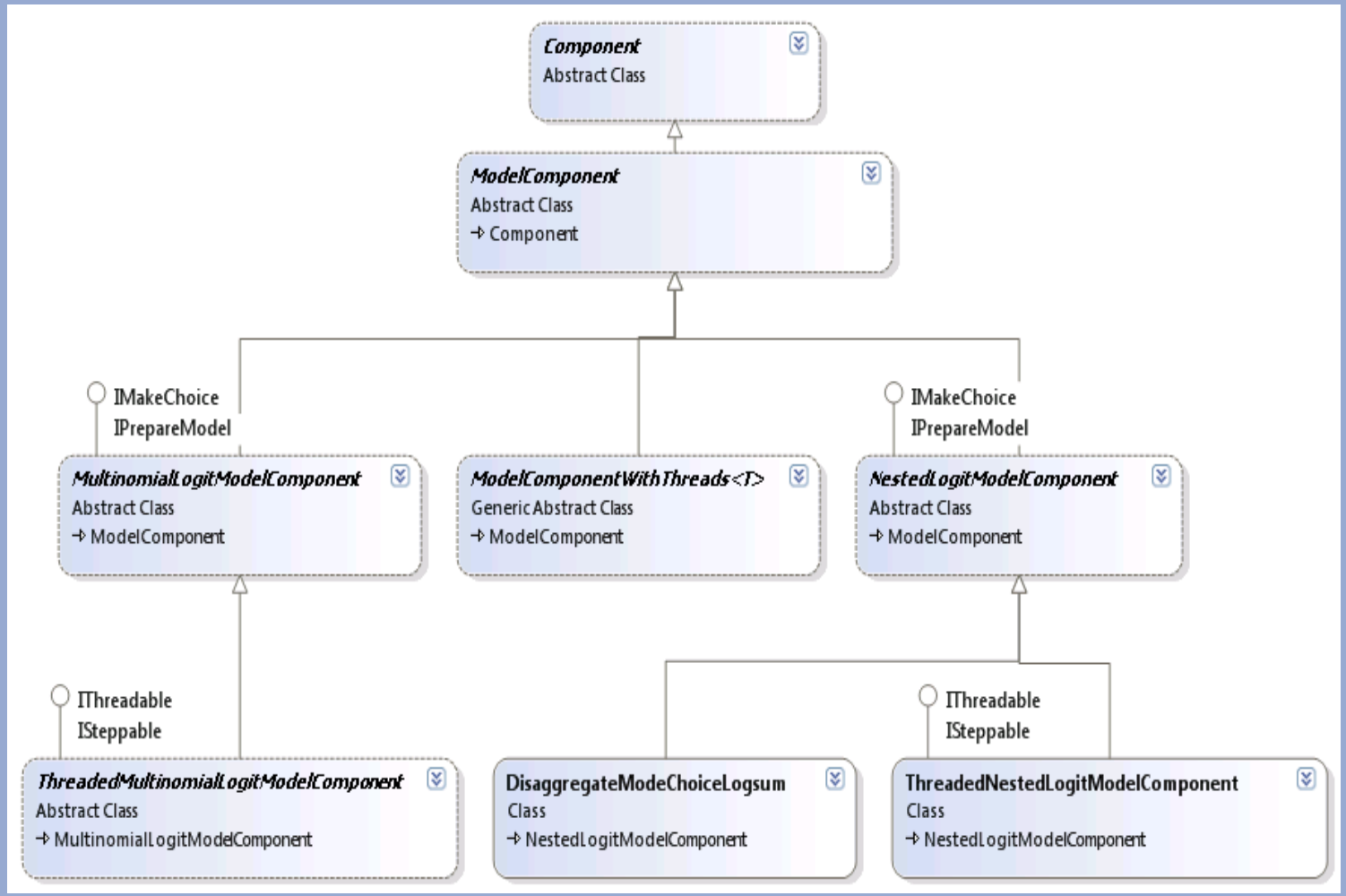
Classes and subclasses



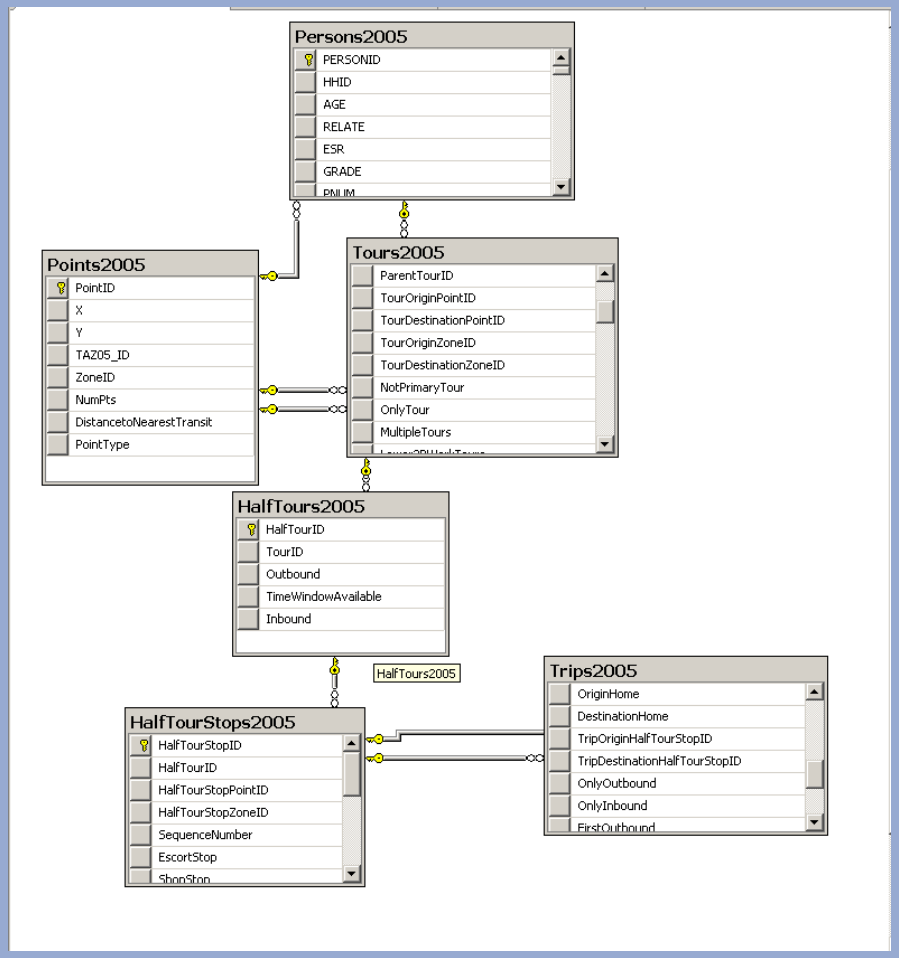
More classes and subclasses



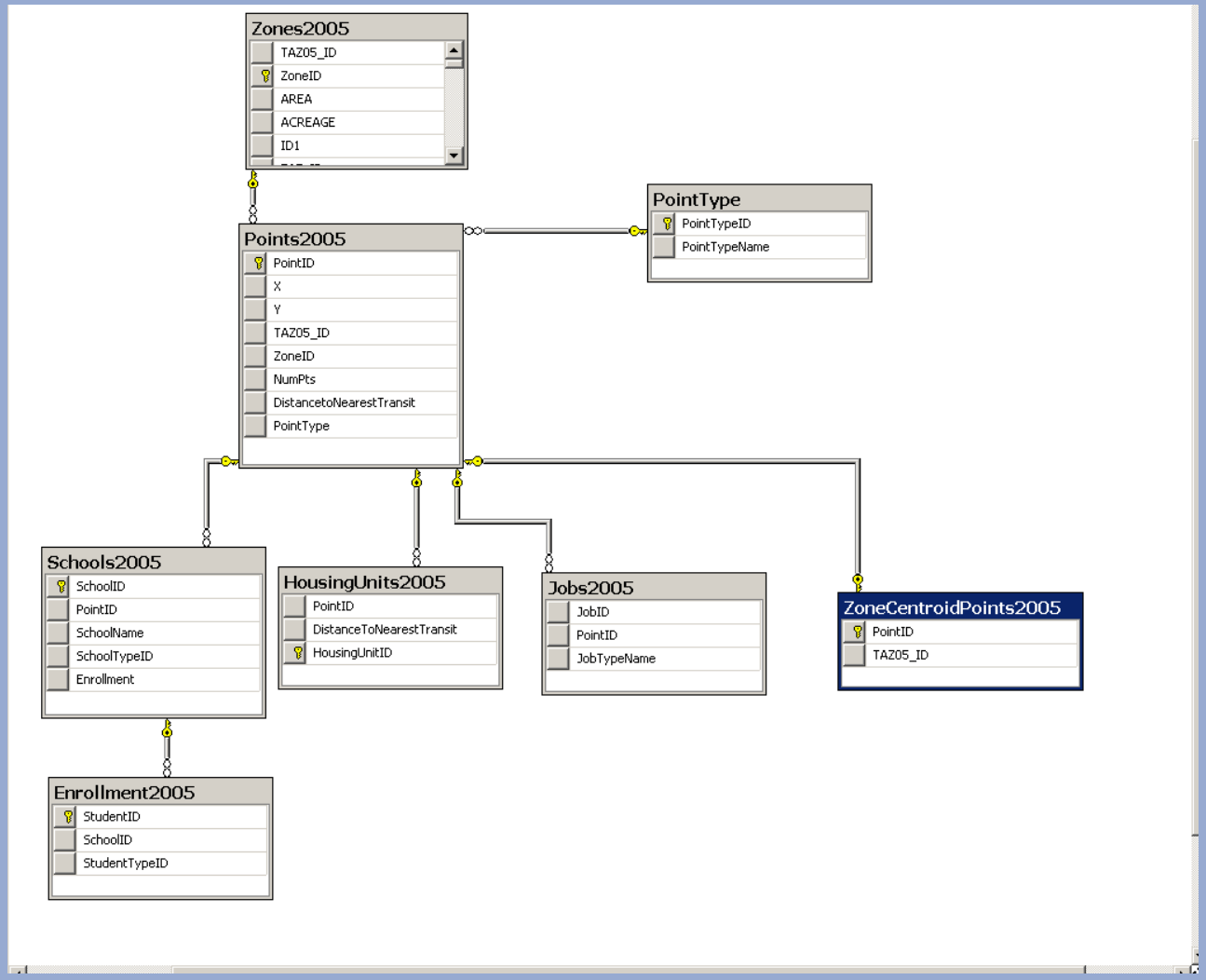
Even more classes and subclasses



Persons, Trips, and Tours



Built environment data



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  - Final development steps were a consultant/DRCOG team effort – worked great!
  - Consultant SW specialists critical at the end
- **Contract structure – consultants responsible for final delivery of some components**
  - DRCOG responsible for others
- **DRCOG did essentially all calibration/validation work**

Calibration

- So far, aggregate results similar to trip-based model
- Initial calibration, 2010
- Updated in 2011
- More updating through Colfax AA / FTA project (on-going)
- VBA-enabled spreadsheet queries output database

TransCAD elements

- **Networks/skimming/assignment**
- **trip generation/distribution/time of day for:**
  - Commercial
  - Airport (uses entire trip-based model)

Model Development Questions?

DRCOG

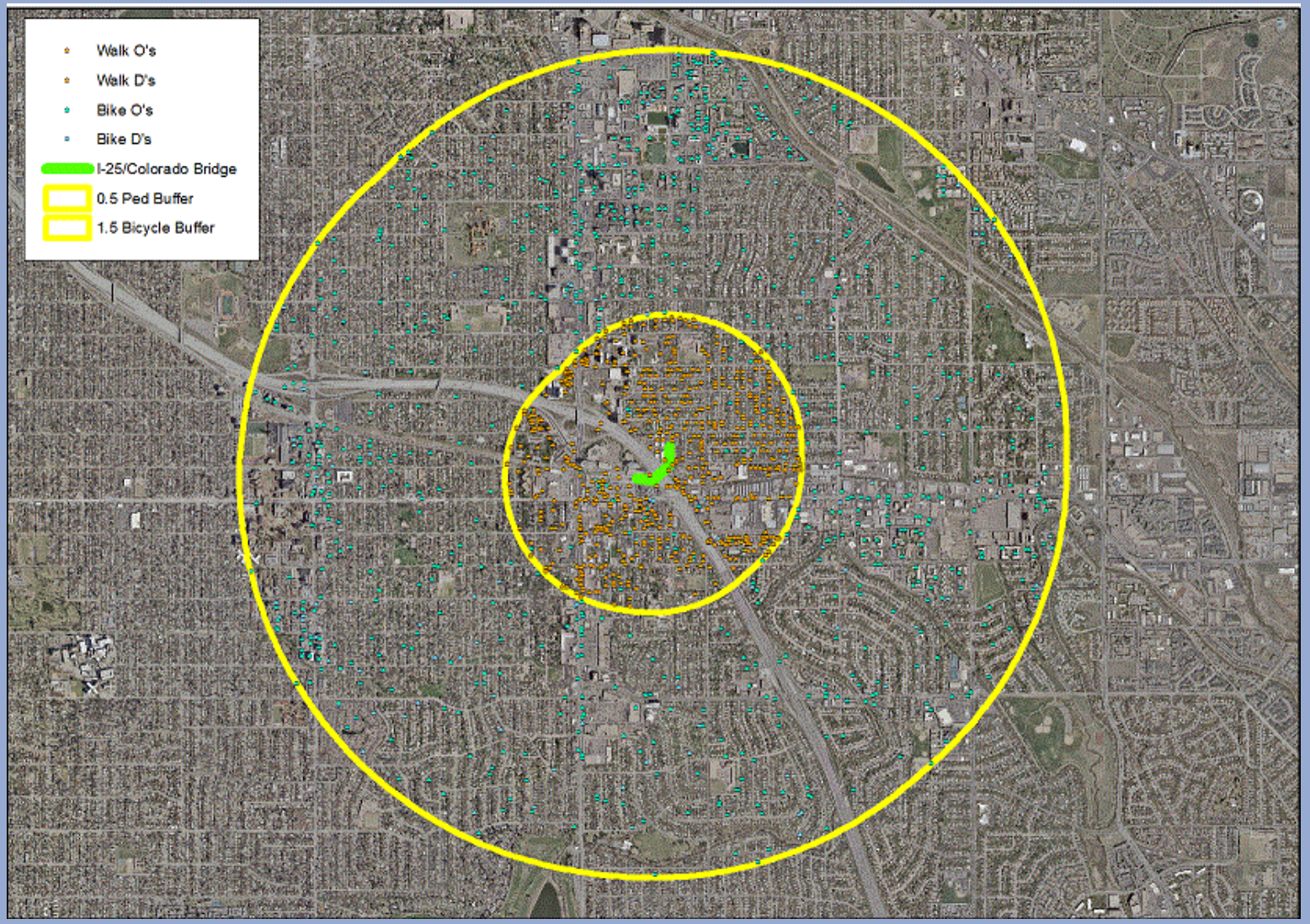
DENVER REGIONAL COUNCIL OF GOVERNMENTS

We make life better!

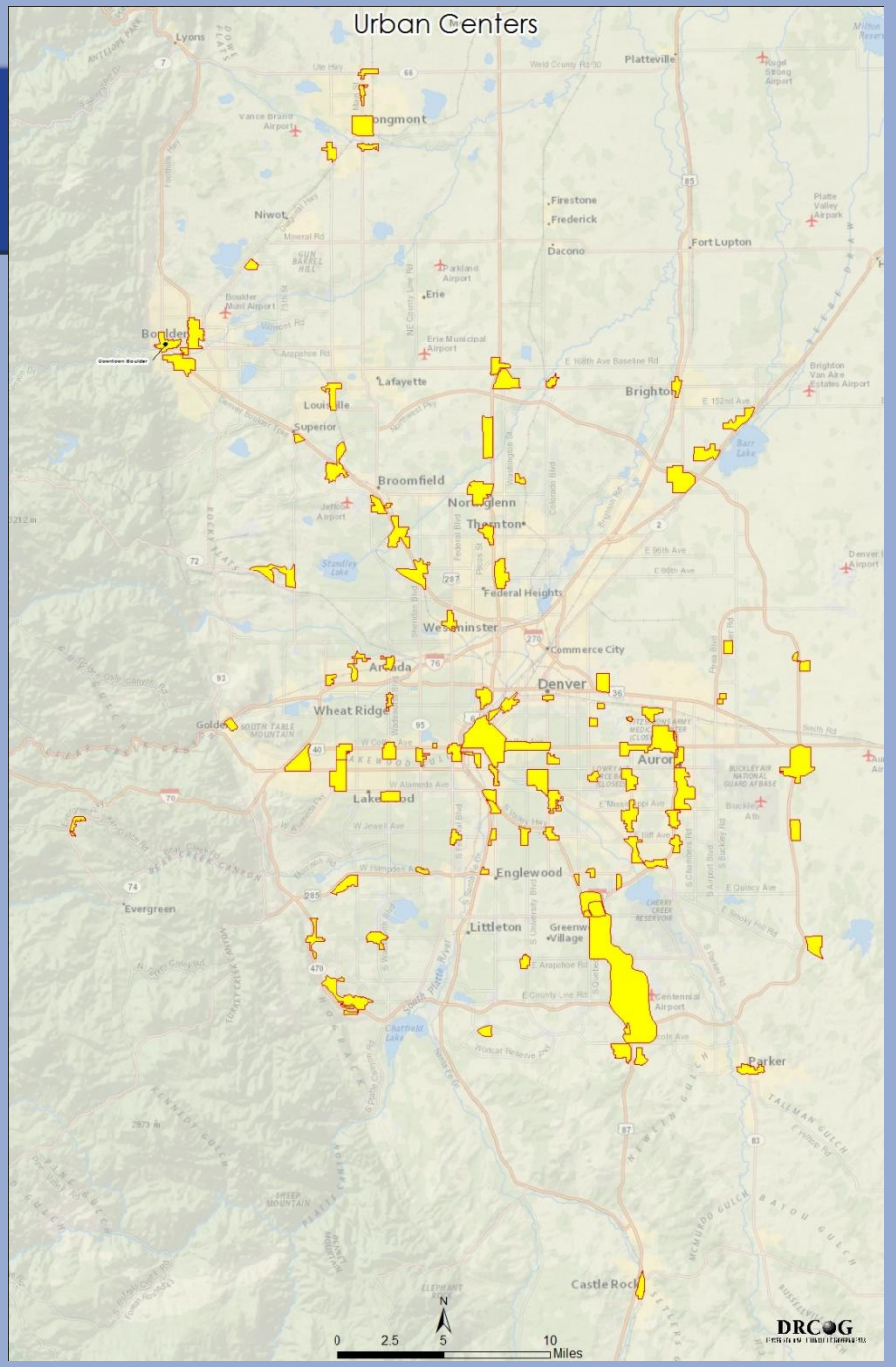
Bike/Ped Project Selection

- **TIP project selection**
- **Trip origin/destination density around the project**
- **Statistics of the trips**
  - Number of bike trips
  - Number of pedestrian trips
  - Average bike trip length
  - Average walk trip length
  - Etc.

Bike and Ped Trip Os and Ds



Urban Centers



Jobs in Urban Centers

UrbanCenterName	2010	2015
All Urban Centers	**510,738**	**588,384**
Ralston Fields	919	876
Olde Town/New Town	1,904	1,970
Candelas	76	493
Iliff Avenue Center	5,137	7,084
Aurora City Center	10,464	11,686
Florida	2,218	2,272
Iliff	2,193	2,292
13th Avenue	2,709	2,871
Peoria - Smith	1,649	2,429
Smoky Hill	814	985
I-225/Parker Road	2,188	2,770
Buckingham Center	2,103	2,141
1st Avenue Center	1,070	1,218
Hampden Town Center	615	769
E-470 / I-70	63	256
Fitzsimons	15,122	17,985
Colfax Avenue	1,550	1,900
Jewell Avenue	14	217
Airport Gateway	10	147
56th Avenue		5
28th/30th Streets (BVRC)	11,179	11,276
University Hill	8,518	8,749
Downtown Boulder	14,235	14,232
Gunbarrel Activity Center	2,548	2,552
I-25 Corridor	100,226	119,153
Original Broomfield TOD	48	53
Interlocken Loop Activity Center	6,330	8,033
I-25 & SH 7 Activity Center	70	891
Urban Transit Village	61	944
Alameda Station	3,389	3,874
62nd and Pena TOD		11
29th Ave. Town Center	339	481
Bear Valley	1,073	1,192
Broadway Station TOD	1,015	1,835
Colorado Blvd Health Care Dist	9,400	9,428
Denver Technology Center	15,703	18,781
Federal and Evans	1,617	1,338
Pena & 40th	3	44
Southmoor Park TOD	408	342
Central Park TOD	264	365
Tamarac & Hampden	1,753	1,688
St. Anthony's Urban Center	1,487	1,554
DU Campus Urban Center	4,237	4,507
38th and Blake TOD	1,862	2,714
Colorado Station	6,237	6,486

Urban center travel statistics

urban_cente	urban_center_name	Avg UC HH VMT	Avg UC VMT per Person	Avg UC TotalVMT per worker(emp)
0	Outside Urban Centers	49.2	19.4	27.3
1	Original Broomfield TOD	51.9	19.3	24.3
2	Interlocken Loop Activity Center	49.0	21.3	27.0
3	I-25 & SH 7 Activity Center	74.3	25.3	20.3
4	Adams Crossing Activity Center	71.4	24.1	29.3
5	Prairie Center Activity Center	65.6	22.3	28.4
6	Bromley Park Activity Center	70.0	21.4	33.1
7	S Westminster Activity Center	35.6	12.7	25.4
8	Westminster Ctr Activity Ctr	39.4	15.2	24.3
9	West 120th Ave Activity Ctr	39.5	16.4	24.5
10	Westminster Promenade Act Ctr	48.6	19.4	25.8
11	North I-25 Activity Center	65.8	23.8	43.2
12	Downtown Brighton Activity Ctr	43.0	13.5	28.5
13	Englewood City Center	25.2	12.1	25.1
14	Ralston Fields	37.6	16.5	26.8
15	Olde Town/New Town	29.8	13.7	24.6
16	Smoky Hill	59.5	27.9	31.8
17	I-225/Parker Road	32.1	15.0	24.6
18	Buckingham Center	27.9	13.9	21.7
19	1st Avenue Center	30.4	13.0	23.4
20	Hampden Town Center	30.1	14.0	20.8
21	E-470 / I-70	42.5	30.6	34.8
22	Iliff Avenue Center	34.1	14.9	23.7
23	Fitzsimons	31.0	11.0	25.5
24	Colfax Avenue	29.6	9.8	23.1
25	Jewell Avenue	32.1	32.1	39.8
27	56th Avenue	37.7	37.7	43.0
28	Aurora City Center	26.5	12.8	23.2
29	Urban Transit Village	48.3	21.2	23.7
30	Highlands Ranch Town Center	48.3	17.5	27.0
31	Lincoln Station TOD	53.6	17.1	29.3
32	Glendale City Center	22.3	13.1	23.7
33	C-470 Corridor	60.4	21.5	30.1
34	Fehringer Ranch	56.8	24.0	26.4
35	Bowles	63.7	23.3	29.2
36	Bergen Park	97.5	39.4	45.6
37	Southwest Plaza	59.7	19.8	26.5
38	Denver West/CO Mills Center	36.9	16.7	29.1
39	Lakewood Center	32.0	15.7	25.0
40	Union Center	21.9	21.7	27.1
41	RidgeGate City Center	40.1	14.3	25.4
42	Twin Peaks Activity Center	35.7	14.5	21.9
43	North Main Street AC	30.9	12.4	18.4

2010 Regional Transp. Plan

- Base year and three forecast years
- All standard outputs from GISDK
- Plus numerous outputs from SQL database
- Overall VMT similar to previous run of the trip-based model
- Ditto for transit ridership
- Is this right? Time will tell!

Colfax Avenue AA

- **Upgrade Focus – FTA consultation**
  - Acceptable for future New Starts analysis?
- **Use for detailed alternatives analysis**
  - Heavy commercial – retail development
  - Space constrained
  - High bus transit use
  - High non-motorized trip rates
  - Dense residential areas adjacent
- **First use by outside consultant**

Maintenance comments

- **Lost all key developers (except me)**
  - Still ran the model successfully! Yeah!
- **Consultants provided all Alogit code and estimation datasets**
- **We're in continuous update mode!**
- **Excel/VBA/SQL-Server model summary tool**
  - Easy way of monitoring runs in real time

Things I like about Focus

- **DaySim theoretical structure works well**
- **Rah-rah relational database**
- **Point-based land use is great**
  - Total geographic flexibility
  - Ties in naturally with UrbanSim
  - Great support of non-motorized modes
- **Use of COTS software going well**

Documentation

- Estimation report for all choice components (18 reports)
- Various aspects of the software (16 reports or so)
- Overview and users guide documents (half dozen or so)
- Database (half dozen or so)
- Comprehensive list of model variables
- All Alogit estimation code and datasets

Things I'd do differently

- Somewhat simpler database
- Somewhat simpler "plumbing"
- DRCOG estimate a few more models
- Form partnerships sooner

Related work

- **UrbanSim – first working draft in August, 2013**
- **DynusT – took delivery of version 1.0 this September**
  - Network geo-rectification complete
- **Pilot "complete networks" project**
- **Continuous Focus upgrades**
  - FTA acceptance modifications
  - Enhance price sensitivity
  - Run-time performance improvements

More resources can be found on the DRCOG website at:

http://www.drcog.org/index.cfm?page=FocusTechnicalResources