10. Uncertainty Analysis

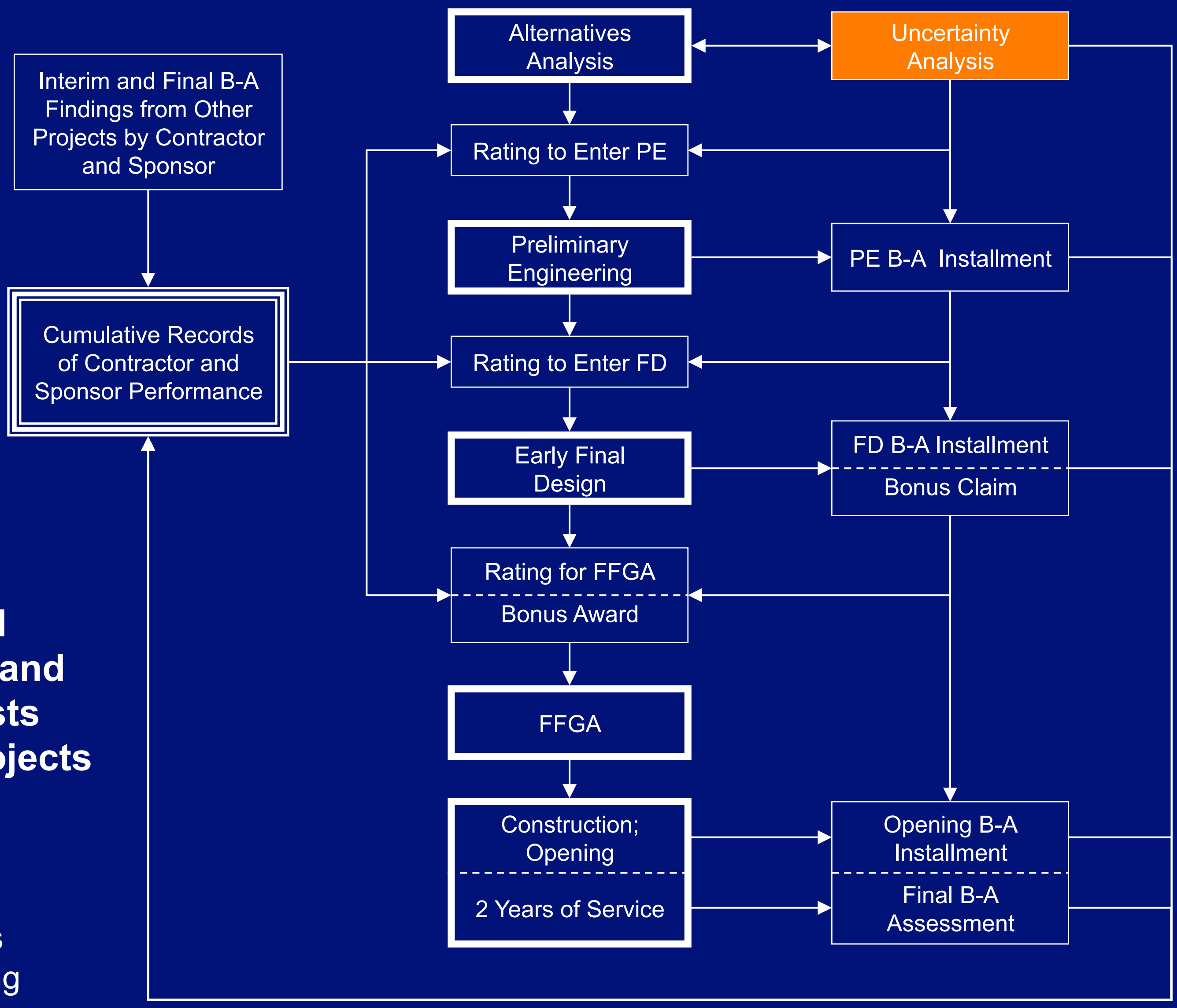
- FTA requirements for New Starts
- Implementation

FTA Requirements

- Specific SAFETEA-LU provisions
  - Project ratings and reliability of forecasts
  - Before-After studies of predicted/actual
  - FFGA bonus awards for "good" forecasts
  - Tracking of contractor performance
- Travel forecasting measure
  - Guideway riders
  - Measurable; most visible element

Uncertainty in and Accuracy of Cost and Ridership Forecasts for New Starts Projects

- Uncertainty Analysis
- FTA Ratings
- Before-After Studies
- FFGA Bonus Awards
- Performance Tracking



Implementation

- Prior to PE application (in AA, post AA)
  - Build-up of preferred-alternative forecast
  - Scrutiny of large contributors
  - Range of forecasts
  - Formal documentation
- Updated at entry to Final Design

Build-up of LPA Forecast

- Series of forecasts for:
  - Today
  - Plus future transit network
  - Plus new transit behaviors
    - Choice riders
    - Park/ride
    - Guideway effects
    - etc.
  - Plus future trip tables
  - Plus future highway congestion
  - Plus future parking costs

  - Plus alternative land use (?)

Scrutiny of “Drivers”

- Perspectives
  - Reliability of technical methods
  - Consistency with current behavior, trends
  - Consistency with peers
- Alternative outcomes

Range of Forecasts

- Complete forecasts (not factored)
  - Most likely
    - Adjustments to key contributors?
    - For project evaluation, so with user benefits
    - Template for opening-year forecast
  - Lower bound: P(lower outcome) < 20%
  - Upper bound: P(higher outcome) < 20%

Documentation

- Range of forecasts (low, likely, high)
  – Ridership patterns
  – Guideway ridership
- Discussion
  – Key drivers of most-likely forecast
  – Significant downside uncertainties
  – Significant upside uncertainties

11. Before-After Studies

- FTA requirements for New Starts
- Implementation
- Thoughts on good practice

FTA Requirements

- New/Small Starts → Before-After study
- Element of project scope
  - Pre-approved work-plan required
  - Eligible for FTA New Starts funds
- Dual purposes
  - Impacts of the project: "before vs. after"
  - Accuracy of forecasts: "predicted vs. actual"
- Annual report to Congress on findings

FTA Requirements

- Before versus after
  - Conditions prior to project implementation
  - Conditions 2 years after project opening
  - Understanding of project impacts
- Predicted versus actual
  - Accuracy of forecasts
  - Causes of differences
  - Implications for methods, QC, management

FTA Requirements

Milestone	Activities
Post AA	Uncertainty analysis; forecast preservation
Post PE	Analysis of revisions; forecast preservation
Pre-project	Collection of “before” data
After opening (+2 yrs)	Collection of “after” data Analysis of project impacts Assessment of forecast accuracy

Implementation

- Uncertainties analysis
- Analysis of interim changes
- Preservation of forecasts
- Collection of data (“before,” “after”)
- Completion of the study

Implementation

- Analysis of interim changes
  - Identification of causes
    - Changes in project scope
    - Changes in demographic forecasts
    - Others
  - Quantification of impact (no hand-waving)
    - Separate contributions
    - Full travel forecasts

Implementation

- Preservation of forecasts
  - Documentation
  - Networks, demographics, models
  - Preservation of ability to replicate forecasts
    - Computer(s) in the closet
    - Migration to new software, hardware, models
  - FTA oversight contractor → archives

Implementation

- Collection of data (“before,” “after”)
  - Conceptual design/budget in approved plan
  - Detailed design
    - Sampling plan, methods, data items
    - Opportunity for FTA comment (approval?)
  - Preservation of data
  - FTA oversight contractor

Implementation

- Completion of the study
  - Impact of the project
    - Changes in services, ridership
    - Meaningful differences in “before,” “after” data
  - Accuracy of forecasts
    - Ridership forecast versus “after” data
    - Analysis of differences
      - Full forecasts demonstrating impacts of changes
      - No handwaving

Implementation

- Completion of the study (continued)
  - Documentation
  - FTA contractor
  - FTA acceptance of completed study
- Experience to date
  - Salt Lake City and Dallas
  - “After” with no “before;” limited “predicted”
  - Demonstrate importance of <u>preservation</u>

12. Performance Tracking

- FTA requirements for New Starts
- Implications
- Implementation ideas
  - Outlines of a proposal
  - Formal draft, comments, and final policy guidance in 2008

FTA Requirements

- Annual report to Congress
  - Projects: FFGA New Starts; PCA Small Starts
    - Summary of forecasts
    - Identification of forecasting "contractors"
  - New Starts projects opened to service
    - Summary of first-year ridership
    - Assessment of forecasts, causes of errors

Implications

- Some areas of tension
  - – Risk | control
    - Contractors assume the risk of "bad" performance grades
    - Sponsors and others control key resources for forecasting
    - Budget, schedule, data, existing models …
  - – Conditions | funding
    - Contractors' risk minimized by identifying uncertainties
    - Sponsors' funding put at risk by identified uncertainties
  - – AA contractor | PE contractor
    - May not be the same (good or bad for analytical rigor??)

Implications

- Some more areas of tension
  - Evaluation measure | measurable impacts
    - Projects are evaluated on mobility benefits
    - Project ridership is more measurable and visible
  - Forecast year | performance year
    - Projects are evaluated with 2030 benefits
    - Contractor performance is based on opening year

Implementation Ideas

- Scope: assessment of all contributions
  - Contractor
  - Project sponsor, MPO, others
- Uncertainties analysis
  - Required prior to PE application
  - Forecasts and methods preserved for use in later analyses

Implementation

- Principal measures
  - Guideway ridership
  - System ridership
- Consistency
  - 2030 & 1st year: same methods
  - Allowance for initial maturation effects
- FTA oversight contractor

Performance Scoring

- Parallels project ratings
  - Five rating categories (High … Low)
  - Multiple measures
  - Weighted average with judgment
- Criteria
  - Proximity of actual ridership to forecast
  - Sources of error controlled by contractor
  - Sources of error controlled by others

Criteria

- Proximity: actual vs. most likely forecast
  - Within ±20 percent
  - Below floor
  - Above ceiling
- Sources of error (contractor)
  - Source identified/explored
  - Implications quantified
  - Adjustments high/low forecasts

In uncertainties analysis

Criteria

- Sources of error (others)
  - Source identified/explored
  - Implications quantified
  - Adjustments high/low forecasts

} In uncertainties analysis

Ideas and Comments

- Now
- E-mail, soon
- Formally in early 2008

13. Transit Path Choices

- No FTA requirements on this topic
- Some observations
- Three presentations
- Discussion

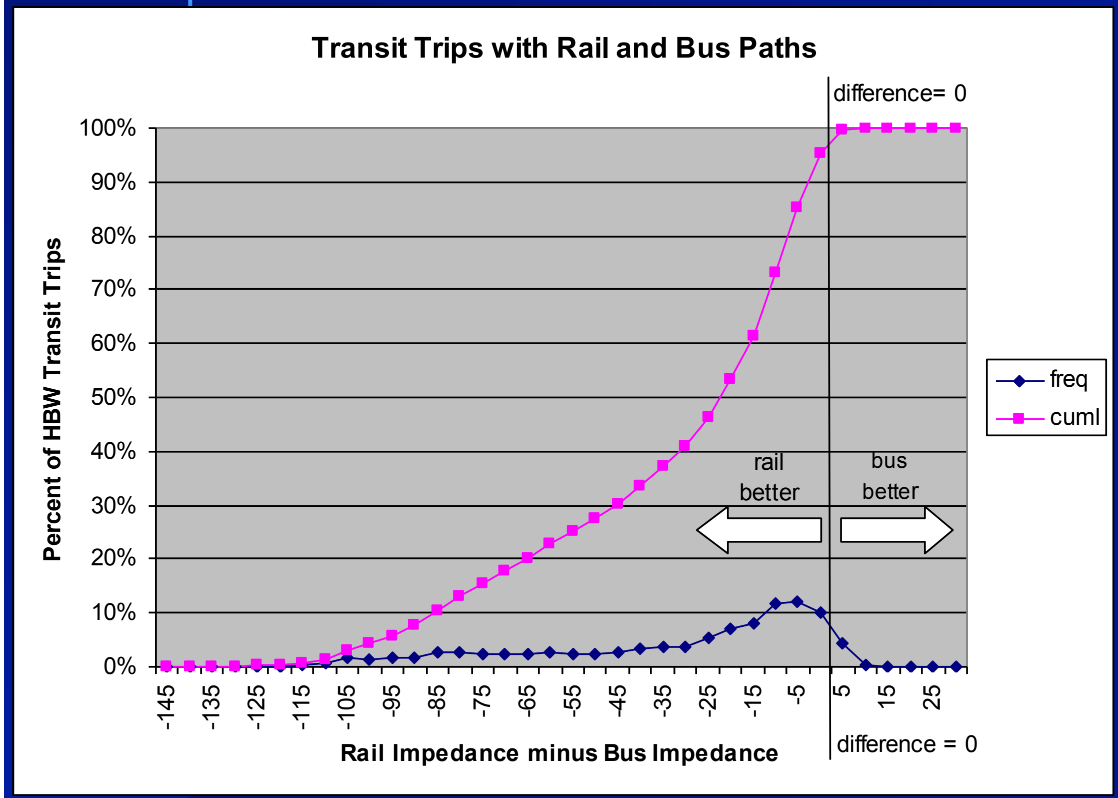
Some Observations

- Transit choices
  - Access mode (walk, bus, PnR, KnR, etc.)
  - Line-haul mode (bus, rail, etc.)
  - Path (first boarding, last alighting)
- Central issue for model design
  - Choices handled by the pathbuilder?
  - Choices handled in “mode” choice?

An Example

- Setting: Honolulu
  – Dense existing bus network
  – Corridor defined by geographic constraints
  – Rail options imply lots of bus changes
- Pathbuilder
  – All-or-nothing (with combined headways)
- Question: pathbuilder-alone adequate?

Some Analysis



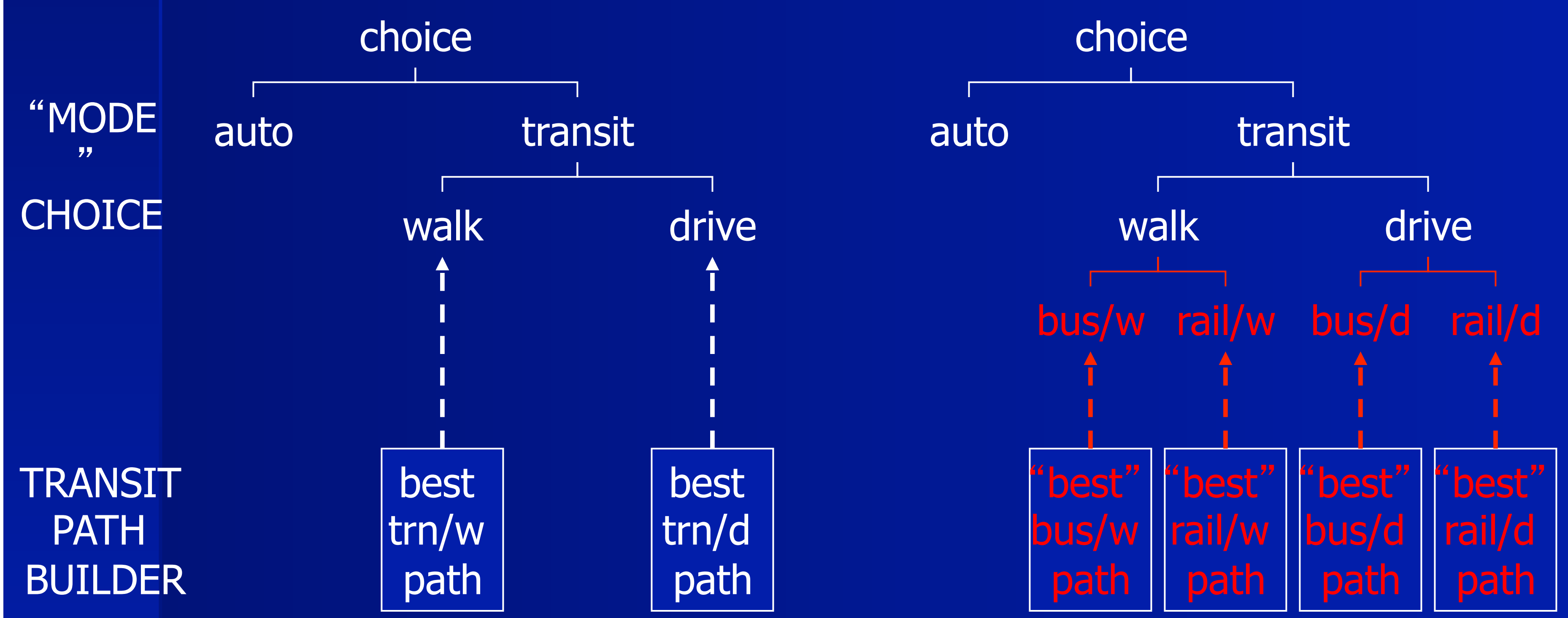
- Transit trips
  - Build alternative
  - HBW/peak = 81,200 trips
- Transit paths
  - Best bus-only
  - Rail, bus IVT weight = 1.2
- Observations
  - 34,500 trips have choice
  - 9,200 trips, |Δ| < 5 min.
  - 16,100 trips, |Δ| < 15 min.
  - Best path → more rail trips
  - Path choice → more UBs

A Modified Approach

- Pathbuilder: four best paths
  - Best bus/walk
  - Best bus/drive
  - Best rail/walk
  - Best rail/drive
- Mode choice model
  – "Transit" mode = four discrete choices
  – Probably with some nested structure

Two Design Options

Option A   Option B



Actually, Many Design Options

- Other transit choices
  - Ferry
  - Local bus, limited-stop bus, express bus
  - Walk-rail versus walk-bus-rail
- Other influences
  - Transit pathbuilding algorithm
  - Zone size
  - Computational intensity

Presentations

- Path Choice with Substantial Reliance On Discrete-Choice Models
  - Bill Davidson, Parsons Brinckerhoff
- Path Choice with Principal Reliance On Networks and Path-builders
  - Bill Woodford, AECOM Consult
- "To Multipath or Not to Multipath" – The Denver Experience
  - David Kurth, Cambridge Systematics, Inc.

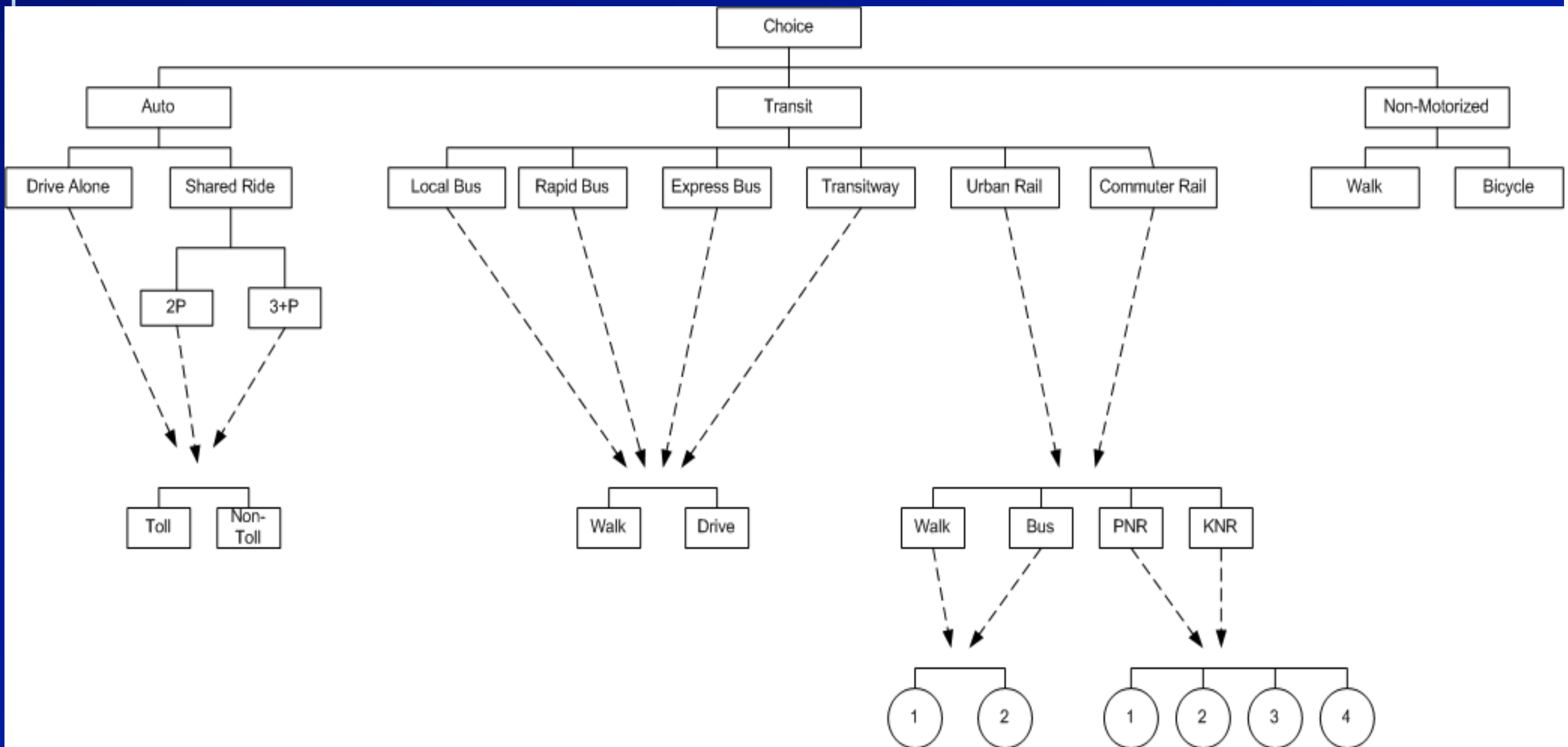
Path Choice with Substantial Reliance On Discrete-Choice Models

Bill Davidson
Parsons Brinckerhoff

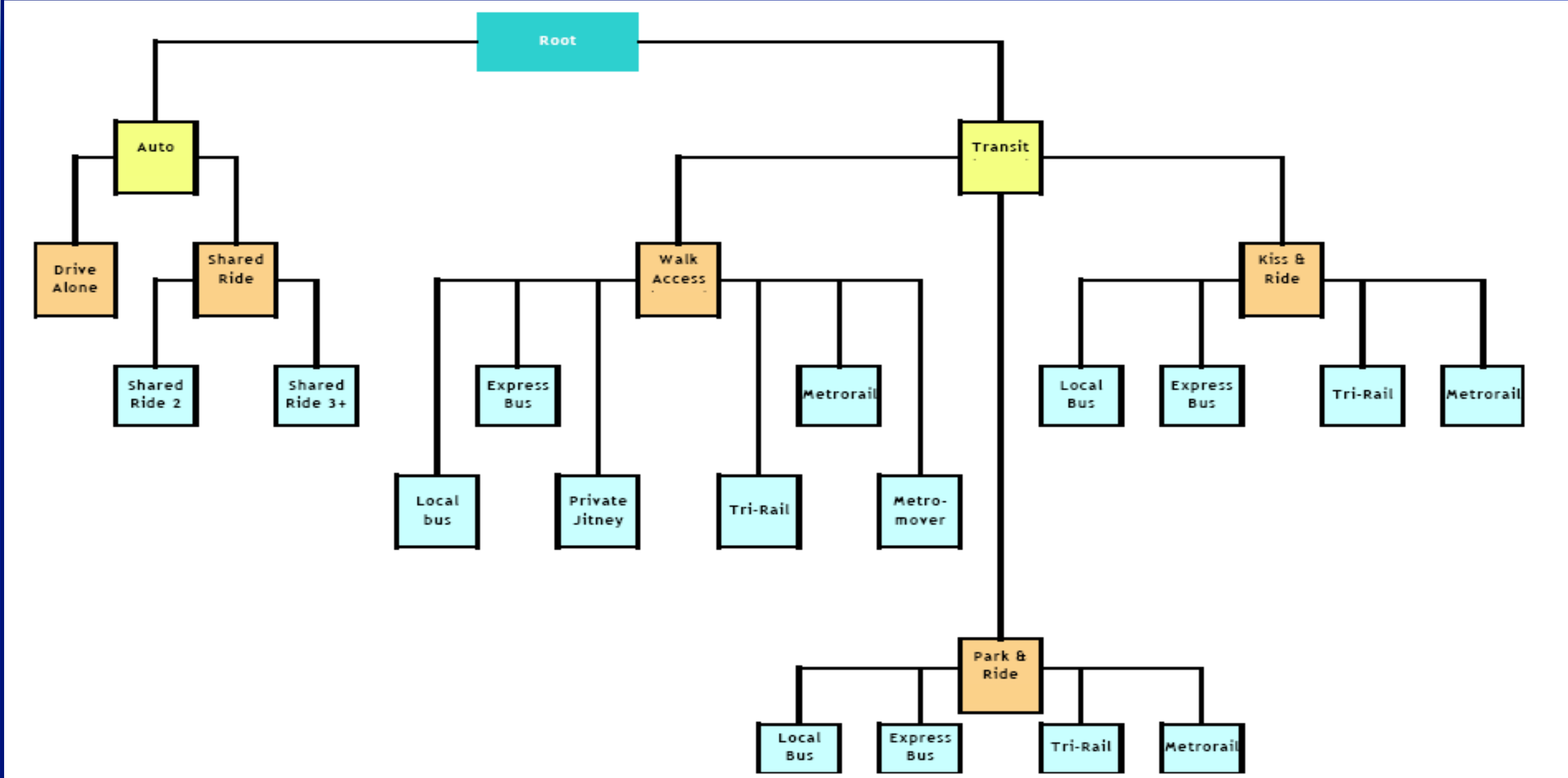
Why Rely Heavily on Discrete Choice Models?

- Many shades of gray?
- What might be a decision framework?
- Considering the full range of choices
- Behavioral implications

Los Angeles Nested Model



Miami Mode Choice Model



Thoughts about a Decision Framework

- What are the choices to be considered?
  - Existing
  - And future
- Understanding markets
  - Context specific ("one size does not fit all")
  - Survey data requirements – and quality

Some Possible Criteria

- Non-included Attributes
  - – Facility related
  - – Span of service
  - – Passenger amenities
  - – Trip characteristics
    - Vehicle, reliability, seat availability……
- Competition

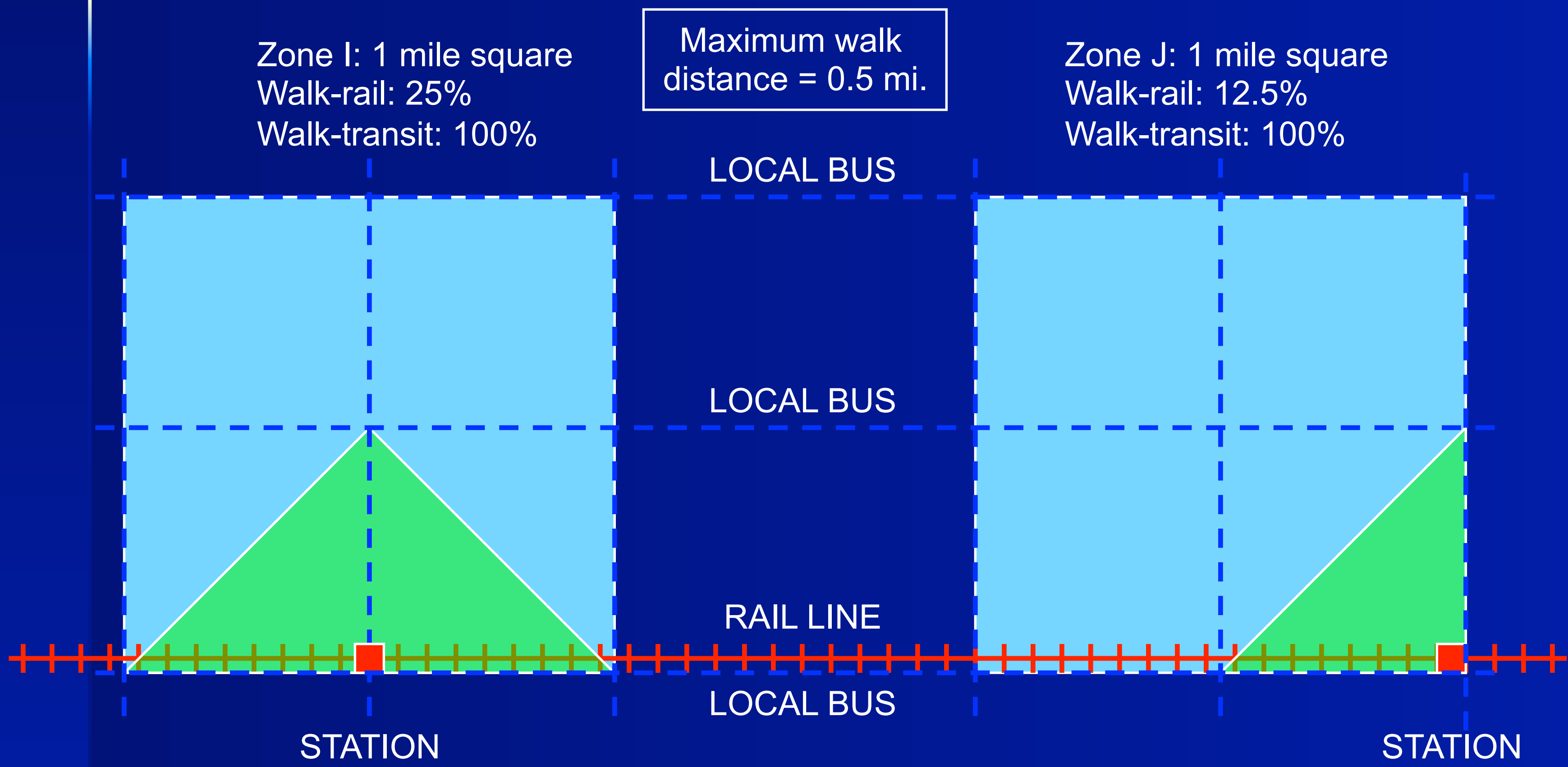
(More) Possible Criteria

- Market segmentation
  - Traveler, access/egress….
- Elasticities
  - Tradeoffs
- Mobility influences
  - More choices available to the traveler

Choice Dimensions

- Physical & operational characteristics
- Access/egress
  - Market segmentation
    - San Diego and small area geography
    - Differences in walk access options (bus v. rail)
  - Boarding location choice
    - Station
    - Bus stop

From the MSP Workshop



What transit options are available to whom?

Access Representation

- Paths from I to J
  - Detailed
    - walk-rail-walk
    - walk-bus-rail-walk
    - walk-rail-bus-walk
    - walk-bus-walk
    - drive-rail-walk
    - drive-rail-bus-walk
  - Typical
    - walk-local-walk
    - walk-premium-walk
    - drive-transit-walk

- Markets from I to J
  - Detailed
    - 25 x 12.5 = 3.125%
    - 100 x 12.5 = 12.5%
    - 25 x 100 = 25%
    - 100 x 100 = 100%
    - 100 x 12.5 = 12.5%
    - 100 x 100 = 100%
  - Typical
    - 100 x 100 = 100%
    - 100 x 100 = 100%
    - 100 x 100 = 100%

More Choice Dimensions

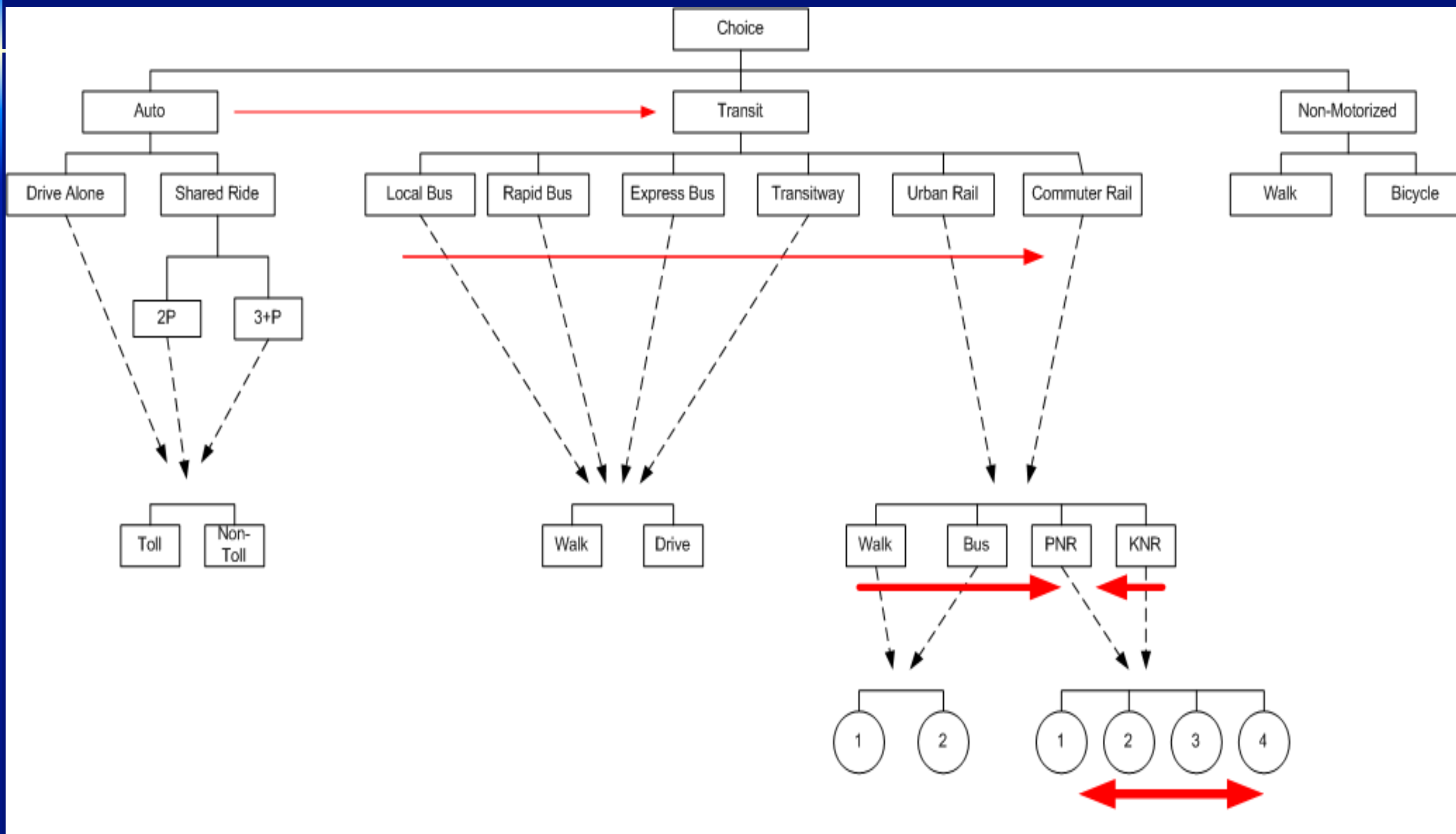
- Competition
  - – Access (WMATA)
    - Walk to bus to rail
    - Direct walk to rail
  - – Primary mode (Los Angeles)
    - Metrolink v. Urban Rail v. Transitway
      - – long distance travel
    - Urban Rail v. Rapid Bus v. Local Bus
      - – Intra corridor travel

Even More Choice Dimensions

- Modal Interactions
  - – Metrolink & Red Line
  - – Orange Line (BRT) & Red Line
    - 60% of Orange Line riders transfer to Red Line
  - – Implicit Hierarchy in Nested Models
    - Where is that Red Line rider?
      - – Metrolink, Urban Rail, BRT, Rapid Bus ???

Behavioral Implications

- Consideration of non-included attributes
  - Fixed v. variable
- Value of time differences
  - Fare contribution to path choice
  - Express bus, urban rail, commuter rail
- Elasticities
  - 500 new spaces at Lot A


Choice
Auto
Transit
Non-Motorized
Drive Alone
Shared Ride
Local Bus
Rapid Bus
Express Bus
Transitway
Urban Rail
Commuter Rail
Walk
Bicycle
2P
3+P
Toll
Non-Toll
Walk
Drive
Walk
Bus
PNR
KNR
1
2
1
2
3
4

Why Rely Heavily on Discrete Choice Models?

- Choice complexities
  - Access/egress (market segmentation)
  - Competition
  - Interactions
- Behavioral considerations
  - Non-included attributes
  - Value of time
  - Elasticities/mobility influences

Path Choice with Principal Reliance On Networks and Path-builders

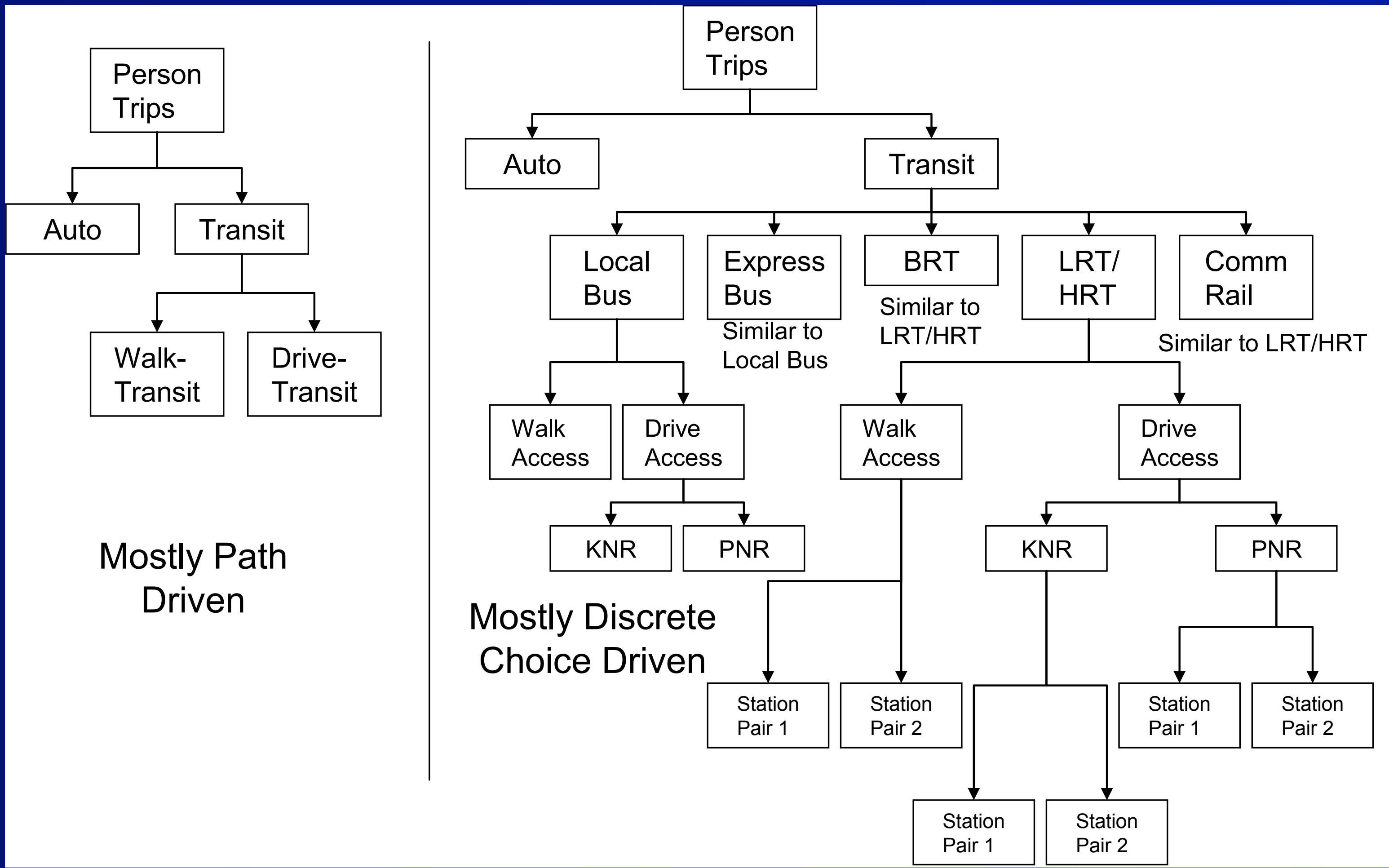
Bill Woodford, AECOM Consult

Range of Options; Not an Either/Or Choice

- Discrete choice models depend on network path builders for each choice (or component of a choice)
- Most models that rely on transit path builders still have separate choices for access mode (walk vs. drive access)
- Key question:

  What is a path-building decision and what is a mode-choice decision?

The Range of Options



Philosophy Behind Reliance on Network/Path-builders

- All other things being equal, a simple model is preferable to a complex model since it is:
  - Faster to develop
  - Easier to understand and explain
  - Less likely to have unknown/undesirable interrelationships
- Complexity is needed when a simpler model doesn't:
  - Depict how travelers behave (mode and submode level)
  - Provide important information on the operation of a project
  - Tell the story of a project
- Bottom Line:
  - Start simple, add complexity as needed
  - Begin by building the best paths possible…good paths are essential for choice based models also.

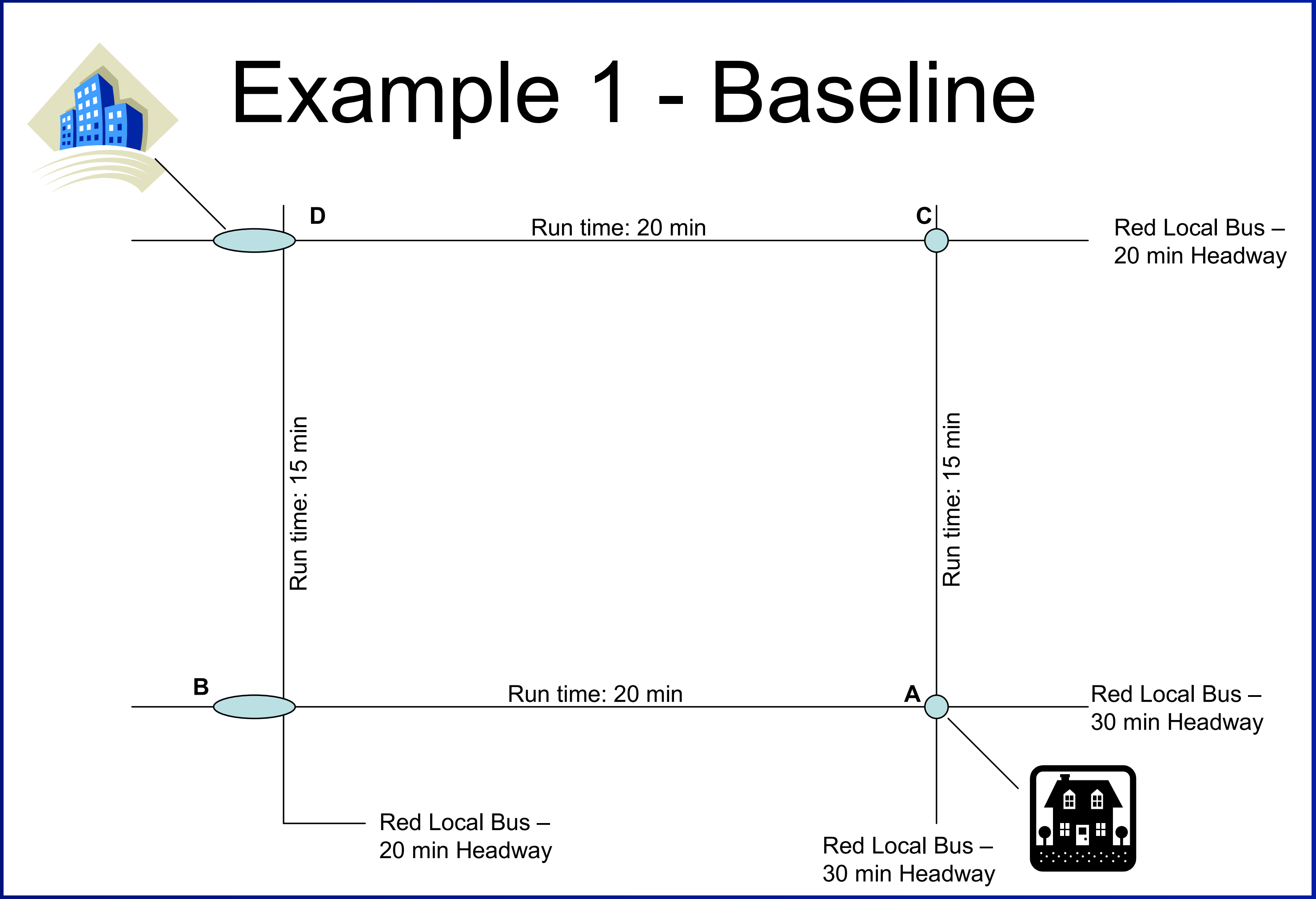
Other Questions Influencing Model Design

- Does the software permit realistic mode-specific paths?
- Can I afford the time/storage associated with a separate set of skims for each choice?
- Can I define a transit sub-mode hierarchy the properly represents the relationships among the options?
- Will this mode hierarchy continue into future with the introduction of new projects?
- Does added complexity help or hinder telling the story of the project?

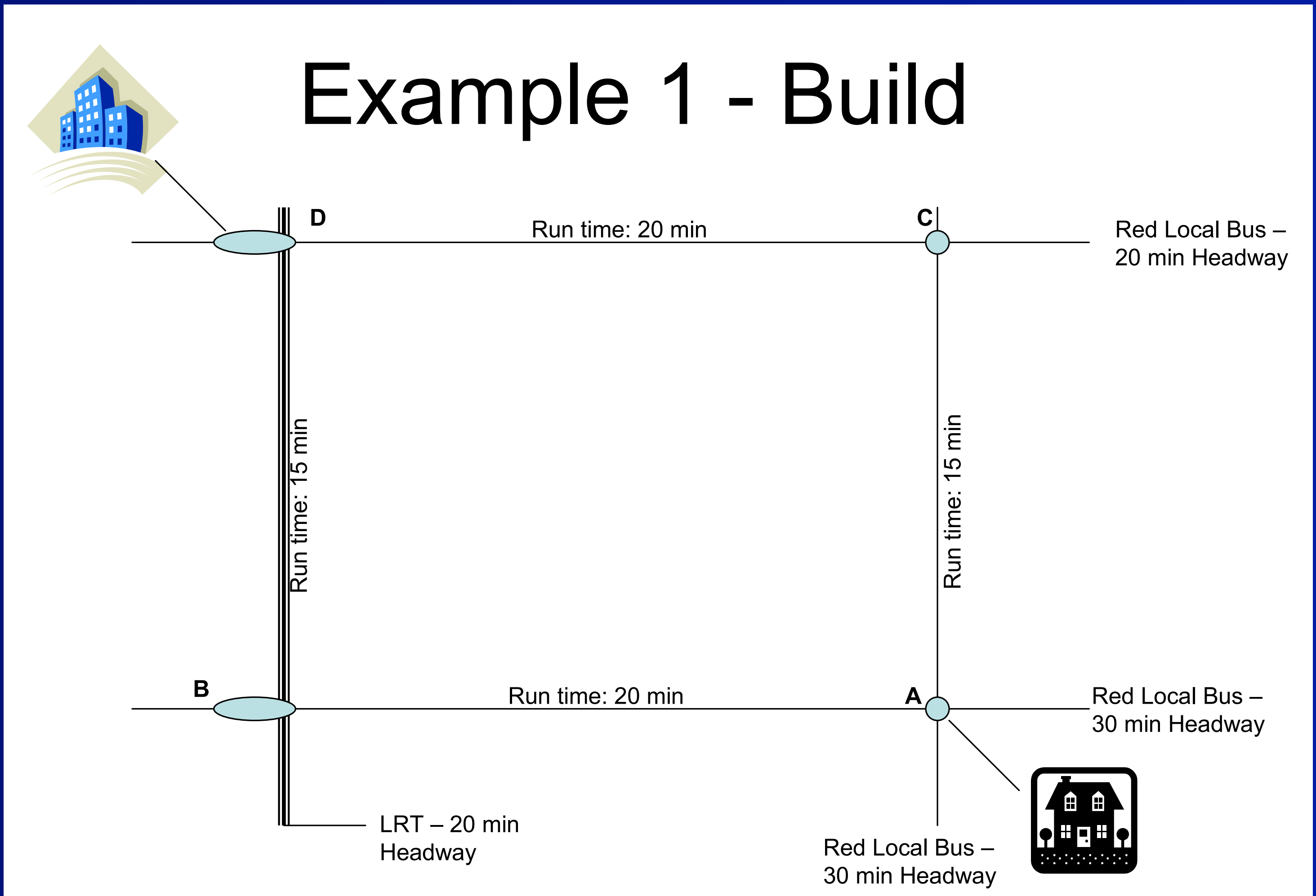
Example

- What happens with rail replaces bus in a simple network?
- Calibration case (and baseline):
  – Bus only system
  – 5% transit share
- Modeling questions
  – UTPS or multipath?
  – Path-based or choice-based?

Example – Baseline



Example – Build



Pathbuilder-Based – As Defined (No Time Savings)

		Pathbuilder (UTPS Paths)			Pathbuilder (multi paths)		
		Nest Coef	1		Nest Coef	1	
Baseline		HWY	Transit	Vacant	HWY	Transit	Vacant
Impedance Terms							
IVTT	-0.025	15	35		15	35	
WAIT	-0.0625		25			17.5	
WALK	-0.0625		10			10	
XFER	-0.125		1			1	
Constant		0	-0.14	-0.14	0	-0.6	-0.6
Mode Choice Computations							
UTIL/nest coef		-3.75000E-01	-3.32750E+00	0.00000E+00	-3.75000E-01	-3.31875E+00	0.00000E+00
e(UTIL/nest coef)			3.58827E-02	0.00000E+00		3.61981E-02	0.00000E+00
Sub Mode Share			100.0%	0.0%		100.0%	0.0%
logsum			-3.32750E+00			-3.31875E+00	
Eutil		6.87289E-01	3.58827E-02		6.87289E-01	3.61981E-02	
Main Mode Share		95.0%	5.0%		95.0%	5.0%	
Share		95.0%	5.0%	0.0%	95.0%	5.0%	0.0%
Trips (per 100)		95.0	5.0	-	95.0	5.0	-
Build		HWY	Transit	Vacant	HWY	Transit	Vacant
Impedance Terms							
IVTT	-0.025	15	35		15	35	
WAIT	-0.0625		25			17.5	
WALK	-0.0625		10			10	
XFER	-0.125		1			1	
Constant		0	-0.14	-0.14	0	-0.6	-0.6
Mode Choice Computations							
UTIL/nest coef		-3.75000E-01	-3.32750E+00	0.00000E+00	-3.75000E-01	-3.31875E+00	0.00000E+00
e(UTIL/nest coef)			3.58827E-02	0.00000E+00		3.61981E-02	0.00000E+00
Sub Mode Share			100.0%	0.0%		100.0%	0.0%
logsum			-3.32750E+00			-3.31875E+00	
Eutil		6.87289E-01	3.58827E-02		6.87289E-01	3.61981E-02	
Main Mode Share		95.0%	5.0%		95.0%	5.0%	
Share		95.0%	5.0%	0.0%	95.0%	5.0%	0.0%
Trips (per 100)		95.0	5.0	-	95.0	5.0	-
Evaluation Measures							
LRT Trips			0 or 5			2.5	
Incremetal Transit Trips			-			-	
UB Min			-			-	

Pathbuilder-Based – Adjusted (1 minute LRT Time Savings)

		Pathbuilder (UTPS Paths)- 1 min LRT saved			Pathbuilder (multi paths)- 1 minute LRT saved		
		Nest Coef	1		Nest Coef	1	
Baseline		HWY	Transit	Vacant	HWY	Transit	Vacant
Impedance Terms							
IVTT	-0.025	15	35		15	35	
WAIT	-0.0625		25			17.5	
WALK	-0.0625		10			10	
XFER	-0.125		1			1	
Constant		0	-0.14	-0.14	0	-0.6	-0.6
Mode Choice Computations							
UTIL/nest coef		-3.75000E-01	-3.32750E+00	0.00000E+00	-3.75000E-01	-3.31875E+00	0.00000E+00
e(UTIL/nest coef)			3.58827E-02	0.00000E+00		3.61981E-02	0.00000E+00
Sub Mode Share			100.0%	0.0%		100.0%	0.0%
logsum			-3.32750E+00			-3.31875E+00	
Eutil		6.87289E-01	3.58827E-02		6.87289E-01	3.61981E-02	
Main Mode Share		95.0%	5.0%		95.0%	5.0%	
Share		95.0%	5.0%	0.0%	95.0%	5.0%	0.0%
Trips (per 100)		95.0	5.0	-	95.0	5.0	-
Build		HWY	Transit	Vacant	HWY	Transit	Vacant
Impedance Terms							
IVTT	-0.025	15	34		15	34.5	
WAIT	-0.0625		25			17.5	
WALK	-0.0625		10			10	
XFER	-0.125		1			1	
Constant		0	-0.14	-0.14	0	-0.6	-0.6
Mode Choice Computations							
UTIL/nest coef		-3.75000E-01	-3.30250E+00	0.00000E+00	-3.75000E-01	-3.30625E+00	0.00000E+00
e(UTIL/nest coef)			3.67911E-02	0.00000E+00		3.66534E-02	0.00000E+00
Sub Mode Share			100.0%	0.0%		100.0%	0.0%
logsum			-3.30250E+00			-3.30625E+00	
Eutil		6.87289E-01	3.67911E-02		6.87289E-01	3.66534E-02	
Main Mode Share		94.9%	5.1%		94.9%	5.1%	
Share		94.9%	5.1%	0.0%	94.9%	5.1%	0.0%
Trips (per 100)		94.9	5.1	-	94.9	5.1	-
Evaluation Measures							
LRT Trips			5.1			2.6	
Incremetal Transit Trips			0.1192			0.0597	
UB Min			5.0212			2.5165	

Choice-Based – As Defined (No Time Savings)

		Choice/UTPS Paths			Choice/Multipaths		
		Nest Coef	0.3		Nest Coef	0.3	
Baseline		HWY	Bus	LRT	HWY	Bus	LRT
Impedance Terms							
IVTT	-0.025	15	35		15	35	
WAIT	-0.0625		25			17.5	
WALK	-0.0625		10			10	
XFER	-0.125		1			1	
Constant		0	-0.14	-0.14	0	-0.6	-0.6
Mode Choice Computations							
UTIL/nest coef		-3.75000E-01	-1.10917E+01	0.00000E+00	-3.75000E-01	-1.10625E+01	0.00000E+00
e(UTIL/nest coef)			1.52388E-05	0.00000E+00		1.56898E-05	0.00000E+00
Sub Mode Share			100.0%	0.0%		100.0%	0.0%
logsum			-1.10917E+01			-1.10625E+01	
Eutil		6.87289E-01	3.58827E-02		6.87289E-01	3.61981E-02	
Main Mode Share		95.0%	5.0%		95.0%	5.0%	
Share		95.0%	5.0%	0.0%	95.0%	5.0%	0.0%
Trips (per 100)		95.0	5.0	-	95.0	5.0	-
Build		HWY	Bus	LRT	HWY	Bus	LRT
Impedance Terms							
IVTT	-0.025	15	35	35	15	35	35
WAIT	-0.0625		25	25		25	25
WALK	-0.0625		10	10		10	10
XFER	-0.125		1	1		1	1
Constant		0	-0.14	-0.14	0	-0.6	-0.6
Mode Choice Computations							
UTIL/nest coef		-3.75000E-01	-1.10917E+01	-1.10917E+01	-3.75000E-01	-1.26250E+01	-1.26250E+01
e(UTIL/nest coef)			1.52388E-05	1.52388E-05		3.28876E-06	3.28876E-06
Sub Mode Share			50.0%	50.0%		50.0%	50.0%
logsum			-1.03985E+01			-1.19319E+01	
Eutil		6.87289E-01	4.41768E-02		6.87289E-01	2.78881E-02	
Main Mode Share		94.0%	6.0%		96.1%	3.9%	
Share		94.0%	3.0%	3.0%	96.1%	1.9%	1.9%
Trips (per 100)		94.0	3.0	3.0	96.1	1.9	1.9
Evaluation Measures							
LRT Trips			3.0			1.9	
Incremetal Transit Trips			1.0776			(1.1038)	
UB Min			45.6151			(46.2099)	

Choice-Based – Adjusted (1 minute LRT Time Savings)

		Choice/UTPS Paths- 1 min LRT saved			Choice/Multipaths - 1 min LRT saved		
		Nest Coef		0.3	Nest Coef		0.3
Baseline		HWY	Bus	LRT	HWY	Bus	LRT
Impedance Terms							
IVTT	-0.025	15	35		15	35	
WAIT	-0.0625		25			17.5	
WALK	-0.0625		10			10	
XFER	-0.125		1			1	
Constant		0	-0.14	-0.14	0	-0.6	-0.6
Mode Choice Computations							
UTIL/nest coef		-3.75000E-01	-1.10917E+01	0.00000E+00	-3.75000E-01	-1.10625E+01	0.00000E+00
e(UTIL/nest coef)			1.52388E-05	0.00000E+00		1.56898E-05	0.00000E+00
Sub Mode Share			100.0%	0.0%		100.0%	0.0%
logsum			-1.10917E+01			-1.10625E+01	
Eutil		6.87289E-01	3.58827E-02		6.87289E-01	3.61981E-02	
Main Mode Share		95.0%	5.0%		95.0%	5.0%	
Share		95.0%	5.0%	0.0%	95.0%	5.0%	0.0%
Trips (per 100)		95.0	5.0	-	95.0	5.0	-
Build		HWY	Bus	LRT	HWY	Bus	LRT
Impedance Terms							
IVTT	-0.025	15	35	34	15	35	34
WAIT	-0.0625		25	25		25	25
WALK	-0.0625		10	10		10	10
XFER	-0.125		1	1		1	1
Constant		0	-0.14	-0.14	0	-0.6	-0.6
Mode Choice Computations							
UTIL/nest coef		-3.75000E-01	-1.10917E+01	-1.10083E+01	-3.75000E-01	-1.26250E+01	-1.25417E+01
e(UTIL/nest coef)			1.52388E-05	1.65631E-05		3.28876E-06	3.57457E-06
Sub Mode Share			47.9%	52.1%		47.9%	52.1%
logsum			-1.03560E+01			-1.18893E+01	
Eutil		6.87289E-01	4.47441E-02		6.87289E-01	2.82462E-02	
Main Mode Share		93.9%	6.1%		96.1%	3.9%	
Share		93.9%	2.9%	3.2%	96.1%	1.9%	2.1%
Trips (per 100)		93.9	2.9	3.2	96.1	1.9	2.1
Evaluation Measures							
LRT Trips			3.0			1.9	
Incremetal Transit Trips			1.1505			(1.0557)	
UB Min			48.7162			(44.2073)	

Deep Nested Choice-Based – Adjusted (1 minute LRT Time Savings)

		Choice/UTPS Paths- 1 min LRT saved			Choice/Multipaths - 1 min LRT saved		
		Nest Coef		0.01	Nest Coef		0.01
Baseline		HWY	Bus	LRT	HWY	Bus	LRT
Impedance Terms							
IVTT	-0.025	15	35		15	35	
WAIT	-0.0625		25			17.5	
WALK	-0.0625		10			10	
XFER	-0.125		1			1	
Constant		0	-0.14	-0.14	0	-0.6	-0.6
Mode Choice Computations							
UTIL/nest coef		-3.75000E-01	-3.32750E+02	0.00000E+00	-3.75000E-01	-3.31875E+02	0.00000E+00
e(UTIL/nest coef)			3.07972E-145	0.00000E+00		7.38786E-145	0.00000E+00
Sub Mode Share			100.0%	0.0%		100.0%	0.0%
logsum			-3.32750E+02			-3.31875E+02	
Eutil		6.87289E-01	3.58827E-02		6.87289E-01	3.61981E-02	
Main Mode Share		95.0%	5.0%		95.0%	5.0%	
Share		95.0%	5.0%	0.0%	95.0%	5.0%	0.0%
Trips (per 100)		95.0	5.0	-	95.0	5.0	-
Build		HWY	Bus	LRT	HWY	Bus	LRT
Impedance Terms							
IVTT	-0.025	15	35	34	15	35	34
WAIT	-0.0625		25	25		25	25
WALK	-0.0625		10	10		10	10
XFER	-0.125		1	1		1	1
Constant		0	-0.14	-0.14	0	-0.6	-0.6
Mode Choice Computations							
UTIL/nest coef		-3.75000E-01	-3.32750E+02	-3.30250E+02	-3.75000E-01	-3.78750E+02	-3.76250E+02
e(UTIL/nest coef)			3.07972E-145	3.75187E-144		3.24313E-165	3.95095E-164
Sub Mode Share			7.6%	92.4%		7.6%	92.4%
logsum			-3.30171E+02			-3.76171E+02	
Eutil		6.87289E-01	3.68201E-02		6.87289E-01	2.32439E-02	
Main Mode Share		94.9%	5.1%		96.7%	3.3%	
Share		94.9%	0.4%	4.7%	96.7%	0.2%	3.0%
Trips (per 100)		94.9	0.4	4.7	96.7	0.2	3.0
Evaluation Measures							
LRT Trips			4.7			3.0	
Incremetal Transit Trips			0.1230			(1.7319)	
UB Min			5.1816			(72.2694)	

Example: Summary

	UTPS Paths	Multipaths	Choice UTPS	Choice Multipath	Deep Nested UTPS	Deep Nested Multipath
No Time Savings						
--Base Transit Trips	5.0	5.0	5.0	5.0	5.0	5.0
--LRT Trips	2.5	2.5	3.0	1.9	4.7	3.0
--Delta Transit Trips	-	-	1.1	(1.1)	0.0	(1.8)
--UB Minutes	-	-	45.6	(46.2)	1.4	(74.7)
--UB Min./Base Transt Trip	-	-	9.1932	(9.2359)	0.2782	(14.9331)
1 min LRT TimeSavings						
--Base Transit Trips	5.0	5.0	5.0	5.0	5.0	5.0
--LRT Trips	5.1	2.6	3.0	1.9	4.7	3.0
--Delta Transit Trips	0.1	0.1	1.2	(1.1)	0.1	(1.7)
--UB Minutes	5.0	2.5	48.7	(44.2)	5.2	(72.3)
--UB Min./Base Transit Trip	1.0	0.5	9.8182	(8.8357)	1.0443	(14.4444)

Note for UTPS, no time savings, equal impedance assumed to be evenly distributed among paths

Questions

- Should multi-path credit be assigned to multiple bus paths also?
- What does define an independent choice as distinct from a typical bus path choice?
- Does it matter since a deeply nested outcome begins to mirror path-based models?
- Can multi-path path-builders co-exist with nested choice models?

Conclusion: Depends on Having a Meaningful *Choice*

- Significantly different level of service / comfort
  - Guaranteed seat
  - Fare different
  - Substantial time improvement
  - Independent marketing identity
- Evidence that presence of multiple choices increases mode share independent of time and cost

Transit Path-Building: "To Multipath or Not to Multipath" – The Denver Experience

David Kurth, Cambridge Systematics, Inc.

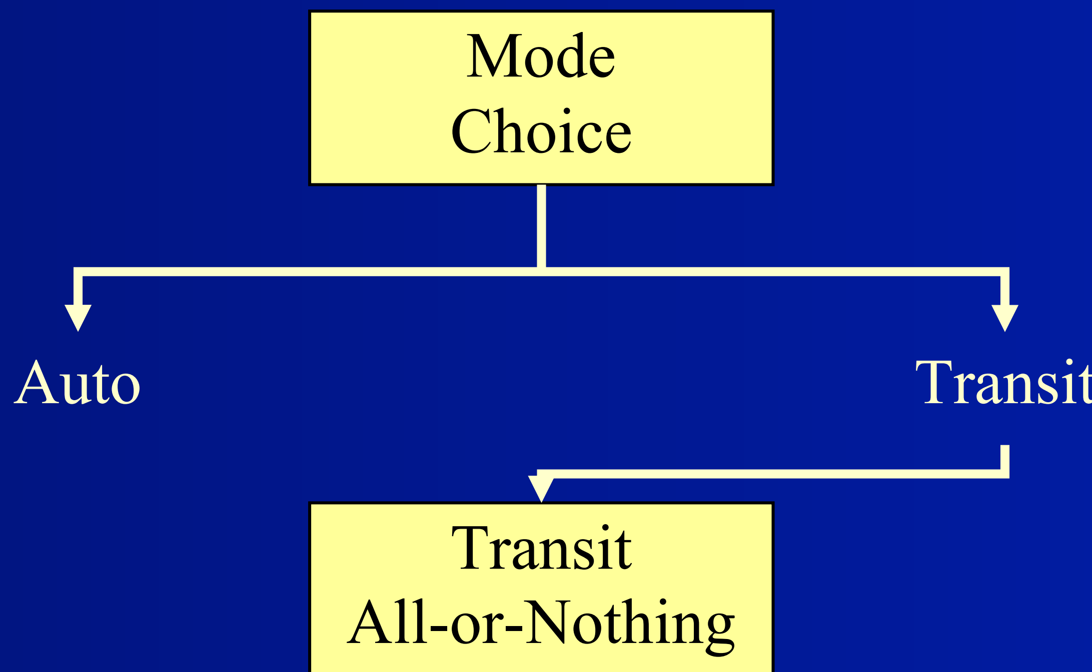
Based on work performed with:

- Suzanne Childress (Parsons)
- Erik Sabina & Sreekanth Ande (DRCOG)
- Lee Cryer (Denver RTD)

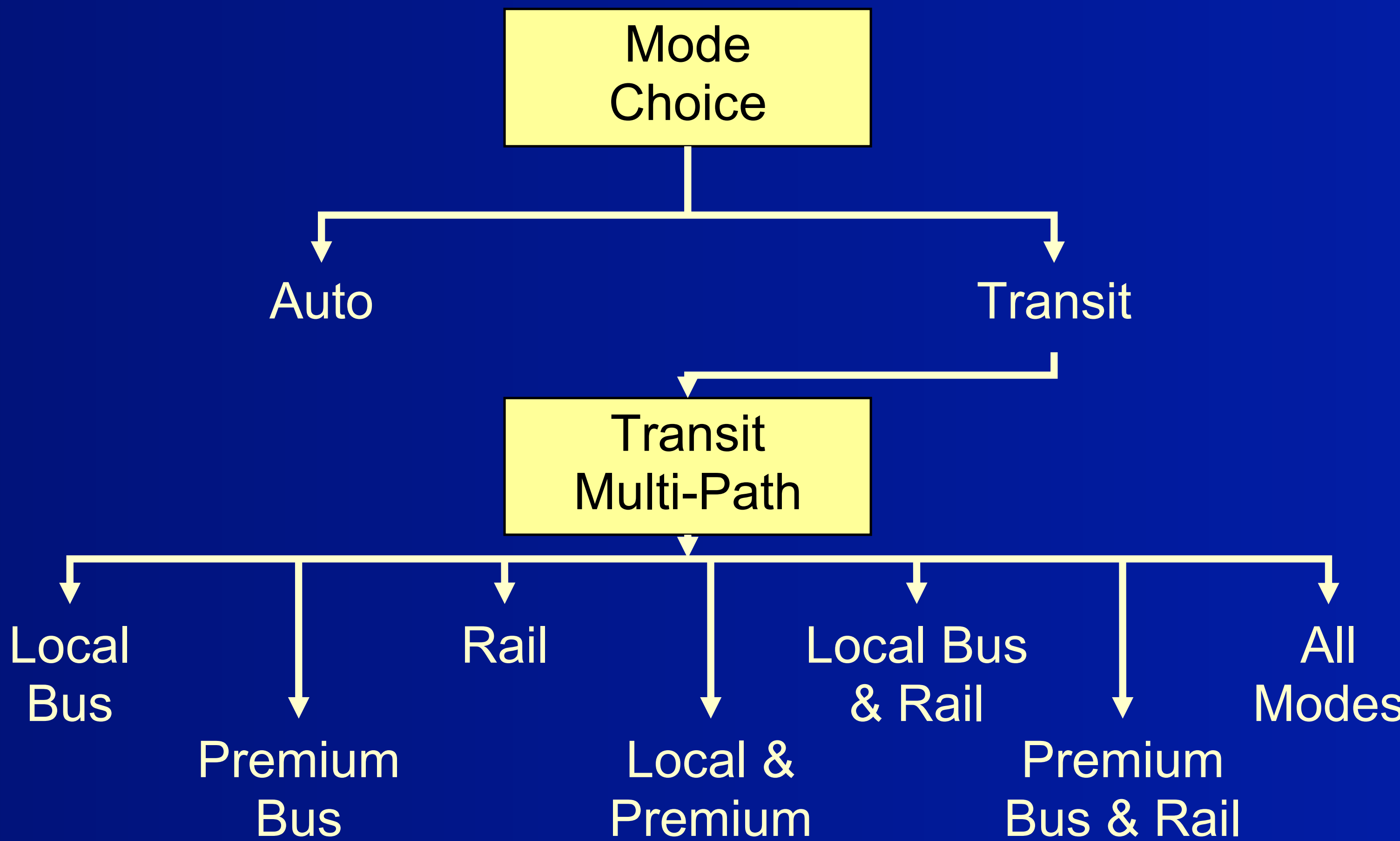
Investigation Context

- DRCOG Integrated Regional Model (IRM) development
  - Activity / tour-based model
  - Better representation of transit possible
  - Correct options in estimation dataset required for proper estimation
- Detailed Travel Behavior Inventory (TBI) data
  - Provided for detailed path-checking

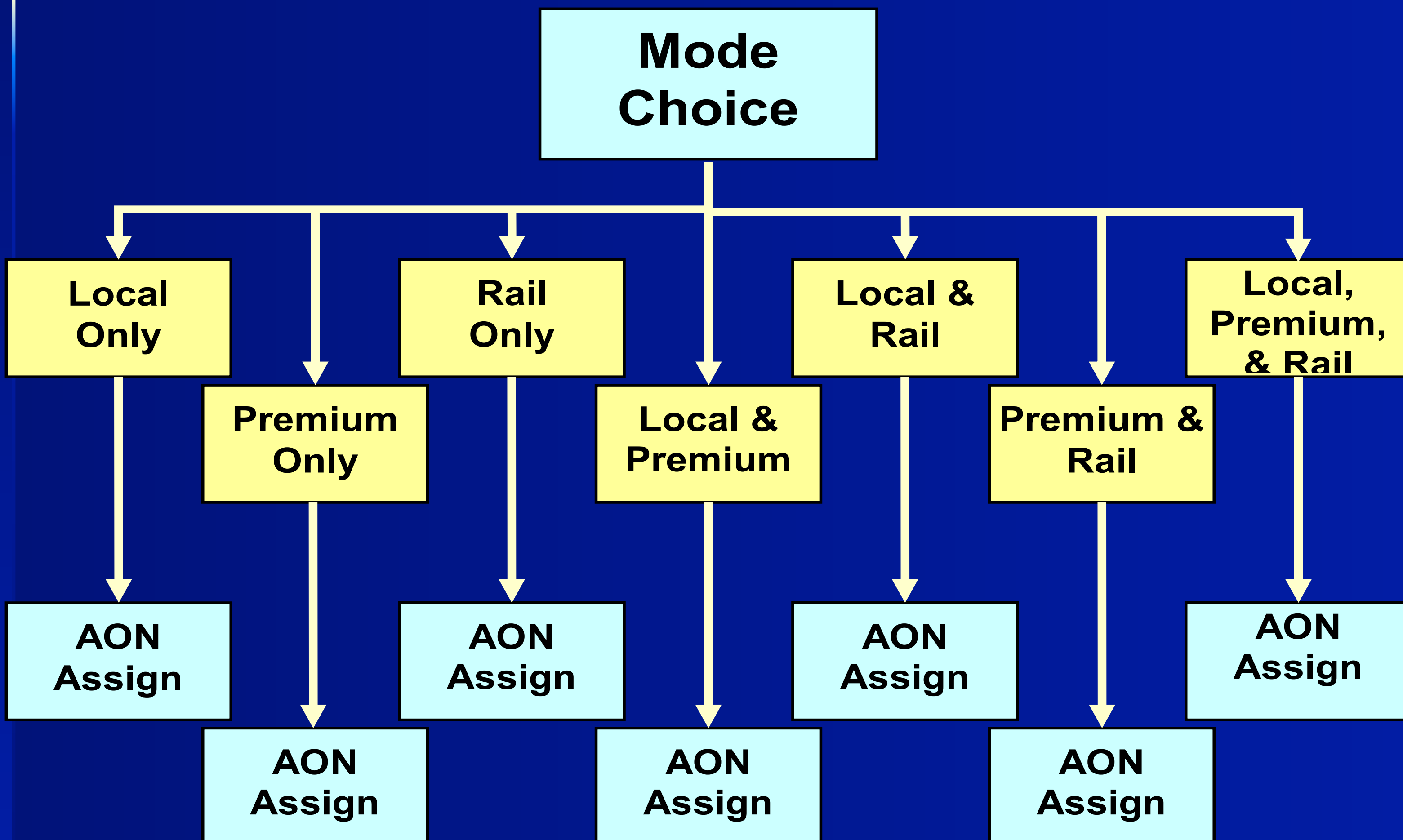
Simple Path-Builder + Simple Mode Choice



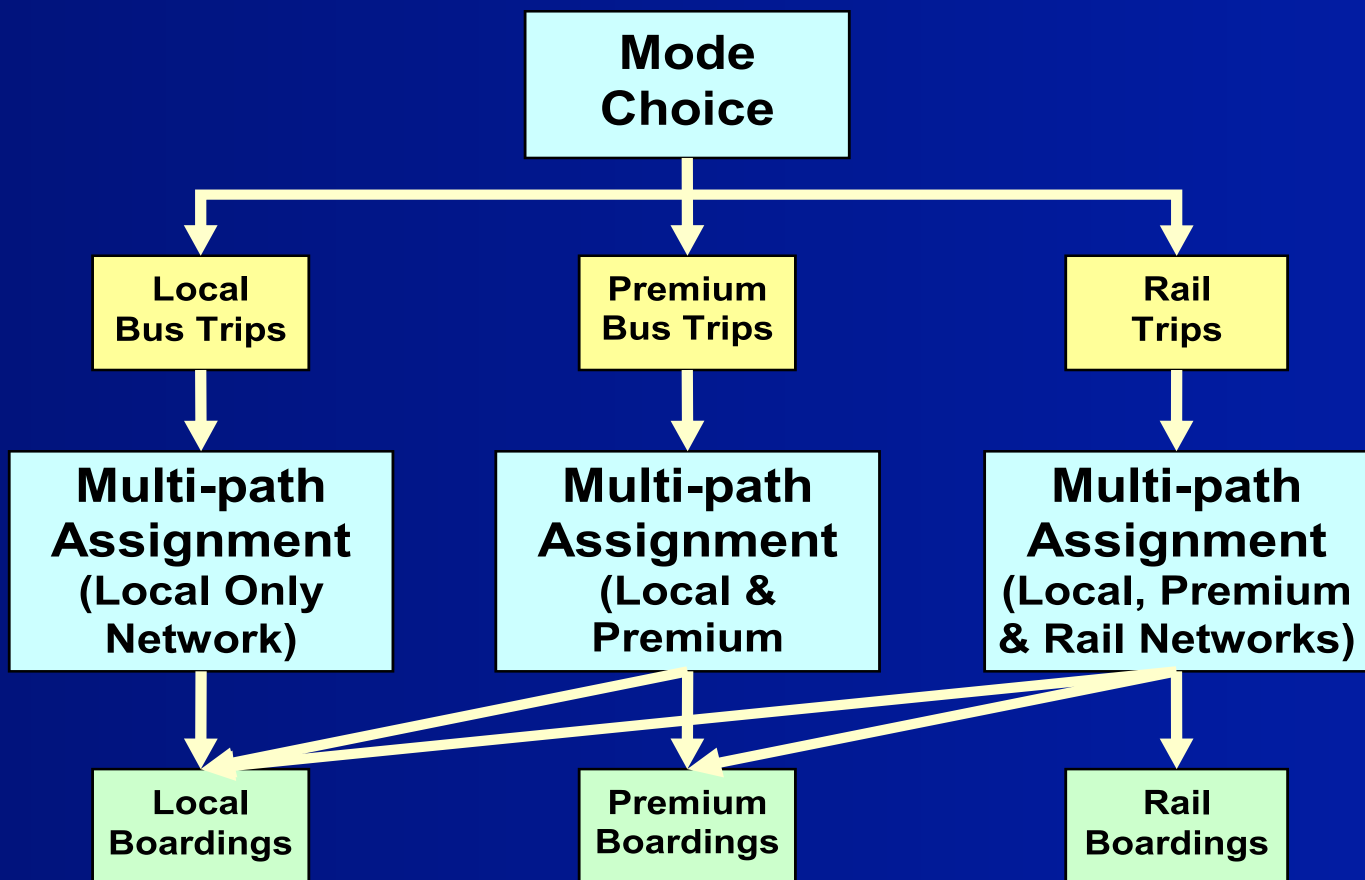
Complex Path-Builder + Simple Mode Choice



Simple Path-Builder + Complex Mode Choice



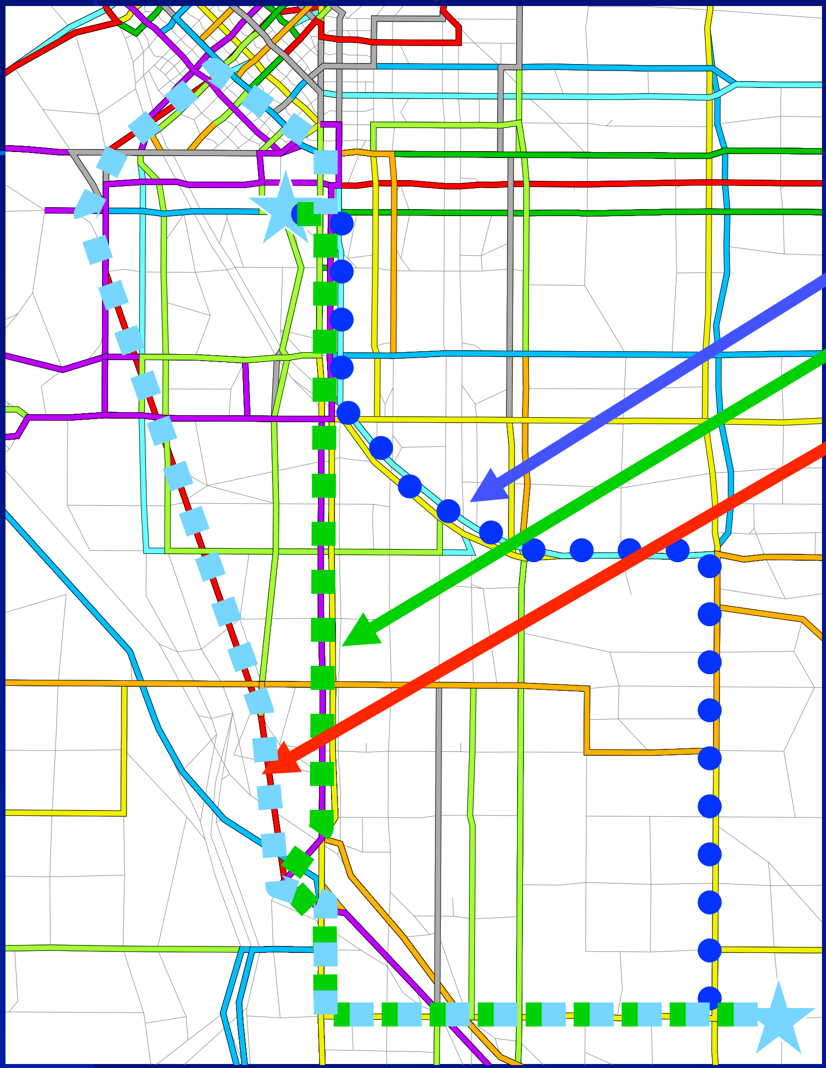
Complex Path-Builder + Complex Mode Choice



IRM Design Options

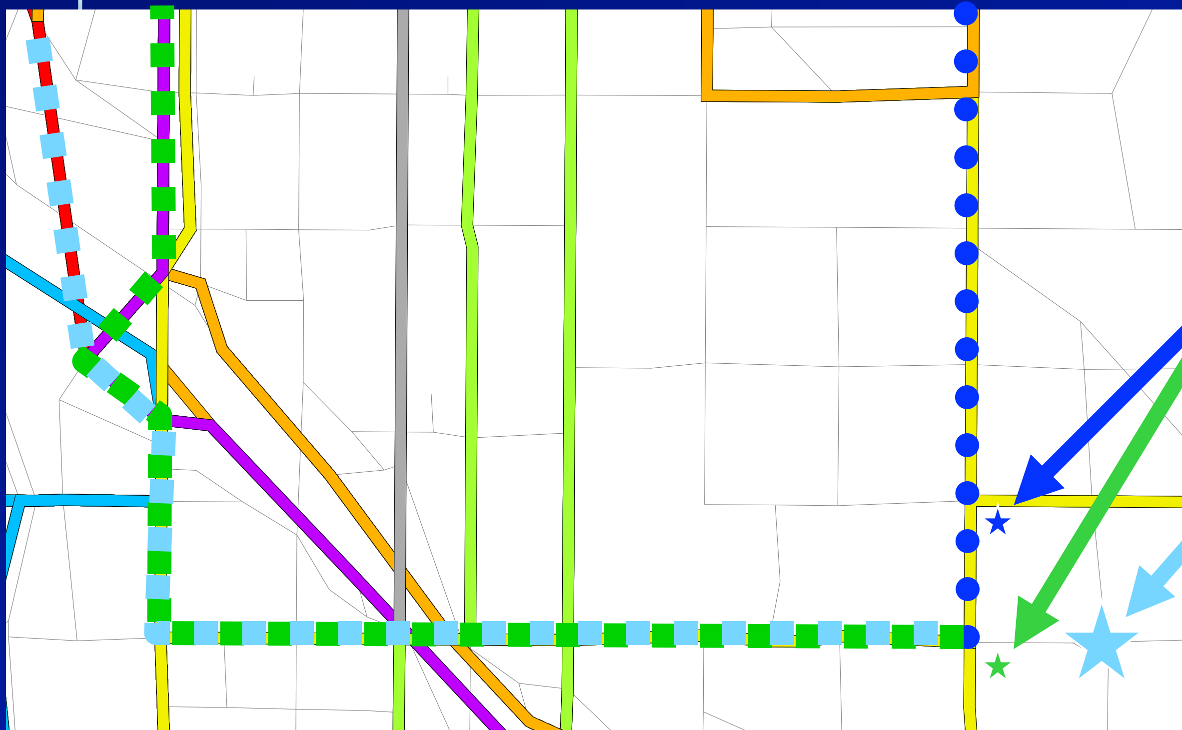
Path-Builder	Mode Choice	
~~Simple~~	~~Simple~~	Shown to not work
Complex	Simple	
Simple	Complex	
~~Complex~~	~~Complex~~	Possible "confusion"

Example RTD Path Options



- 3 Reasonable Paths
  - Path 1: 2 Local Buses
  - Path 2: 2 Local Buses
  - Path 3: Local Bus, Rail, Mall Shuttle
- Travel Behavior Inventory (TBI) had observations for all three!

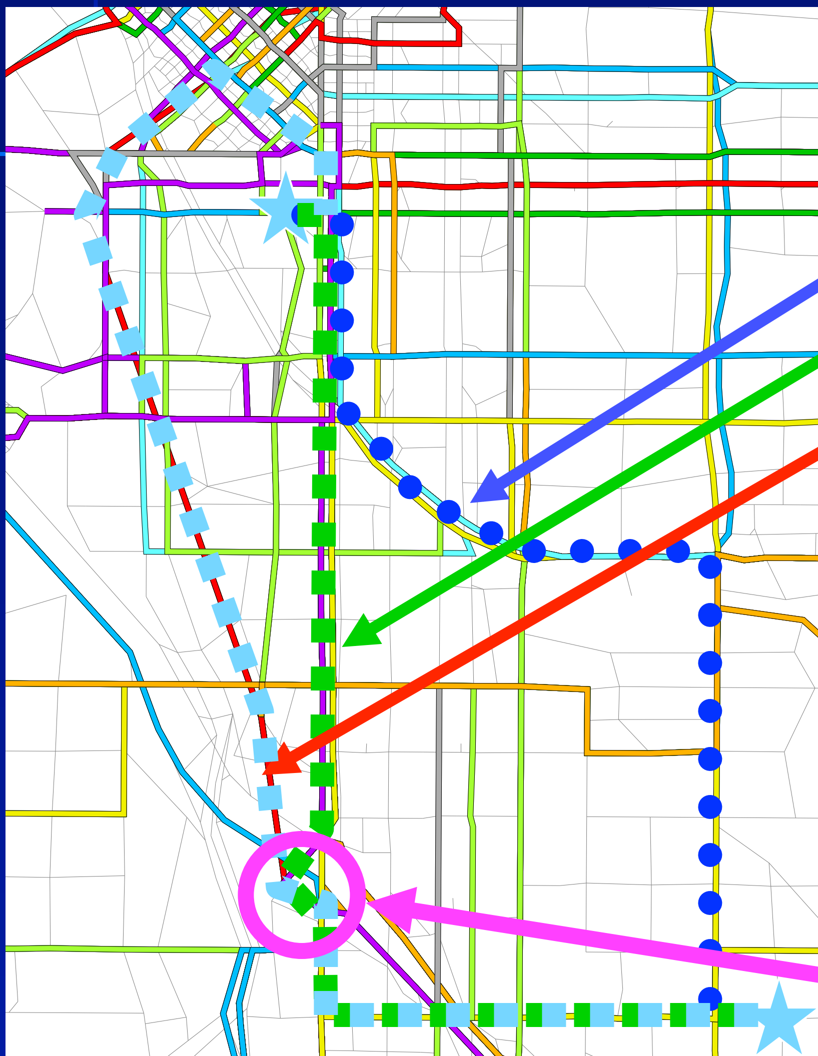
Access Distance Impact on Route Choice



- Possible true trip origins
- Zone centroid for path-building

¼ Mile

Example RTD Path Options



- 3 Reasonable Paths
  - Path 1: 2 Local Buses
  - Path 2: 2 Local Buses
  - Path 3: Local Bus, Rail, Mall Shuttle, Local Bus
- Travel Behavior Inventory (TBI) observations for all three!
- I-25 / Broadway Station

I-25/Broadway Transfers

Transit Network Testing: Typical

- Route specific travel times
  - Modeled versus observed
- Selected transit paths
  - Logical? ("Yep, that makes sense…")
- Boardings per linked trip
  - Assignment of observed on-board survey trips
  - Comparison of assigned to observed boardings
    - By route
    - By service type
    - By access mode (walk versus drive)

Transit Network Testing: Opportunities

- TBI Data –
  – Access and egress mode
  – Individual routes used
- RTD system
  – Reasonable options for paths
  – Reasonable options for modes

TBI Path-Matching Experiments

- Reviewed selected individual reported paths
  - Some logical paths not selected
  - Some multiple path options
  - Some poor reporting by respondents

TBI Path-Matching Experiments

- Review of selected individual reported paths
  - Some logical paths not selected
  - Some multiple path options
  - Some poor reporting by respondents
- **…IS VERY LABOR INTENSIVE!**
- Automated procedure
  - Prediction success tables

Transit Networks for Path-Building

- 7 Networks:
  - Local Bus Only
  - Local & Premium Bus
  - Premium Bus Only
  - Local Bus & Rail
  - Rail Only
  - Premium Bus & Rail
  - All Modes
- 4 Times-of-Day:
  - AM Peak
  - PM Peak
  - Off-Peak
  - Early/Late
- 2 Access Modes:
  - Walk Access
  - Drive Access
- 56 Sets of Paths

How Good Is the Complex MC-Simple Path Approach?

- Prediction success tests
  - Built paths for observed interchanges
    - Based on observed mode combination
      - Local only, premium only, rail only…
  - Compared:
    - Modeled to observed boardings
      - Interchange-by-interchange basis

Prediction Success Results

PM Work Trip – Walk to Rail Only

		Skimmed Boardings			
		No Path	1	2	3+
TBI Reported Boardings	No Path	0	0	0	0
	1	7	3	4	0
	2	1	0	0	0
	3+	0	0	0	0

Prediction Success–Complex MC-Simple Path Approach

Aggregation Level	Number of Linked Trips	Percent with Skimmed Boardings:		
		= Reported Boardings	> Reported Boardings	< Reported Boardings
All Trips	**1,278**	**67%**	**24%**	**9%**
Walk Access	854	67%	23%	9%
Drive Access	424	67%	25%	7%

- 67 percent “correct”
- Unaffected by access mode

Prediction Success Results

Complex MC-Simple Path vs. Simple MC-Complex Path

AM Walk Access Trips

Path-Building Approach	Number of Paths Found	Boardings / Linked Trip	Percent with Skimmed Boardings: = Reported Boardings	> Reported Boardings	< Reported Boardings
Observed	308	1.5	–	–	–
Simple	290	1.6	66%	22%	12%
Complex	302	1.9	52%	38%	10%

- Simple Approach
  - As before
- Complex Approach
  - Observed trips assigned to "All modes" paths

Some Observations…

- Transit users
  - Pick individual paths
  - Do not necessarily:
    - pick the same paths
    - pick logical paths
    - accurately report paths
- Transit multi-path builders
  - Representation of discrete choice
  - Do not capture choice behavior

Conclusions – For Denver

- Transit paths
  - Are choice behavior
  - Should be represented as discrete choices
  - Require substantial resources to model and estimate

Conclusions – In General

- Common network validation measures that may ***not*** be sufficient
  - Ability to assign all observed trips
  - Matching observed boardings / linked trip
- More detailed validation is feasible (prediction success tables)
  - Well designed on-board survey is needed
    - Good origin and destination reporting
    - Access and egress mode
    - Boardings **by mode** for reported trip

Some FTA Observations

Path-Types / Discrete Choice	Network/Pathbuilder
- People choose different paths I-J	- Nesting β's always asserted
- Pathbuilders do fares badly	- Pathbuilder–MC consistency
- Need 1st-board-location choice	- Favoring paths → distortions
- Different choices, different ε's	- Path choices defy discrete labels
- Others ……	- Others ……

Response: DATA → ANALYSIS → SPECIFICATIONS

And kudos to DRCOG

14. Telling a Good Story

- FTA requirements for New Starts
- Useful "Make the Case" documents
- Thoughts on good practice
- Participant experiences
- An example

FTA Requirements

- Make-the-Case document
  - Guide to project benefits and "justification"
    - For FTA staff
    - For FTA briefing papers, talking points
    - For the Annual Report on New Starts
  - Element of project "justification" rating

A Useful Document

- No more than "five pages"
  - Project identification
  - Setting
  - Purpose
  - Current conditions in the corridor
  - Anticipated conditions in 2030
  - The case for the proposed project
  - Risk
  - Summary

Some Not-Useful Elements

- Topics relevant elsewhere (not here)
  - History of project development
  - Detailed project description
  - Financial feasibility
  - Public support; other support
  - "Importance"
  - Pictures

Project Identification

- One or two sentences
  - Transit mode
  - Starter line, expansion, or extension
  - Length of project
  - Location

Setting

- Map
- Key jurisdictions, activity centers
- Any key geographical features
- Major transportation facilities

Purpose of the Project

- Transportation
  - Whom is it intended to serve?
  - From where to where?
- Economic development (if applicable)
  - Development locations
  - Role of the project – specific mechanisms

Current Conditions

- Current ≈ today (usually, today ≠ 2000)
- Conditions relevant to project benefits
  - – Key travel markets (and recent growth?)
  - – Congestion & highway travel times
  - – Transit services & transit travel times
  - – Transit ridership, emphasis on key markets

Conditions in 2030

- Key <u>changes</u>: today to 2030 (No Build)
  - Travel markets
  - Highway system
  - Transit facilities, services, and travel times
  - Transit ridership
- Well linked to current conditions

Case for the Project

- Low-cost approach (TSM)
  - Brief description of key TSM elements
  - Impact on transit service quality
  - Impact on transit ridership
  - Mobility benefits (time savings)
  - Cost-effectiveness versus No-Build
  - Success in addressing the purpose(s)

Case for the Project

- Proposed approach
  - Brief description of the project
  - Impact on transit service quality
  - Impact on transit ridership in key markets
  - Mobility benefits (time savings)
  - Success in achieving the purpose(s)
  - Cost-effectiveness versus TSM

Risk

- Uncertainties in the costs
  - Project scope
  - Unit prices
  - Track record
- Uncertainties in the benefits
  - Time savings
  - Guideway ridership
  - Track record

Summary

- One paragraph; one sentence per topic
- Essential elements of the case
  - What is the purpose?
  - How urgent is the problem?
  - Why is a low-cost approach insufficient?
  - How well does the project succeed?
  - Are costs in scale with the benefits?
  - How firm are the costs and benefits?

Thoughts on Good Practice

- Focus
  - All discussion sections should help explain the benefits of the project
  - A strategy
    1. Figure out the principal benefits (markets: geography, trip purposes, etc.) that make the case
    2. Focus the introductory sections (setting, current and future conditions) on those markets

Thoughts on Good Practice

- Quantification
  - Forecasts have numbers for ≈ everything
  - Use them to avoid hand-waving.
- Clarity
  - "To write well is to think clearly. That's why it's so hard." – David McCollough, 2003
  - Assign someone who can do both.

Thoughts on Good Practice

- Resources
  - Basic summaries often not enough
  - Subtask: extract information from forecasts
  - Preservation of resources for this work
- FTA assistance
- Ethics
  - Reliable numbers for decision-making
  - Bringing project benefits to the discussion

Participant Experiences

- Attempts at Make-the-Case narratives
- Methods to find/correct errors
  - Summit
  - Other tools/procedures
- Methods to better understand a project
  - Summit
  - Other tools/procedures

Making the Case: An Example

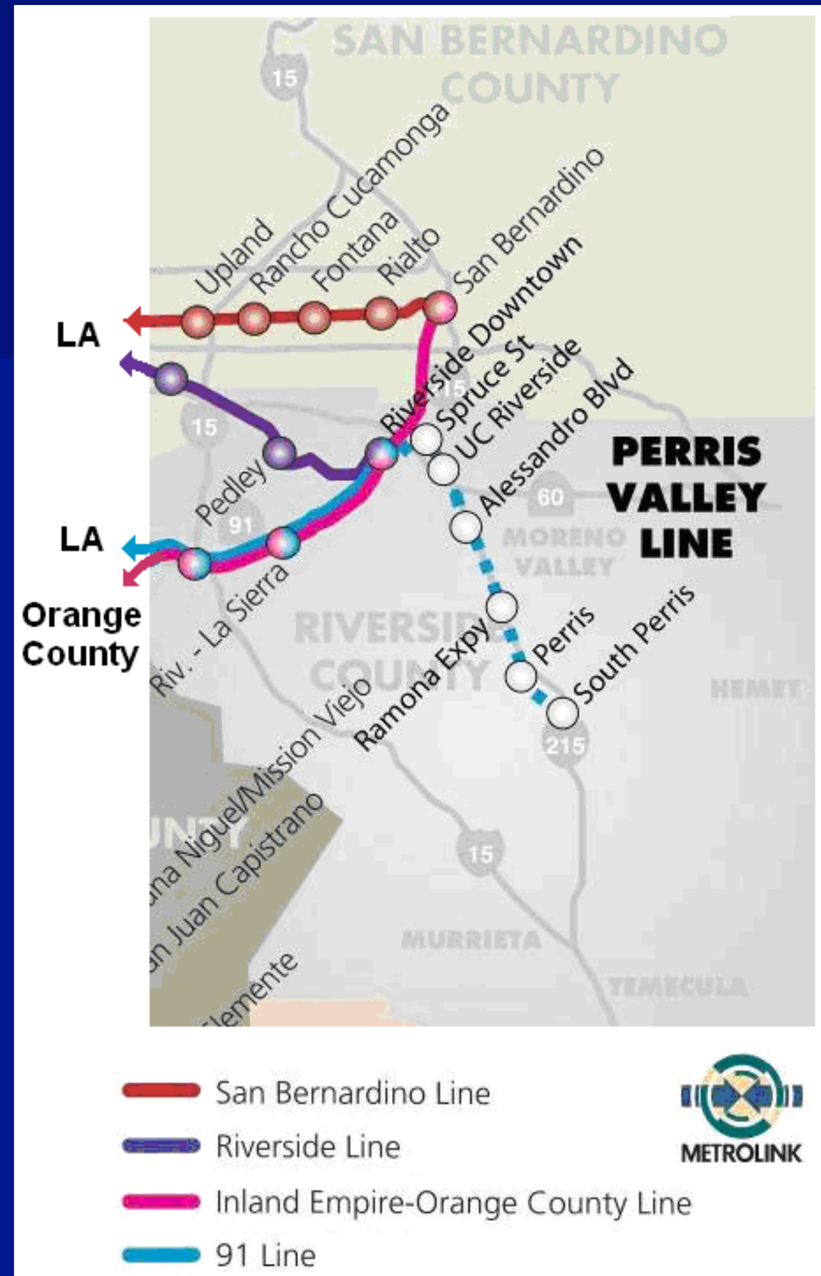
Perris Valley Commuter Rail Extension

- Riverside County Transportation Commission (California)

Perris Valley Line

<u>Identification</u>

- 23-mile extension of the Metrolink commuter rail system from Riverside to communities in Perris Valley southeast of Riverside



Setting

- City of Riverside
  - 50 miles east of downtown LA
  - 30 miles northeast of central Orange County
- Perris Valley and I-215 to southeast
- Moreno Valley and SR-60 to the east
- Metrolink lines
  - Riverside Line to LA via Pomona
  - 91 Line to LA via Fullerton
  - Inland Empire line to Orange County

Purpose of the Project

- The Perris Valley extension will improve transit access to the Metrolink system and the locations it serves for residents of Perris and Moreno Valleys.

Current Conditions

- Demographics
  - 425,000 people and 123,000 jobs
  - One of the most rapidly growing counties nationally
  - Housing prices 25-35% less than in LA and OC
- Long commutes and drive times
  - Riverside to LA CBD: 54 miles, 100 minutes
  - Riverside to Orange: 35 miles in 76 minutes)

Current Conditions

- Key travel markets from Perris Valley
  - 18,000 workers to LA County
  - 30,000 workers to Orange County
- Metrolink service from Riverside
  - 37 trains per day on two lines to LA and one line to OC
  - Focused on peak periods and commuters
- Metrolink ridership: Riverside and adjacent stations
  - 4,000 weekday trips total; 3,000 at Riverside station
  - 84% commuters; 65 % Perris Valley residents
  - 90 percent use auto access; 10 percent connector bus
  - Drive from South Perris to Riverside: 21 miles, 32 mins.

Conditions in 2030

- Rapid growth in Perris Valley
  - +76% population to 600,000 people
  - +115% employment to 210,000 jobs
- Resulting growth in commuter markets
  - 24,000 workers to LA County (+33%)
  - 46,000 workers to Orange Co. (+53%)
- Consequent lengthening of peak periods for auto travel

Conditions in 2030

- Large Metrolink changes
  - 126 trains per day (versus 37 per day currently)
  - 16,300 trips per day using Riverside Co. stations
  - 11,700 of these from Perris Valley
  - Same commuter-oriented characteristics
- More difficult drive-access
  - South Perris to Riverside, 21 miles
    - 32 minutes (39 mph) today
    - 67 minutes (19 mph) in 2030

Case for the Project

- Low-cost alternative
  - New express bus service to Riverside station
  - Additional park/ride facilities
  - Mixed-traffic operations
  - An increase of 216 riders/day over No-Build
  - Key limitation: long travel times because of congested highways

Case for the Project

- Proposed project
  - 23-mile commuter rail line
  - Six stations (5 park/ride with 1,800 spaces)
  - Extension of the 91 line to downtown LA
- Travel times: Perris Valley to Riverside
  - 67 minutes by driving
  - 87 minutes by bus
  - 40 minutes by commuter rail

Case for the Project

- Metrolink ridership
  - 8,800 more weekday riders than in TSM
- User benefits: 3,100 hours/day saved
  - 79% by commuters; 83% by PV residents
  - Key markets – Perris Valley to:
    - Orange County: 1,000 hrs; ≈18 min/trip
    - Los Angeles: 700 hrs; ≈29 min/trip
    - Riverside: 400 hrs; ≈22 min/trip

Case for the Project

- Cost effectiveness
  - Capital: $180 million in 2007 dollars
  - Added O&M cost: $1.5 million/year
  - Time savings: 850,000 hours/year
  - $22.40 per hour of time savings
  - Competitive for federal funding

Risks (Some Thoughts)

- Ridership and transportation benefits
  - Sources of risk?
    - Very high growth projections
    - Very large congestion increases
    - Very large Metrolink service increases (NB)
  - Aspects that help contain risk
    - Existing Metrolink ridership from Perris Valley
    - Large Metrolink system, ridership, DATA
- Costs: from formal risk analysis

Summary

- Rapid growth
- Long-distance commutes
- Difficult access to Metrolink system
- Large time savings (total and per rider)
- Low capital cost
- Costs in scale with the benefits

15. Economic Development

- SAFETEA-LU New Starts requirements
- FTA thoughts, activities
- Discussion / ideas

Requirements

- SAFETEA-LU: Evaluate projects on:

  "… a comprehensive review of its … economic development effects, and public transportation supportive land use policies and future patterns."

FTA Thoughts

- Challenges
  - Land use versus economic development
    - Need clearly distinguished definitions, measures
    - So:
      - Land use = attributes of the project setting
      - Econ-dev = changes because of the project

FTA Thoughts

- Challenges (continued)
  - User benefits (UBs) versus economic development benefits (EDBs)
    - Need to avoid double-counting mobility/accessibility
    - So: looking for clear evidence that a measurable portion of economic development impacts are separable and independent of user benefits

FTA Thoughts

- Challenges (continued)
  - – Demonstrated impacts
    - Need to have analytical basis for EDBs
    - So:
      - – Literature review
      - – Apparently sparse evidence that transit station proximity, by itself, has consistent impacts on land prices (and by extension, development benefits)
      - – Few existing studies distinguish the impacts of the project from the impacts of zoning changes, development incentives, and other policies that affect development

FTA Thoughts

- Challenges (continued)
  - Useful measure
    - Need a measure of EDBs that provides a reasonable accounting of benefits and disbenefits
    - So: concerns on “trip not taken” measurement
      - Location choice = f(travel costs, schools, amenities …)
      - So, different choices → different bundles of attributes
      - Relocation to location with lower travel costs cannot be evaluated solely on the basis of reduction in travel costs
      - Direct parallel to evaluating mode-shift benefits using a strict accounting of “time savings”

FTA Thoughts

- Challenges (continued)
  - Predictive tools
    - Need method for predicting development impacts and EDBs for individual projects in individual contexts
    - So: FTA will be evaluating existing predictive tools
      - Residential-location choice models
      - Workplace/employer-location choice models
      - Others?

FTA Thoughts

- NPRM
  - Evaluate presence of EDB-supportive conditions
    - Opportunity: availability of land for (re)development
    - Market conditions: regional and corridor activity
    - Supporting policies: zoning, tax, & other
    - Accessibility impacts: consequence of the project
    - Permanence: characteristics of the project
  - Premise: favorable conditions → large EDBs
  - Part of the measure of project <u>effectiveness</u>
  - Continued standard allowance in <u>cost-effectiveness</u>

FTA Thoughts

- "Measures" document
  - Rely on location choice models for predictions and measures of benefits
  - Possible advantages
    - Project-specific quantification of EDBs
    - Possible inclusion in cost-effectiveness calculations
    - Probability that some projects are "above average" in that they have more EDBs than they get from the standard allowance (implications for others?)

FTA Activities

- NPRM
  - Receipt of formal comments; then … ?
- FTA-sponsored applied research
  - Literature review (→ FTA website)
  - Kick-off: meeting of expert panel 10/2007
  - Development of predictive tool(s)
- Ideas from travel forecasters?

16. Wrap-Up

- Additional comments by participants
- FTA to-do list
- FTA objectives for travel forecasting in support of New Starts

Additional Comments

-
-
-
-
-
-
-

FTA To-do List

- Research?
- Written guidance?
- Training?
- Future workshop?
- Other?

FTA Objectives

- Travel forecasting for New Starts
  - Sufficient data to inform technical work
  - Meaningful testing of travel models
  - Adequate QC <u>and analysis</u> of forecasts

  - *Understanding of project benefits*