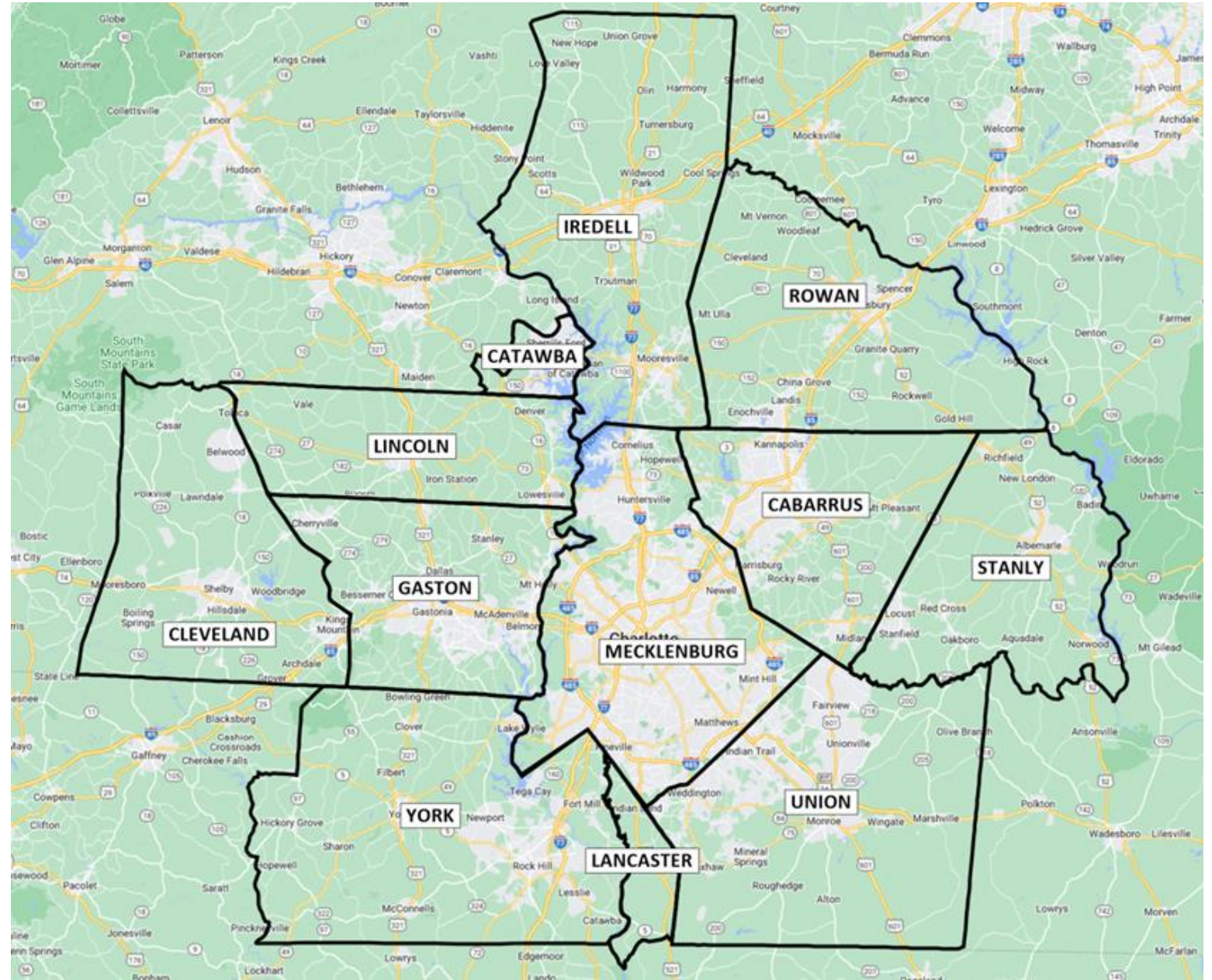# Metrolina Regional Simplified Tour-Based Model

Today's Presentation

- WHY MAKE THE CHANGE FROM A TRIP-BASED TO TOUR-BASED MODEL

- KEY ELEMENTS AND DIFFERENCES FROM TRADITIONAL FOUR-STEP MODEL

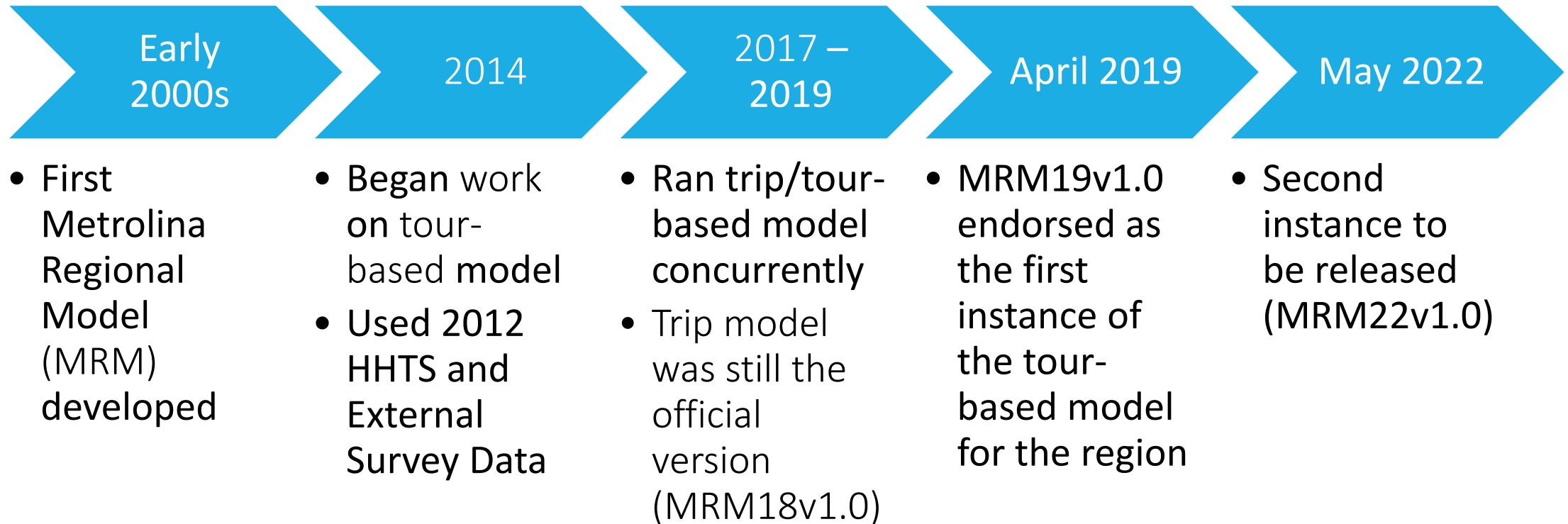- LESSONS LEARNED TO DATE

- NEXT STEPS

Metrolina Regional Model

- **12 Counties**
- **2 States**
- **4 MPOs**
- **2 RPOs**

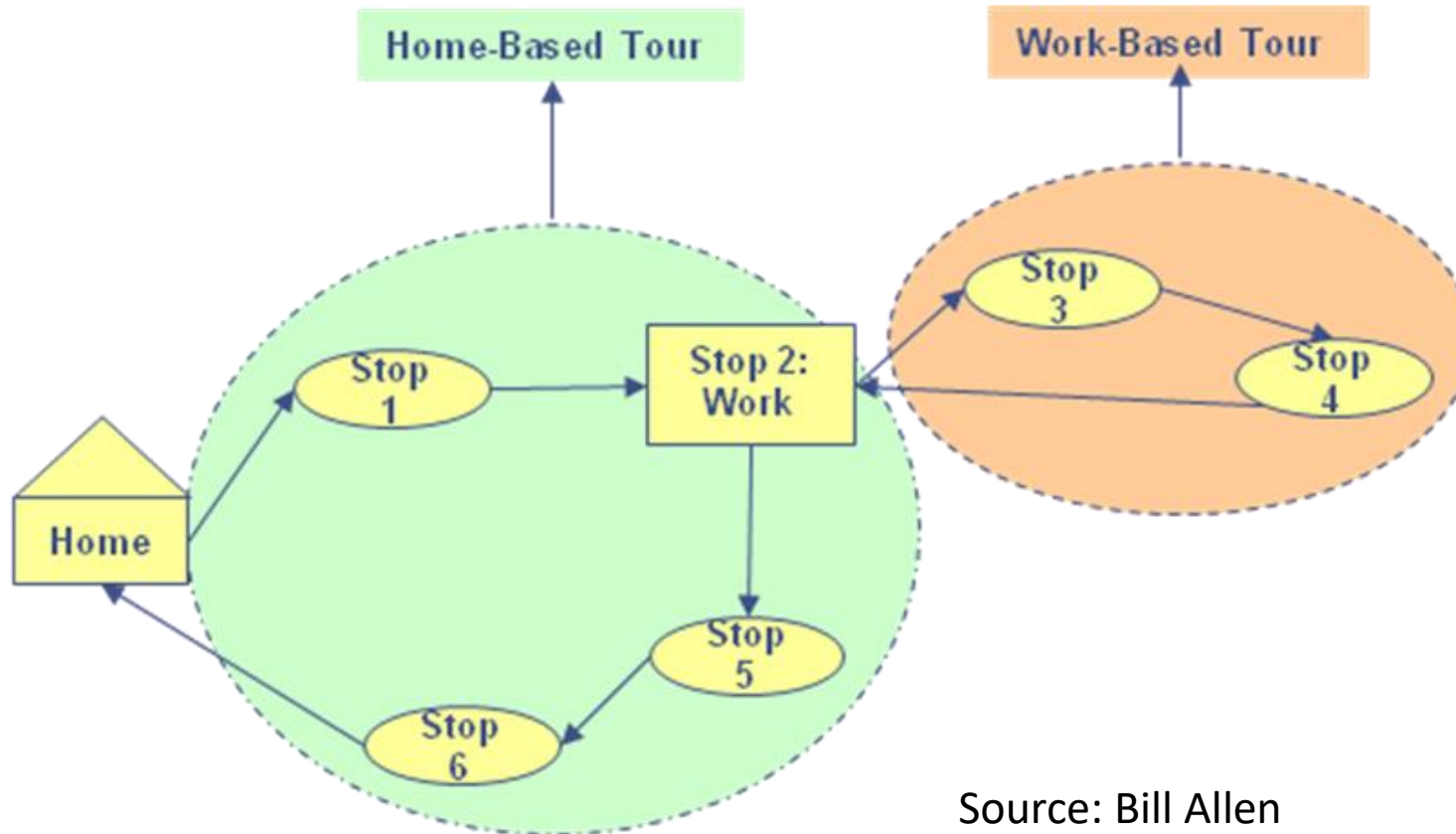# Why move to a tour-based model?

- Began post-2010 Census model update only as a trip-based model

- However…
  - Modeling team had concerns about parts of the model (fractions, NHB, etc)
  - Region was changing, with Charlotte becoming one of the fastest growing cities in the country
  - City staff interested in using model to inform difficult policy questions regarding growth

- Bill Allen
  - 75% of the benefit of ABM for 10% of development cost, run time

Simplified Tour-Based Model

Early 2000s
- First Metrolina Regional Model (MRM) developed

2014
- Began work on tour-based model
- Used 2012 HHTS and External Survey Data

2017 – 2019
- Ran trip/tour-based model concurrently
- Trip model was still the official version (MRM18v1.0)

April 2019
- MRM19v1.0 endorsed as the first instance of the tour-based model for the region

May 2022
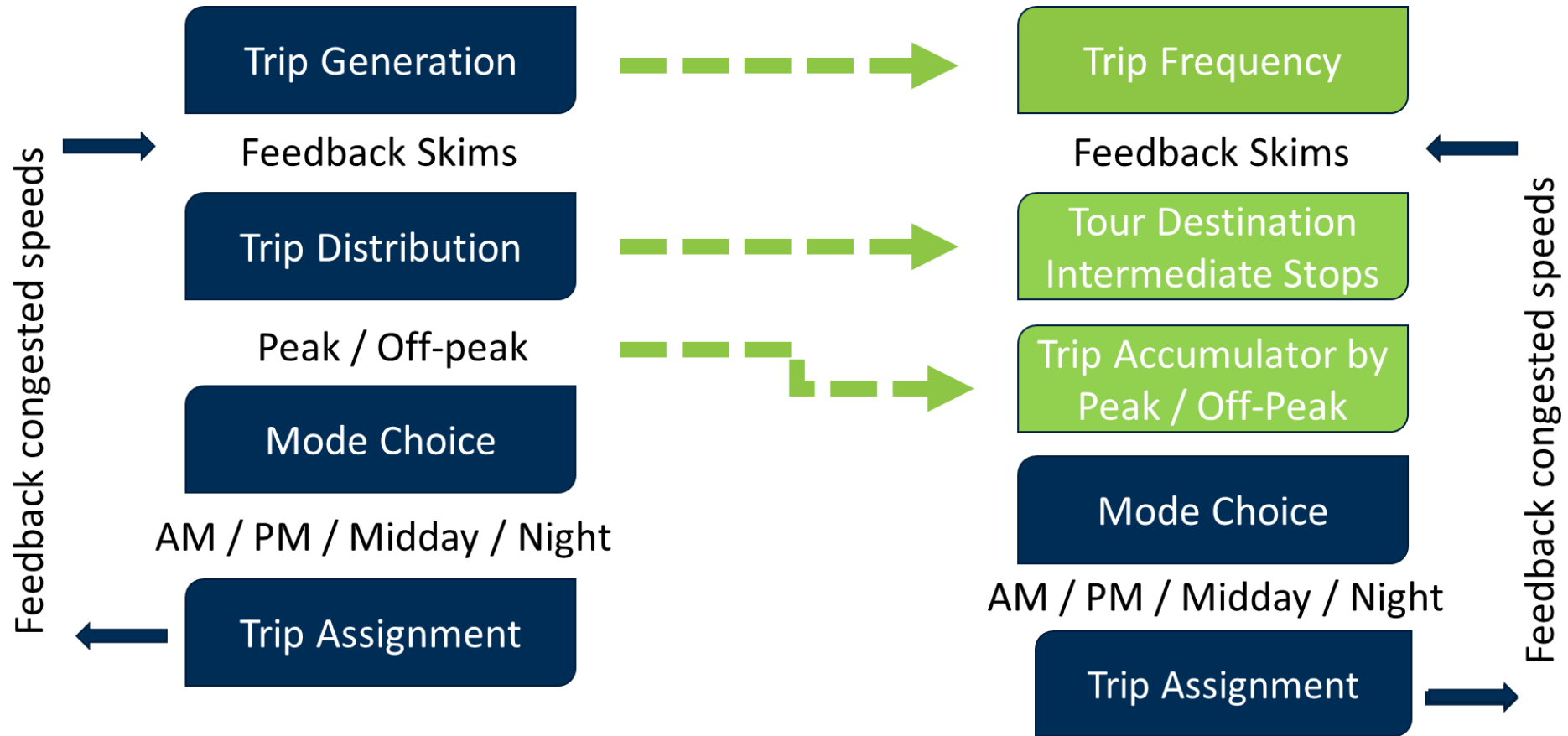- Second instance to be released (MRM22v1.0)

What is a tour?

Source: Bill Allen

What is Simplified Tour Modelling?

- New way of modelling individual tours

- Better represents the way people travel

- Concepts are familiar, math is different

- Avoids unnecessary complexity

- Quick to calibrate, runs fast

- Easy transition from four-step model

Trip vs Simplified Tour

KEY ELEMENTS AND DIFFERENCES FROM TRADITIONAL FOUR-STEP MODEL

Key Benefit: Modeling Households

- Avoid aggregation bias
  - using average data masks important differences
  - more accurate to model individual behavior

- Improved reporting
  - more detailed cross-tabs of travel behavior
  - better understanding of how system changes affect certain individuals
  - helpful for Environmental Justice analyses

Household Synthesis

Census data and surveys allocate attributes - HH size, income level, life cycle and number of workers

However, does not currently reflect car **ownership**, **something** we are interested **in adding**

*No substantial change from our previous trip-based model

Tour Frequency

Logit equations instead of trip rates

Discrete choices for each household (not aggregated to TAZs)

Previous tours affect number of subsequent

Essentially creating a travel diary

Dataview1 - TourRecords

HH_ID	TAZ	SIZE	INCOME	LIFE	WRKRS	SCH	HBU	HBW	HBS	HBO	ATW
1	1	1	1	3	0	0	0	0	0	0	--
2	1	1	2	1	0	0	0	0	1	1	--
3	1	1	2	3	1	0	0	1	1	1	--
4	1	1	3	1	0	0	0	0	1	8	--
5	1	1	3	3	1	0	0	1	1	1	--
6	1	1	3	3	1	0	0	1	1	1	--
7	1	2	2	1	0	0	0	0	1	1	--
8	1	2	2	3	1	0	0	0	1	1	--
9	1	2	3	1	0	0	0	0	1	8	--
10	1	2	3	3	1	0	0	1	1	3	--
11	1	2	4	1	0	0	0	0	0	3	--
12	1	2	4	3	0	0	0	0	1	2	--

Dataview: Records 1 - 12 of 1050033

Tour Purposes

- Similar to four-step model but are prioritized:
  1. HBSchool
  2. HBU
  3. HBW
  4. HBShop
  5. HBOther

- At-work after Destination Choice

- No NHB!

- Purposes are interrelated in a household

- More important purposes influence less important ones

EX: HBO Tour Frequency Model

Choice set: 0 / 1 / 2 / 3 / 4+ tours, so 4 utility equations

- utility of zero tours defined as zero by convention

**Utilities are a linear function of key variables**

- number of people (+)
- is HH high income? (+) or low income? (-)
- number of workers (-)
- area type (more rural = fewer tours)
- any kids? (+)
- zonal median income (+)
- SCH, HBU, HBW, HBS tours (-)

Sample HBO TF Utility Equation

U(4+ tours) = -4.202 + 1.859 * persons

   + 0.6085 * high income?

   – 0.7486 * low income?

   – 0.5127 * workers

   – 0.0537 * area type

   + 0.3765 * any kids?

   + 0.000005842 * zonal median income

   – 0.6965 * (SCH + HBU tours)

   – 1.0350 * HBW tours

   – 0.8163 * HBS tours

"Wheel of Fortune"

Tour Frequency

- 0 tour: 30%
- 1 tour: 40%
- 2 tours: 20%
- 3+ tours: 10%
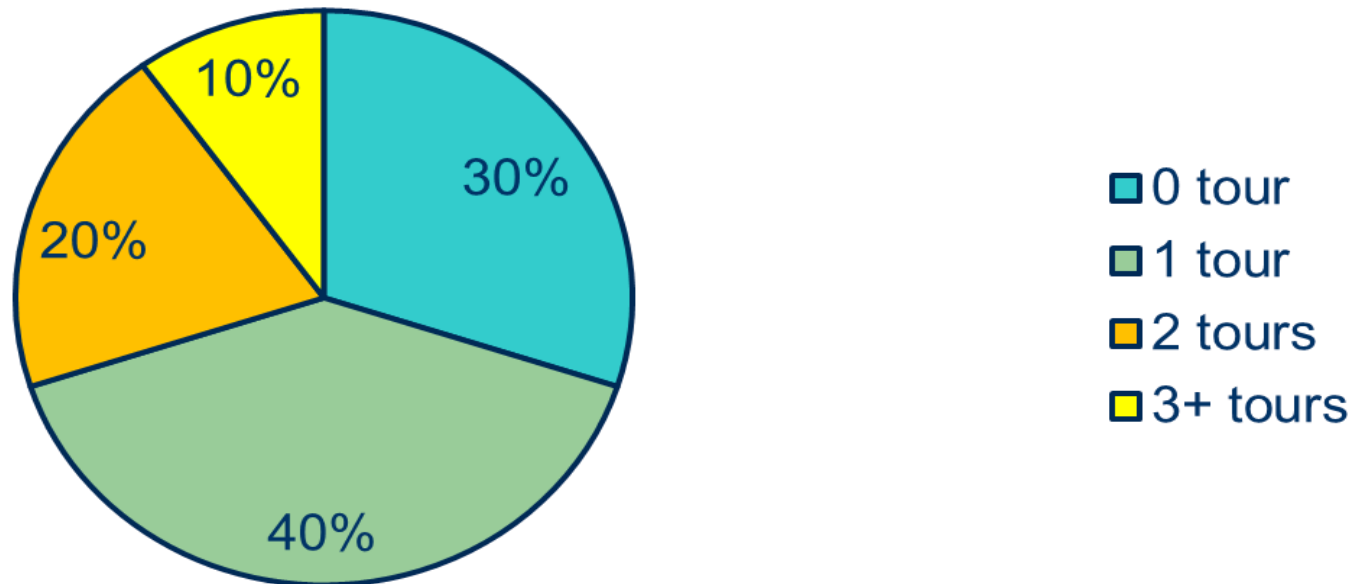
Destination Choice

- Logit model instead of gravity model
- Attractions are similar to Trip Model (but no NHB)
- Main destination zone (anchor) of the tour
  - Choose from universe of TAZs
  - Doubly constrained
  - Remove an attraction once it is chosen
- Continue to fill in "travel diary"
- Hold onto HH attributes so perhaps can make a more informed choice
- Run time comparable to Trip Distribution

Destination Choice Features

- Key variables: travel time, area type, same AT dummy, CBD dummy, intra-county dummy, accessibility

- Size variables: jobs, pop, enrollment

- HBW example:
  - Choice set: all zones that have jobs
  - O-D time (-)
  - are O and D in same county? (+)
  - is Dest. in the CBD? (+)
  - Dest. accessibility to jobs in 15 min of comp. time (-)
  - natural log of employment (+)
  - Different coefficients for low vs. high income

Sample HBW DC Utility Equation

$U_{inc1-3}(j) = -0.08588 *$ hwy time

$+ 0.7249 *$ O&D same county?

$+ 0.4477 *$ Dest. in CBD?

$- 0.1147*10^{-7} *$ Dest. accessibility

$+ \ln(\text{employment})$

Destination Choice Issues

- Required lots of testing

- Sorting the order that HHs are done

- Last sets of HHs
  - Ended up re-setting attractions once reached x%

- Getting run time to reasonable

Intermediate Stops

- Number of Stops along the tour
  - do separately for leg 1 vs. leg 2
  - more stops on leg 2

- Logit equations similar to Tour Frequency

- Replaces NHB, JTW, and attractions of some HBO trips

- Secondary purposes, mostly shop and personal business

- 10 - 30% of tours make intermediate stops

- Max of 7 stops in each direction

Who makes stops?

MORE LIKELY

- ✓ Higher HH income
- ✓ Have kids
- ✓ High retail employment near tour O or D
- ✓ Home zone densely developed
- ✓ Rural destination
- ✓ Longer tour time
- ✓ More likely to stop on leg 2 if stopped on leg 1

LESS LIKELY

- ✓ Lowest HH income
- ✓ Fewer people in HH
- ✓ Tour O and D in same zone
- ✓ CBD destination
- ✓ Rural origin
- ✓ If HH made more tours (some purposes)

Stop Locations

- Logit models similar to Destination Choice

- Different models by purpose and stop number

- Don't consider all 3,000+ zones for each tour
  - max search radius: generally twice the tour O-D distance
  - max detour time: 30-90 min (by purpose)
  - avoid looking at zones that aren't viable choices

- Still consider a few hundred zones for each tour

Detour Time
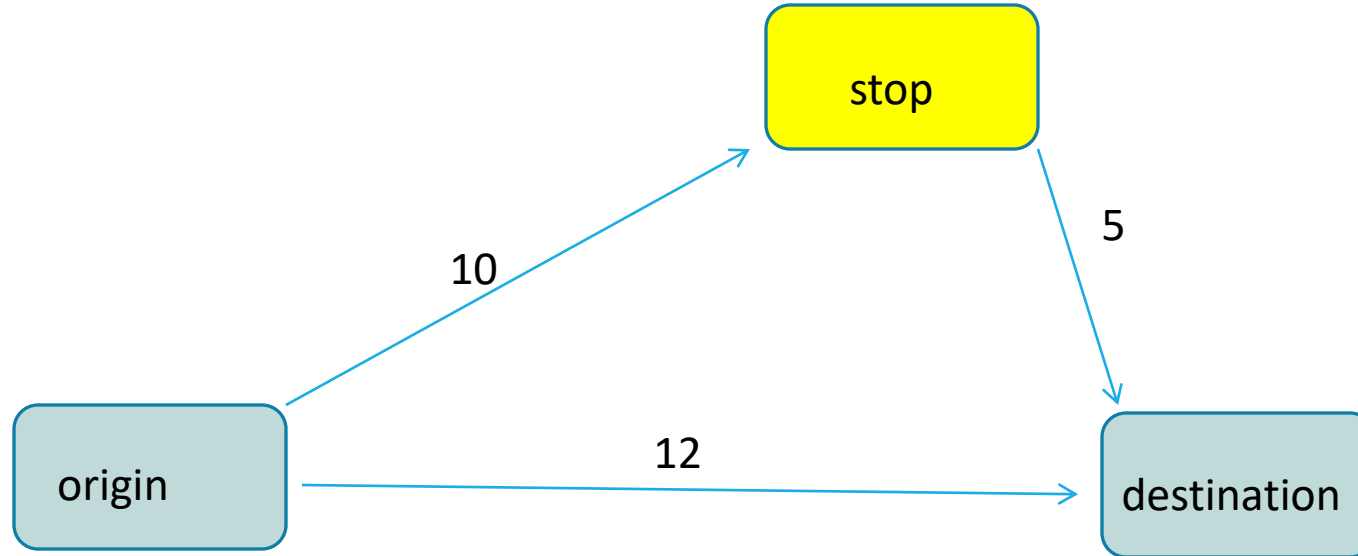
detour time = 10 + 5 − 12 = 3

Stop Locations Issues

- Stop location attractions are unconstrained

- Even with a negative CBD variable, we are still getting too many stops in Uptown
  - Did not fully realize until we started to develop an Uptown Subarea Model

- Longest time to run of the tour model

Time of Day

Metrolina uses two ToD models
1) pre-mode choice: peak vs. off-peak
2) post-mode choice: AM, MD, PM, NT
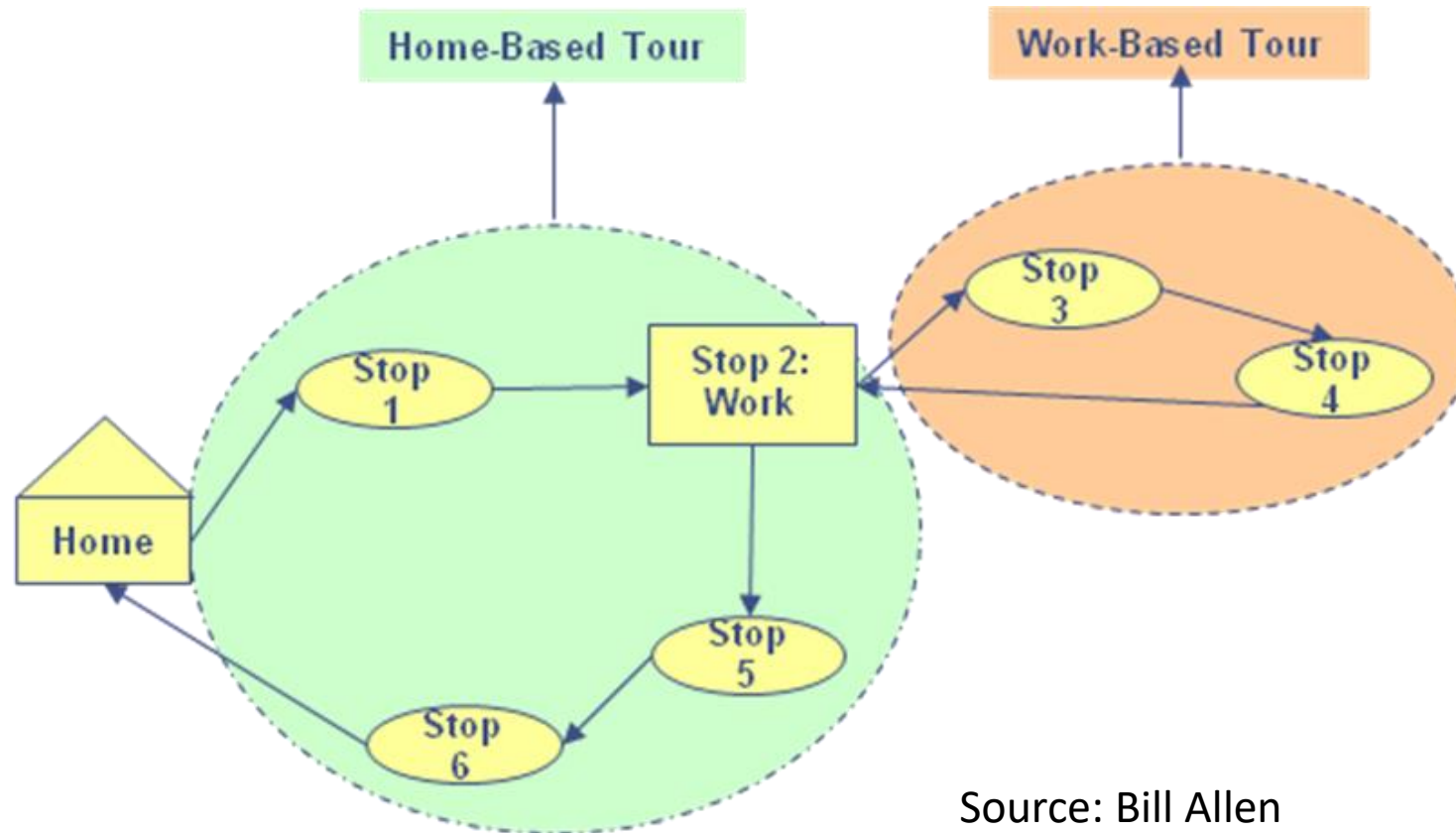
Tour model includes ToD 1 now

Logit model by tour direction, purpose

ToD 2 to be added later

Trip Accumulator

- Now have complete tour records with all HH, destination, stop, time period data

- Use records to build trip tables
  - deconstruct tours into O/D trips

- Person trips by HBW, HBU, HBO, NHB
  - by income
  - by peak vs. off-peak
  - **input to existing mode choice model**

Back to Trips!

Source: Bill Allen

But Still …

- Improved representation of travel
  - more accurate trip table
  - better sensitivity to system changes

- Improved base and future year assignment?

- New capabilities for testing impacts
  - Scenario Planning, etc

- Staff deeply involved in the new model

Current State of Tour Model

- Official model

- Tour components stop at mode choice

- Pleased, will not go back to 4-step
  - Would be ok if this is where at for a while, but ...

- Base year validated to counts well

Run Time : 2018 ~ 12 hours, 2050 ~ 16.5

Next Steps

- Convert rest of model to tour (Mode Choice, TOD2)
  - Transit survey (Spring 2023)
  - HHTS (Spring 2023?)

- Re-evaluate destination choice attraction constraints

- Investigate constraining stop locations

- More sensitivity testing

Questions?

MARTIN KINNAMON, PE | SENIOR TRAVEL DEMAND MODELER

MARTIN.KINNAMON@CHARLOTTENC.GOV