Bi-Coastal Comparison and Transfer of Land Use Modeling Methods

Speed Data-Ing ??
If Got to be done, better be done earlier than later

Troy Hightower, Kern COG

Colby Brown, Citilabs

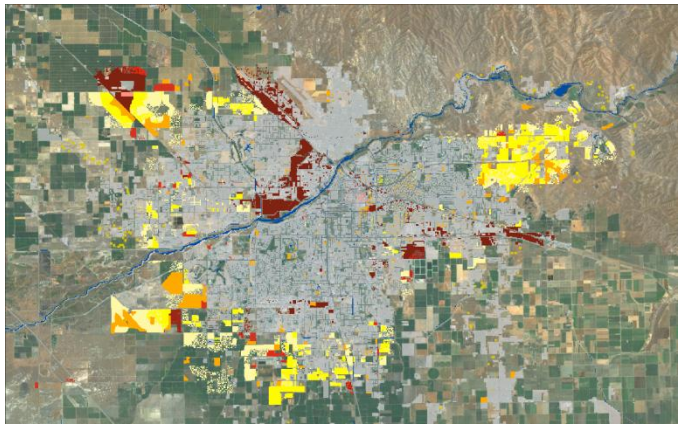
David J.-H. Lee, FAMPO / GWRC

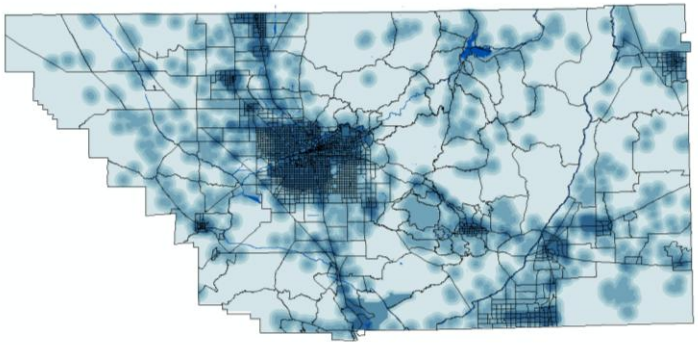
Overview

- It is increasingly possible to separate the **bid**, **rent**, and **cost** *functions* that describe the behavior of actors in the real estate markets from the *adjustments* that are required to calibrate a model to local conditions
- This raises the possibility of partial land use model **transfer** from one area to another
- In this case, we attempt a model transfer from Bakersfield, California, to Fredericksburg, Virginia

Kern COG (Bakersfield, CA)

- Kern County
  - Population 661,645 (2000 Census)
  - ~1.5 hours northwest of Los Angeles
- Background
  - Regional Blueprint Plan (since 2005)
  - Used Uplan (rule-based GIS model) with existing travel demand model
- New challenges: SB 375, AB 32
  - “Sustainable Community Strategies”
  - Comparison of carbon emissions and consideration of economic effects
- SB 375 pilot study
  - Leverage information from Uplan in GIS
  - Integrate with travel demand model and the D’s processor





KernCOG Land Use: Uplan Categories

1. Residential High
2. Residential Medium
3. Residential Low
4. Residential Very Low
5. Mixed Use
6. Basic Production
7. Retail High
8. Retail Medium
9. Retail Service
10. Service Other
11. Service Warehouse

- Identifies use and intensity
- Attributes describe land consumption rates (per-HH and per-job)
- Use as *Real Estate Supply Types* in SB 375 pilot study

KernCOG Household Types

- Use income / size categories in travel model (derived from Census PUMS) as household types in new land use allocation model

Table 5-1: Proportion of Households by Income Group and Household Size from 2000 PUMS Data

Income Group (2000 $)	Household Size, percent				Total
	1	2	3	4+	
$0 – $24,999	12%	9%	6%	9%	36%
$25,000 – $49,999	5%	9%	4%	11%	30%
$50,000 – $74,999	2%	5%	3%	7%	17%
$75,000 or more	1%	6%	3%	7%	18%
Total	**20%**	**28%**	**17%**	**35%**	**100%**

Non-residential Real Estate Markets

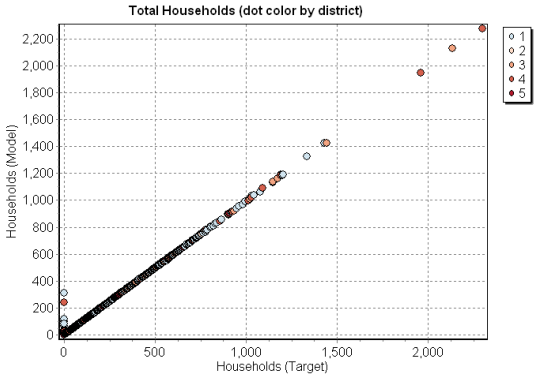
Several NAICS categories “compete” for units in each Kern land use type

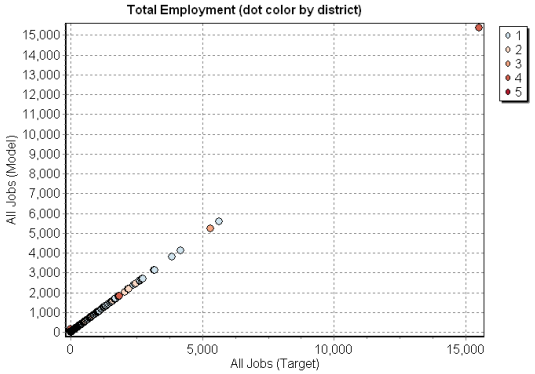
NAICS	Description	BASIC	BWOTH	RHRET	RMRET	SCSER	SOSER
11----	Forestry, Fishing, Hunting, and Agriculture	1	0	0	0	0	0
21----	Mining	1	0	0	0	0	0
22----	Utilities	0	1	0	0	0	0
23----	Construction	0	0	0	0	1	0
31----	Manufacturing	1	0	0	0	0	0
42----	Wholesale Trade	0	0	0	0	1	0
44----	Retail Trade	0	0	1	1	0	0
48----	Transportation and Warehousing	0	1	0	0	0	0
51----	Information	0	0	0	0	0	1
52----	Finance and Insurance	0	0	0	0	0	1
53----	Real Estate and Rental and Leasing	0	0	0	0	0	1
54----	Professional, Scientific, and Technical Services	0	0	0	0	0	1
55----	Management of Companies and Enterprises	0	0	0	0	0	1
56----	Administrative, Support and Waste Management	0	0	0	0	1	0
61----	Educational Services	0	0	0	0	0	1
62----	Health Care and Social Assistance	0	0	0	0	0	1
71----	Arts, Entertainment, and Recreation	0	0	0	0	1	0
72----	Accommodation and Food Services	0	0	1	1	0	0
81----	Other Services (except Public Administration)	0	0	0	0	1	0
99----	Unclassified	0	1	0	0	0	0

Aggregate to get jobs by Kern category

KernCOG Calibration Results

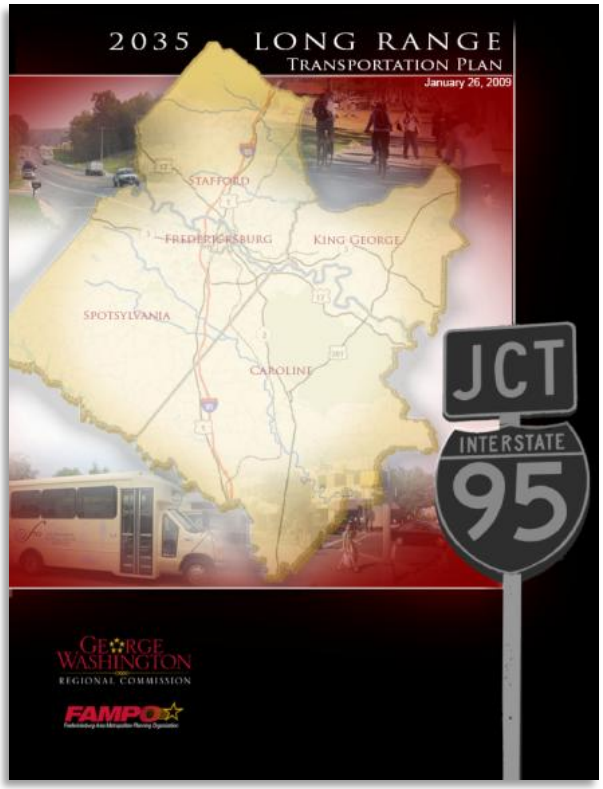
- Auto-calibration routine iteratively refines bid, cost adjustments until allocated households and jobs match user-defined targets
- Function *parameters* (coefficients / elasticities) are <u>untouched</u> by this

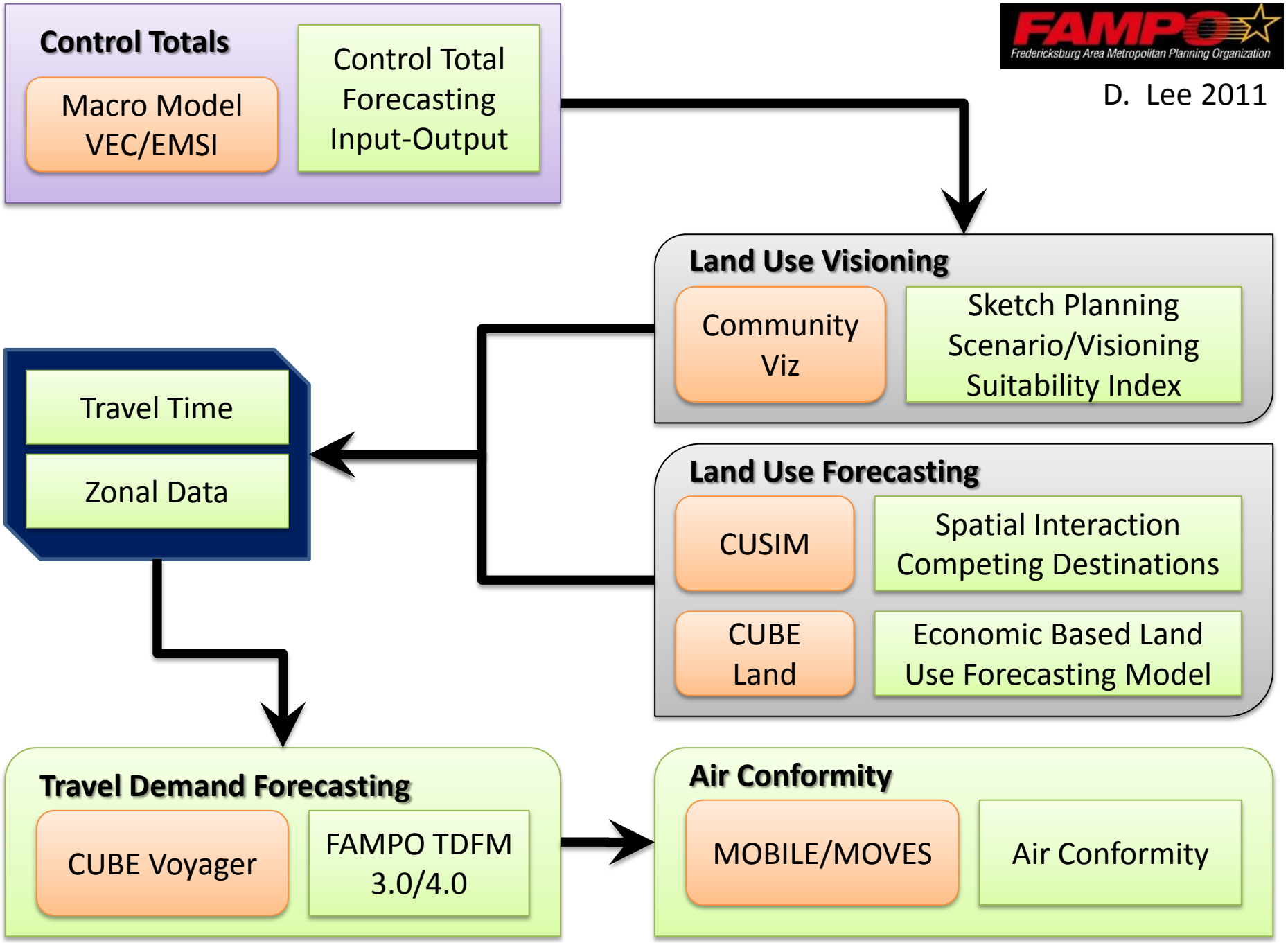




Fredericksburg Area MPO / George Washington Regional Commission

- GWRC area
  - Population 241,044 (est. 2000 Census)
  - Located ~1 hour southwest of Washington, DC
- Agency experience with integrated land-use/travel demand models
  - Dr. David J.-H. Lee's CUSIM-M model
  - Competing Destinations based on own research
- Ongoing efforts in scenario-based land use planning with GIS tools
  - Using GIS (CommunityViz) in public workshops to show sensitivities/impacts
- Moving forward…
  - Better integration with travel demand model
  - Opportunity to use scenario plan inputs

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Control Totals
Macro Model VEC/EMSI
Control Total Forecasting Input-Output
Land Use Visioning
Community Viz
Sketch Planning Scenario/Visioning Suitability Index
Travel Time
Zonal Data
Land Use Forecasting
CUSIM
Spatial Interaction Competing Destinations
CUBE Land
Economic Based Land Use Forecasting Model
Travel Demand Forecasting
CUBE Voyager
FAMPO TDFM 3.0/4.0
Air Conformity
MOBILE/MOVES
Air Conformity

Consensus Building through Visioning

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Land Use Visioning

Community Viz

Sketch Planning; Scenario/ Visioning; Suitability Index

- Public Participation in Planning Process
- Redirecting Land Use Policy Direction (UDA, Green Infrastructure, etc)
- Reconsideration Various Policies
- Provide Tools to Planners (Plan, Ordinances)
- Influence on Future Development Patterns
- Influence on LUFM Assumptions
- Complementary to LU Forecasting
- GIS/ Parcel Based (Incorporate Zoning)

Consensus Building: Grass root/ Bottom-Up Approach

On-Line Citizen Survey

Focus Group Meetings

Citizen Workshops

Project Steering Committee

Residents, Business leaders, Planners and Elected officials

George Washington Region Regional Land Use Scenario Plan

Scenarios-at-a-Glance

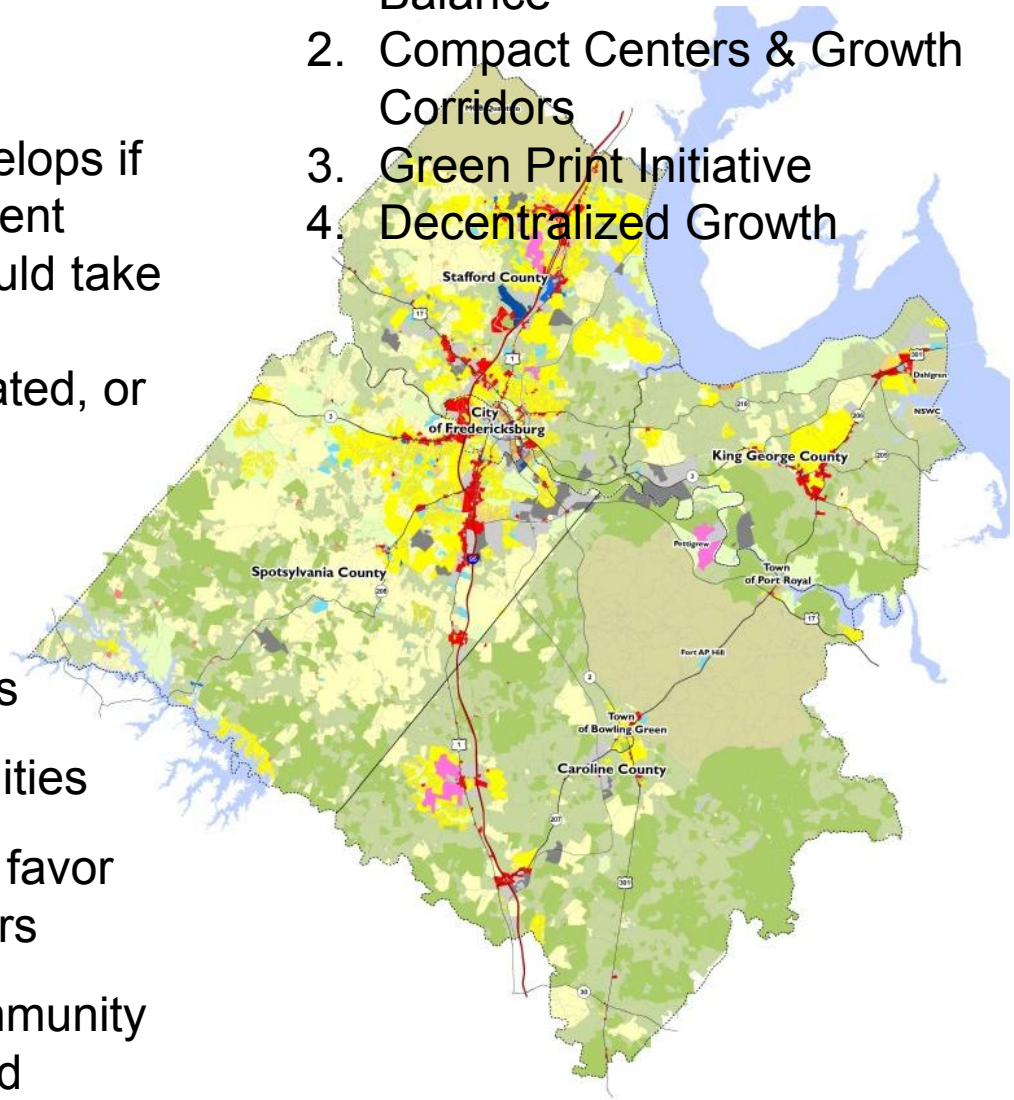
- Evaluate the four development scenarios
  1. Greater Jobs-Housing Balance
  2. Compact Centers & Growth Corridors
  3. Green Print Initiative
  4. Decentralized Growth

Decentralized Growth:

Contemplates how the region develops if the dispersed pattern of development were to continue. New growth would take the form of single use, low-density development that is generally isolated, or not well-connected.

Common Features:

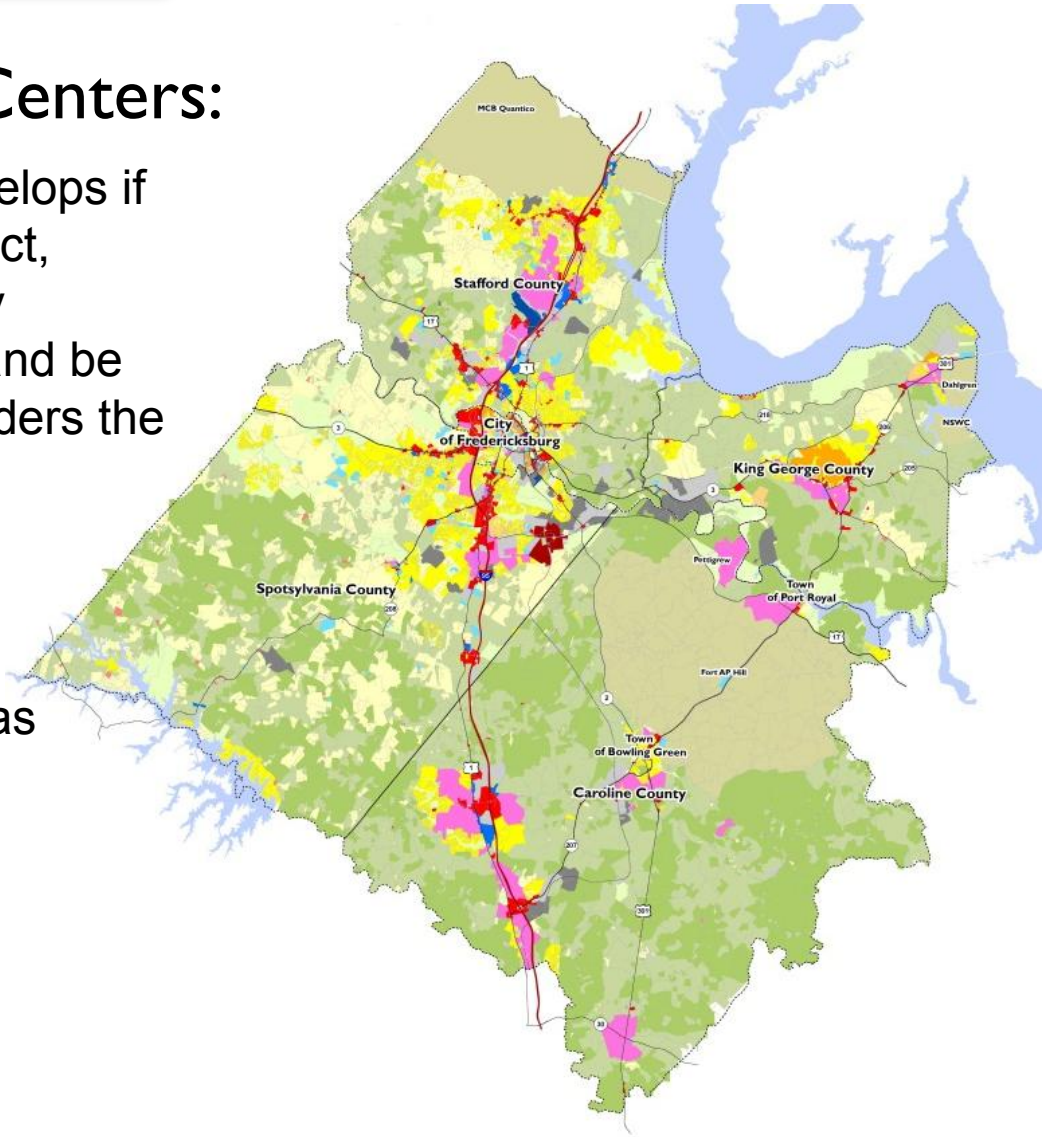
- Greenfield development patterns
- Outward expansion of public utilities
- Transportation investments that favor single-occupant automobile users
- Region remains a bedroom community to Washington D.C. or Richmond



Scenarios-at-a-Glance

Compact Development Centers:

Contemplates how the region develops if new growth is focused into compact, walkable communities with nearby opportunities to live, work, shop, and be entertained. This scenarios considers the concept of UDAs for the region.



Common Features:

- Concentrated development areas
- Land preservation outside the development areas
- Variety of development types & intensities
- More travel options within & between centers

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Roles

- Scenario planning provides a **forum**, process, set of tools, and measurable outcomes so the region might contemplate alternative growth futures.
- Allows stakeholders the **opportunity** to measure results and **evaluate the trade-offs** associated with competing scenarios.
- Scenario planning **tools** are being developed for each jurisdiction in the region.
- Becomes a resource / tool for local government **planning initiatives**.

Scenario Report Card

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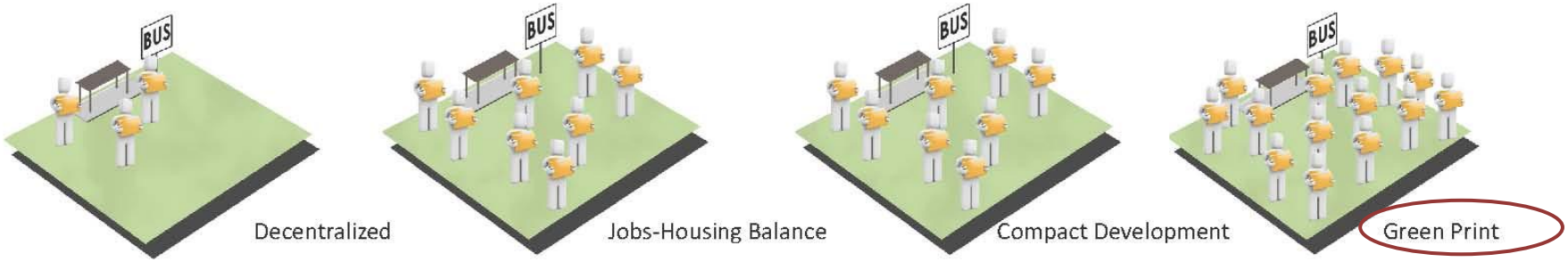
Mobility Principle (1 example of 6 selected principles)

Percent of Population Near Transit



Percent of Income Spent on Transportation

Viable Mobility Options

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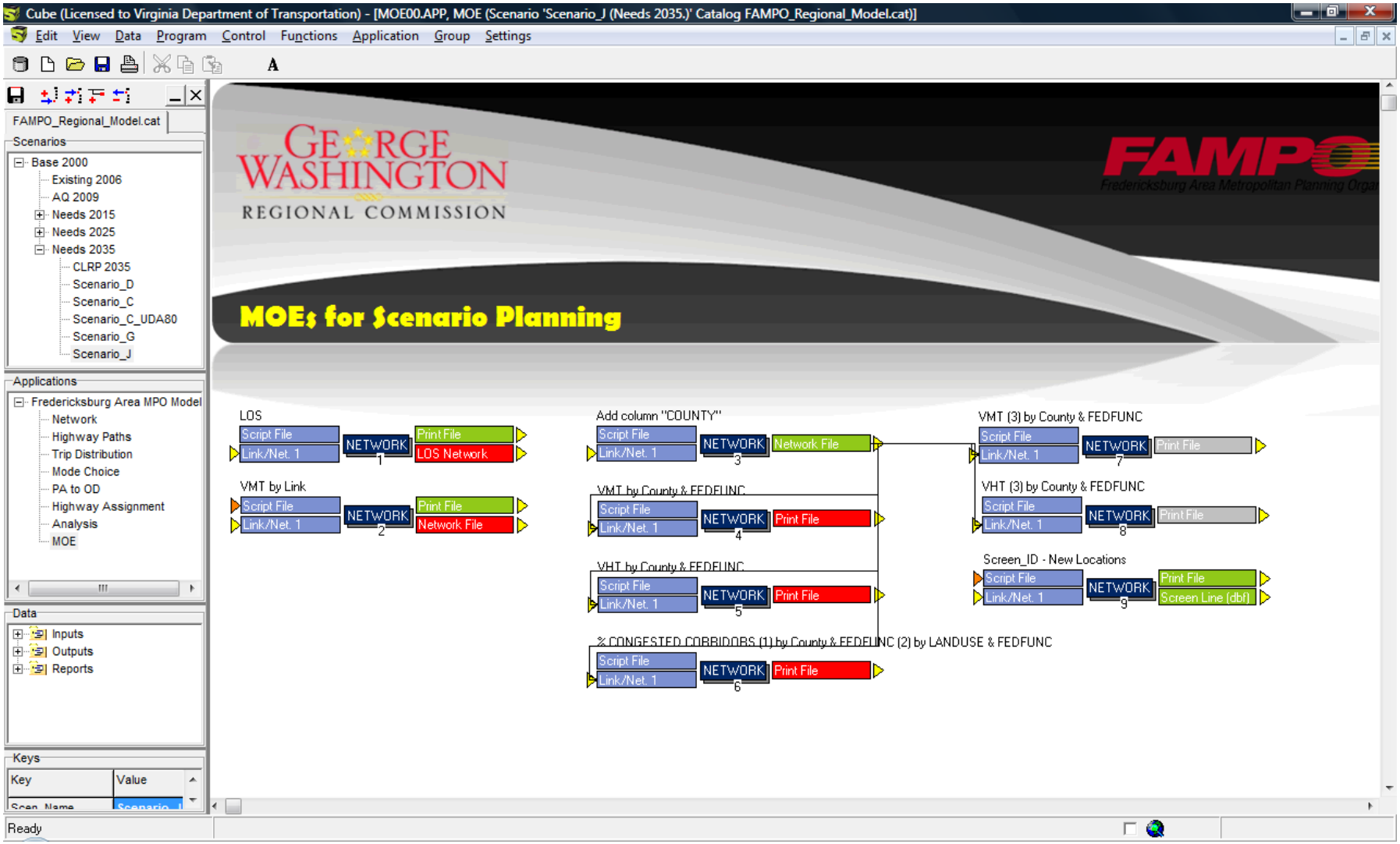
Connecting LU Visioning to CUBE Voyager



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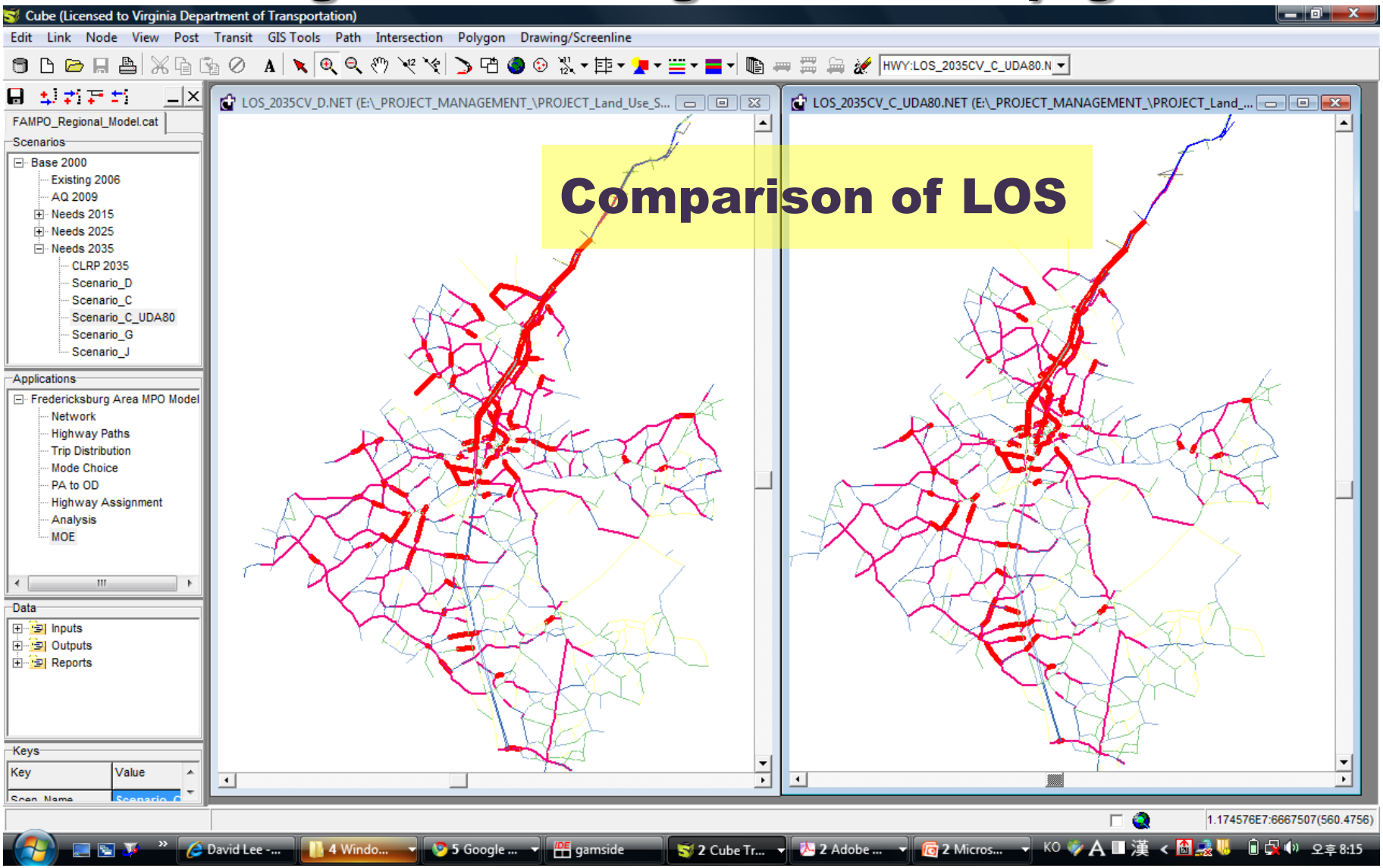
Connecting LU Visioning to CUBE Voyager



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Connecting LU Visioning to CUBE Voyager

Comparison of VMT, VHT, Avg. Speed

Cube (Licensed to Virginia Department of Transportation)

Edit Run Search Insert

FAMPO_Regional_Model.cat

Scenarios
- Base 2000
  - Existing 2006
  - AQ 2009
  - Needs 2015
  - Needs 2025
  - Needs 2035
    - CLRP 2035
    - Scenario_D
    - Scenario_C
    - Scenario_C_UDA80
    - Scenario_G
    - Scenario_J

Applications
- Fredericksburg Area MPO Model
  - Network
  - Highway Paths
  - Trip Distribution
  - Mode Choice
  - PA to OD
  - Highway Assignment
  - Analysis
  - MOE

Data
- Inputs
- Outputs
- Reports

Keys

Key	Value
Scen_Name	Scenario_D

VHT2_2035CV_D.PRN (E:_PROJECT_MANAGEMENT_\PROJECT_Land_Use_...

```
CROSSTAB ROW=COUNTY COL=FEDFUNC VAR=VMTDAILY
                        1              2              3
-------- -------------- -------------- -------------- --------
 1 -  1       3,476,156        857,775      1,480,960      1,4
 2 -  2               0        428,786        586,564        2
 3 -  3         596,292        443,468        129,496
 4 -  4       1,564,275      1,310,925      1,017,571      1,3
 5 -  5       1,802,384        649,384        332,185        8
Page 29  (VOYAGER NETWORK)
Virginia Department of Transportation
-------------------------------------

CROSSTAB ROW=COUNTY COL=FEDFUNC VAR=VHTDAILY
                        1              2              3
-------- -------------- -------------- -------------- --------
-------------------------------------------------------------
 1 -  1          87,639         24,134         40,872
 2 -  2               0          9,243         12,354
 3 -  3          16,870         13,097          4,299
 4 -  4          27,971         38,771         25,910
 5 -  5          28,598         13,104          7,554


CROSSTAB ROW=COUNTY COL=FEDFUNC COMP=VMTDAILY/VHTDAILY
                        1              2              3
-------- -------------- -------------- -------------- --------
 1 -  1           39.66          35.54          36.23
 2 -  2               0          46.39          47.48
 3 -  3           35.35          33.86          30.12
 4 -  4           55.92          33.81          39.27
 5 -  5           63.02          49.56          43.97

NETWORK  ReturnCode = 1  Elapsed Time = 00:00:00
#################################################################
```

VHT2_2035CV_C_UDA80.PRN (E:_PROJECT_MANAGEMENT_\PROJECT_Lan...

```
CROSSTAB ROW=COUNTY COL=FEDFUNC VAR=VMTDAILY
                        1              2              3
-------- -------------- -------------- -------------- --------
 1 -  1       3,501,666        808,787      1,466,566      1,28
 2 -  2               0        449,043        687,682        22
 3 -  3         601,371        477,284        143,043        10
 4 -  4       1,483,150      1,243,370        949,299      1,23
 5 -  5       1,657,026        697,113        344,004        99
Page 29  (VOYAGER NETWORK)
Virginia Department of Transportation
-------------------------------------

CROSSTAB ROW=COUNTY COL=FEDFUNC VAR=VHTDAILY
                        1              2              3
-------- -------------- -------------- -------------- --------
-------------------------------------------------------------
 1 -  1          87,187         22,760         40,221
 2 -  2               0          9,648         14,521
 3 -  3          17,193         14,667          5,096
 4 -  4          26,550         36,217         22,577
 5 -  5          26,394         14,278          7,872


CROSSTAB ROW=COUNTY COL=FEDFUNC COMP=VMTDAILY/VHTDAILY
                        1              2              3
-------- -------------- -------------- -------------- --------
 1 -  1           40.16          35.54          36.46
 2 -  2               0          46.54          47.36
 3 -  3           34.98          32.54          28.07
 4 -  4           55.86          34.33          42.05
 5 -  5           62.78          48.82          43.70

NETWORK  ReturnCode = 1  Elapsed Time = 00:00:00
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```

LOS_... LOS_...

Ready 308:1

David Lee -... 4 Windo... 5 Google ... gamside 2 Cube Tr... 2 Adobe ... 2 Micros... KO 오후 8:20

Scenario Comparisons

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Land Use Visioning

Community Viz

Rule Based Scenario/ Visioning Suitability Index

	Decentralized Growth	Green Print Initiative	Compact Development	Jobs-Housing Balance
Mobility				
Vehicle Miles Traveled per Capita	○	⊙	◪	●
Vehicle Hours Traveled per Capita	○	⊙	◪	●
Percent of Population Near Potential Transit Node	○	⊙	●	●
Congested Corridors	○	⊙	◪	●
Percent of Income Spent on Transportation	○	◪	●	●
Viable Transportation Options	○	◪	●	●
Environment				
Urban Footprint	○	●	◪	◪
Agricultural Land Consumed	○	●	◪	◪
Eco-Core Land Consumed	○	●	◪	◪
Amount of Protected Open Space	○	●	◪	◪
Genuine Communities				
Housing Mix	○	◪	●	●
Proximity to Existing Development	○	●	◪	◪
Jobs-Housing Balance	○	○	○	●
Regional Collaboration				
Consistency with Local Plans & Ordinances	●	○	◪	◪
Consistency with Regional Plans	○	⊙	◪	◪
Land Use / Transportation Connection	○	◪	●	●
Maximizing Efficiencies in Public Infrastructure				
Demand for New Parks	○	⊙	⊙	●
[illegible]	○	○	○	●
Demand for Water	○	⊙	⊙	●
Demand for Sewer	○	⊙	⊙	●
Quality-of-Life				
Protection of Civil War Battlefields	○	●	⊙	⊙
Jobs-Housing Balance	○	○	○	●
Amount of Protected Open Space	○	●	◪	◪
Maintaining Rural Character	○	●	◪	◪
Composite Grade (w/ Equal Weighting for All Variables)		⊙	◪	●

Preferred Alternative for Policy Direction

Notes:
● = Most satisfies the performance measure
◪ = Moderately satisfies the performance measure
⊙ = Somewhat satisfies the performance measure
○ = Least satisfies the performance measure

FAMPO LU Forecasting

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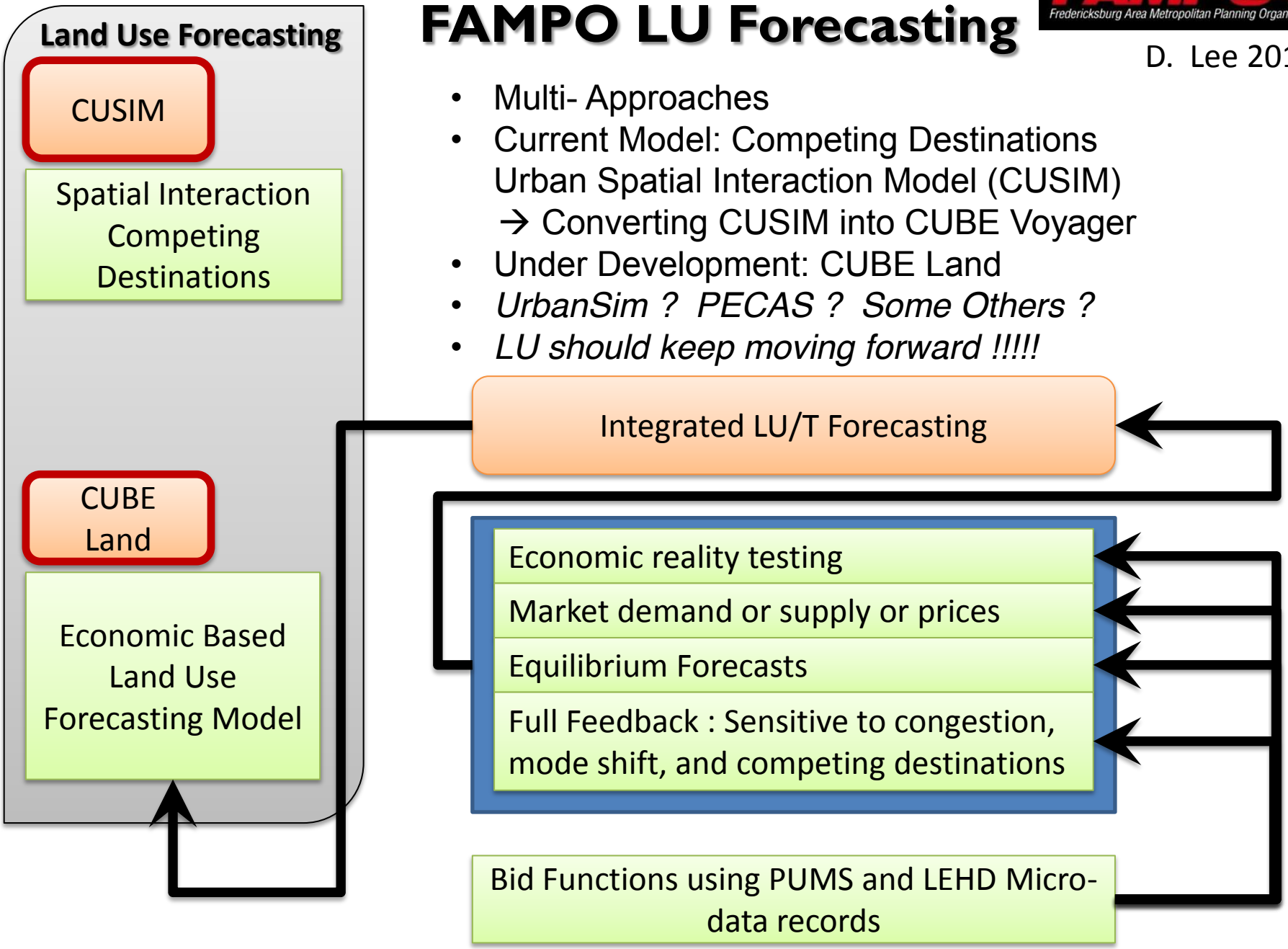
- Multi- Approaches
- Current Model: Competing Destinations Urban Spatial Interaction Model (CUSIM)
  → Converting CUSIM into CUBE Voyager
- Under Development: CUBE Land
- *UrbanSim ? PECAS ? Some Others ?*
- *LU should keep moving forward !!!!!*



CUSIM

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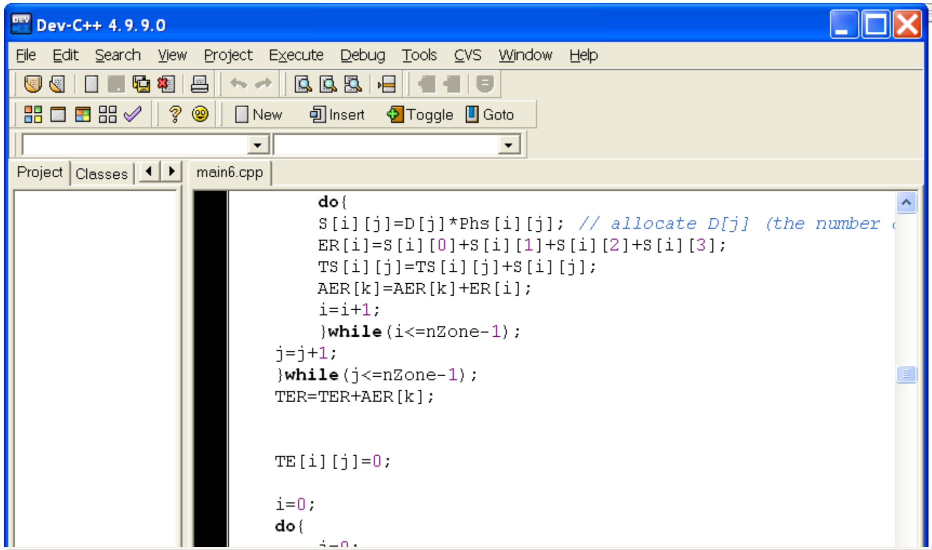
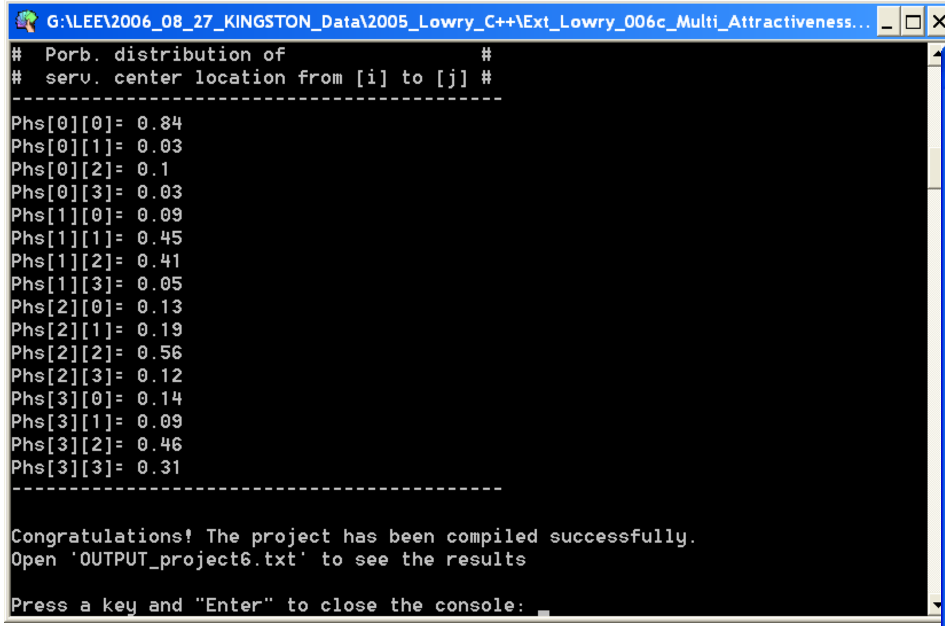
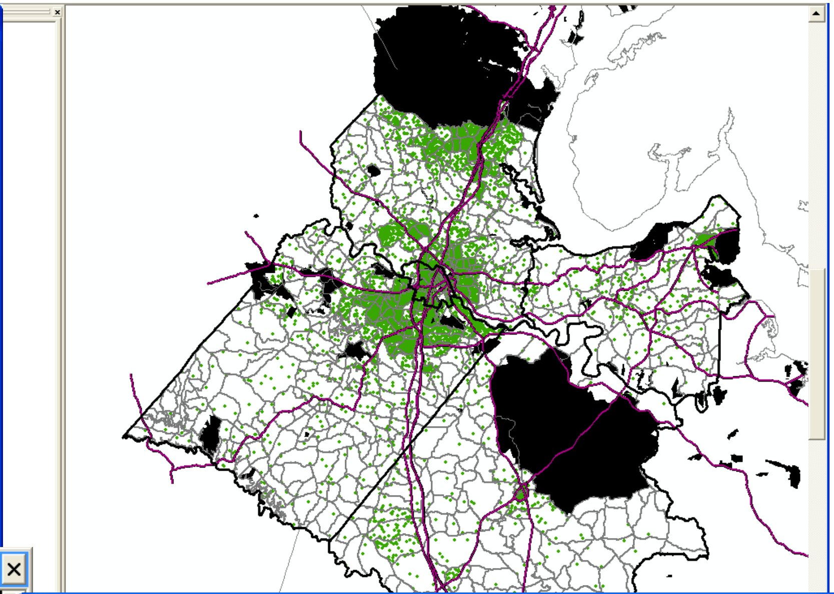
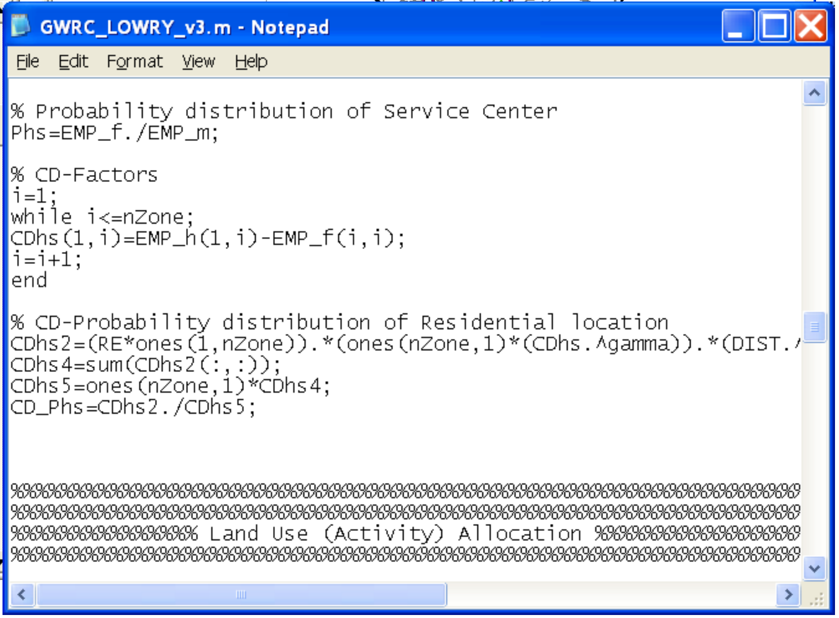


```
            do{
            S[i][j]=D[j]*Phs[i][j]; // allocate D[j] (the number
            ER[i]=S[i][0]+S[i][1]+S[i][2]+S[i][3];
            TS[i][j]=TS[i][j]+S[i][j];
            AER[k]=AER[k]+ER[i];
            i=i+1;
            }while(i<=nZone-1);
        j=j+1;
        }while(j<=nZone-1);
        TER=TER+AER[k];


        TE[i][j]=0;

        i=0;
        do{
```



```
#  Porb. distribution of             #
#  serv. center location from [i] to [j] #
------------------------------------------
Phs[0][0]= 0.84
Phs[0][1]= 0.03
Phs[0][2]= 0.1
Phs[0][3]= 0.03
Phs[1][0]= 0.09
Phs[1][1]= 0.45
Phs[1][2]= 0.41
Phs[1][3]= 0.05
Phs[2][0]= 0.13
Phs[2][1]= 0.19
Phs[2][2]= 0.56
Phs[2][3]= 0.12
Phs[3][0]= 0.14
Phs[3][1]= 0.09
Phs[3][2]= 0.46
Phs[3][3]= 0.31
------------------------------------------

Congratulations! The project has been compiled successfully.
Open 'OUTPUT_project6.txt' to see the results

Press a key and "Enter" to close the console: _
```





```
% Probability distribution of Service Center
Phs=EMP_f./EMP_m;

% CD-Factors
i=1;
while i<=nZone;
CDhs(1,i)=EMP_h(1,i)-EMP_f(i,i);
i=i+1;
end

% CD-Probability distribution of Residential location
CDhs2=(RE*ones(1,nZone)).*(ones(nZone,1)*(CDhs.^gamma)).*(DIST./
CDhs4=sum(CDhs2(:,:));
CDhs5=ones(nZone,1)*CDhs4;
CD_Phs=CDhs2./CDhs5;



%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%% Land Use (Activity) Allocation %%%%%%%%%%%%%%%%%
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

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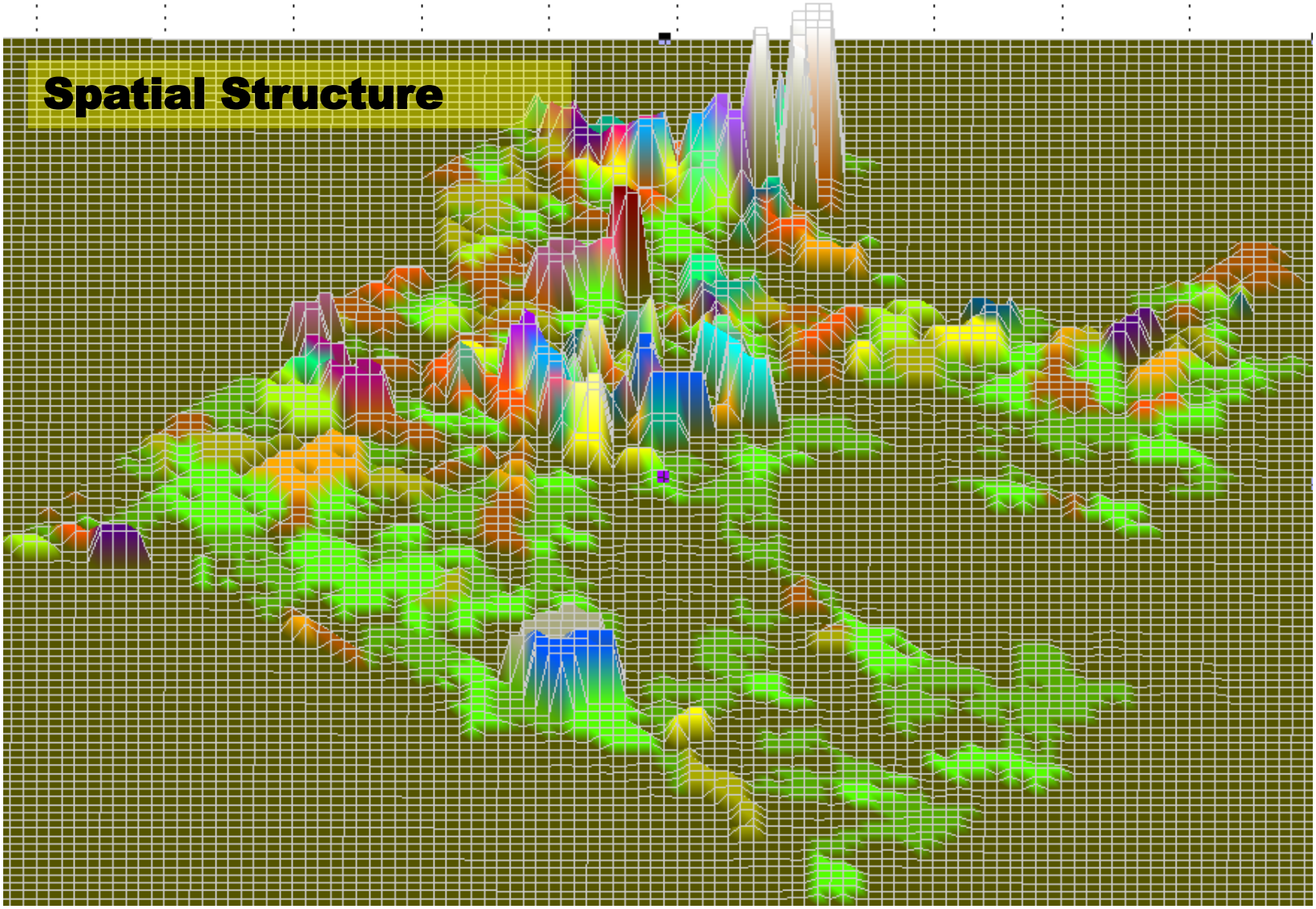

CUSIM

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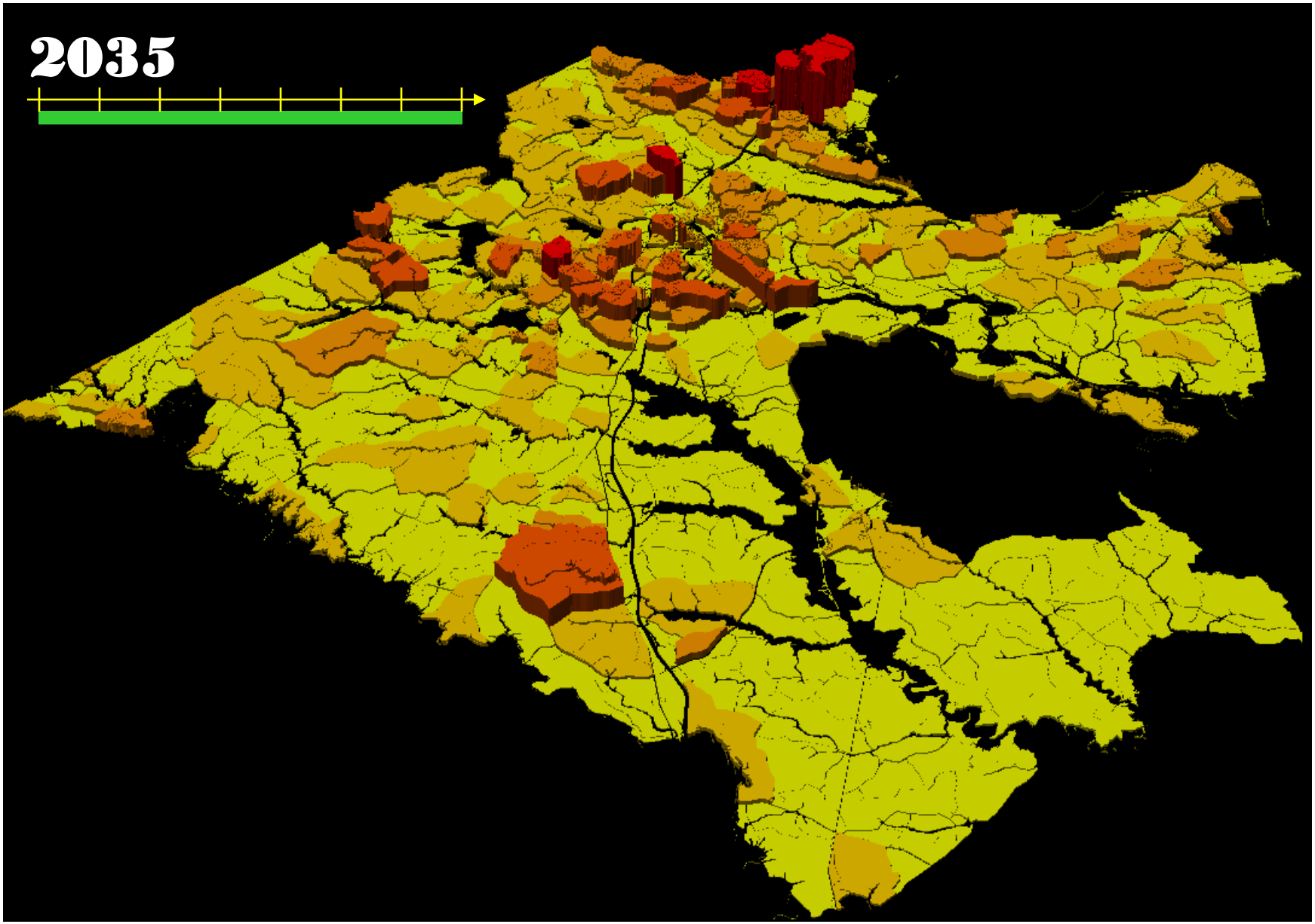

CUSIM

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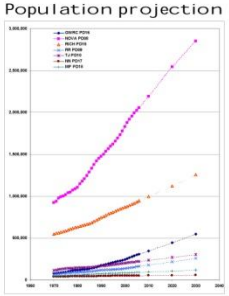
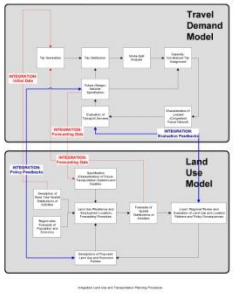
Modeling concept

Population projection



Integration



model structure

$$A_i^{\alpha}\left\{\sum_{j=1}^{n} A_j^{\alpha}\exp(-\beta d_{ij})\right\}^{-1}\exp(-\beta d_{ij})$$

$$\sum_{i=1}^{n} A_i^{\alpha}\left\{\sum_{j=1}^{n} A_j^{\alpha}\exp(-\beta d_{ij})\right\}^{-1}\exp(-\beta d_{ij})$$

$$A_i^{\gamma}\left\{\sum_{j=1}^{n} A_j^{\gamma}\exp(-\theta\cdot d_{ij})\right\}^{-1}\exp(-\theta\cdot d_{ij})$$

$$\sum_{i=1}^{n} A_i^{\gamma}\left\{\sum_{j=1}^{n} A_j^{\gamma}\exp(-\theta\cdot d_{ij})\right\}^{-1}\exp(-\theta\cdot d_{ij})$$

A_i^{α} : Residential attractiveness factor of zone (i)
A_j^{γ} : Labor attractiveness factor of zone (j)
T_{ij}^{α} : Distributed employees (work-to-home interaction) from (j) to (i)
T_{ij}^{γ} : Service employment allocation (home-to-service interaction) from (i) to (j)
E_{ij} : Employment at (j)
D_{ij} : Serving population (zonal service employment to be allocated to service centers)
X_i : Residential-specific relative location of destination zone (i) with all other possible destinations (competing destinations factor)
Y_j : Labor-specific relative location of zone (j) with all other possible destinations (competing destinations factor)
d_{ij} : Distance between (j) and (i)
β : Distance decay parameter for the residential allocation model
γ : Distance decay parameter for the service allocation model
θ : Residential-specific competing destinations factor parameter
f : Labor-specific competing destinations factor parameter

Spill-over effect

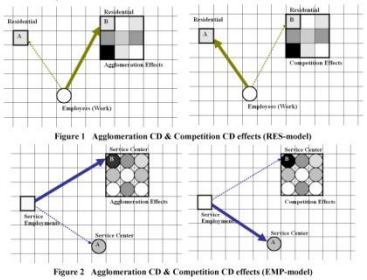
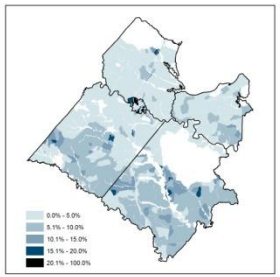


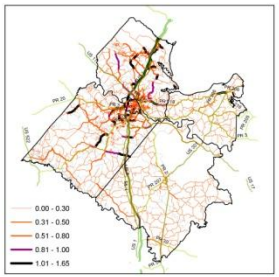
Figure 1 Agglomeration CD & Competition CD effects (RES-model)

Figure 2 Agglomeration CD & Competition CD effects (EMP-model)

2000 Poverty Rate

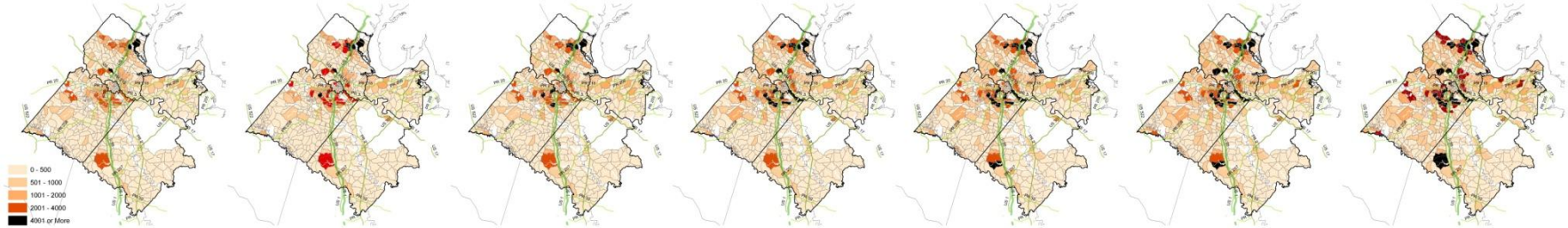


2006 Network V/C Ratio



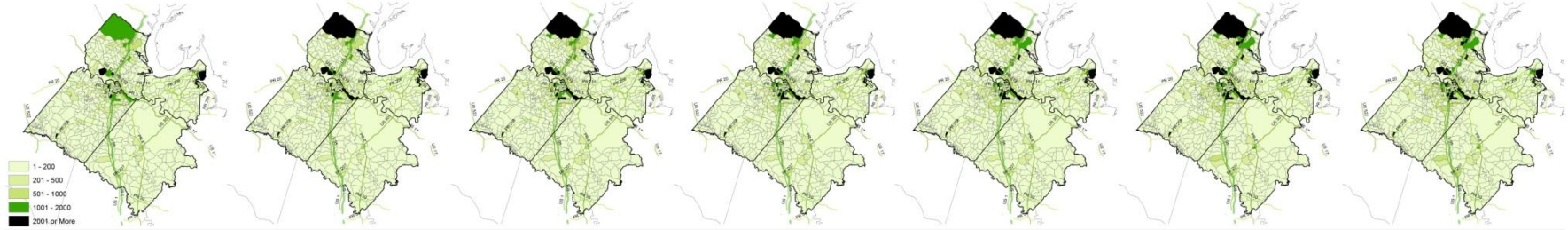
Population

2006 2009 2015 2020 2025 2030 2035



Employment

2006 2009 2015 2020 2025 2030 2035



CUSIM and TDFM

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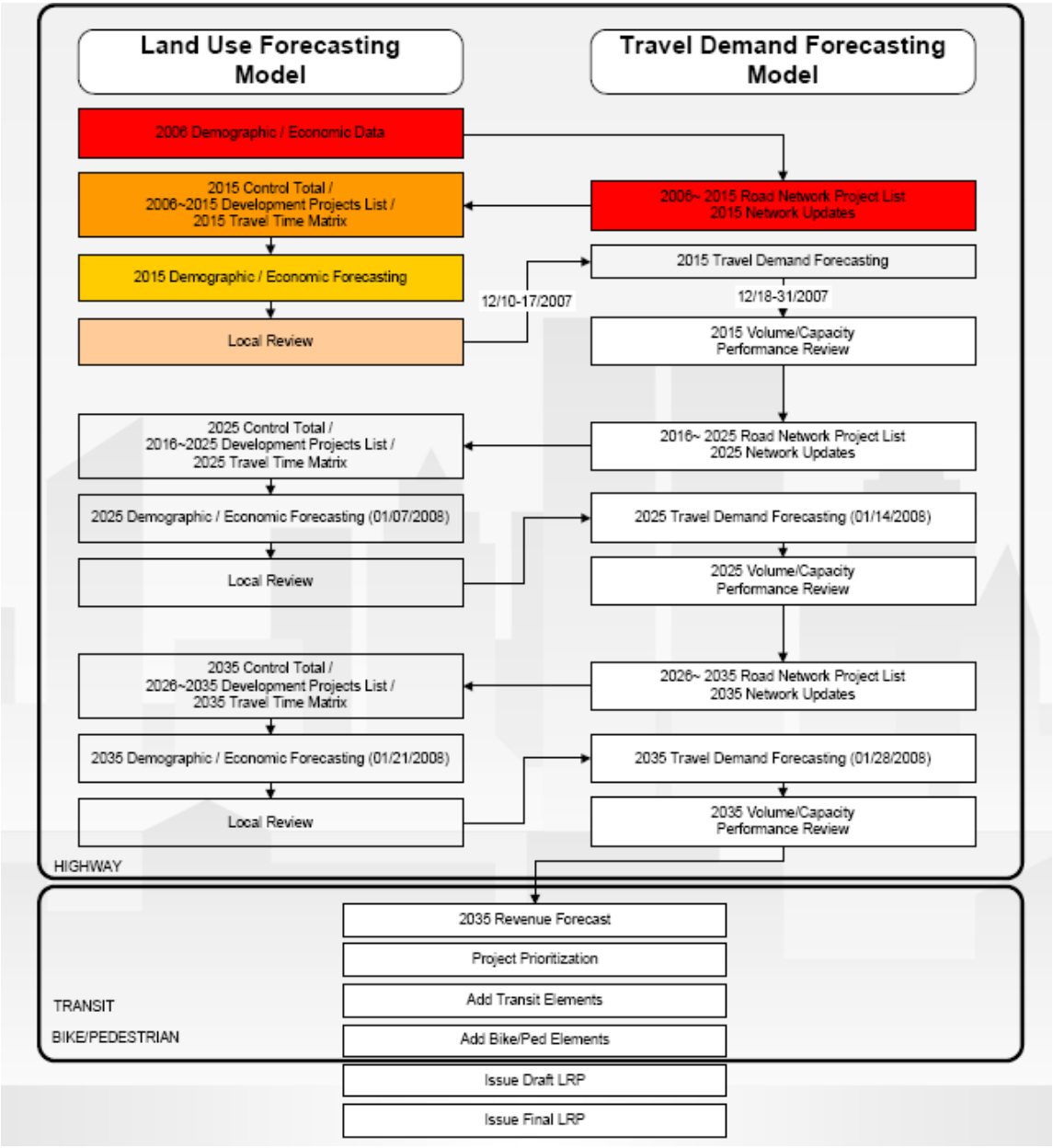

Loosely coupled

Converted CUSIM into CUBE Voyager Integrated LU/T (w/ CUSIM)

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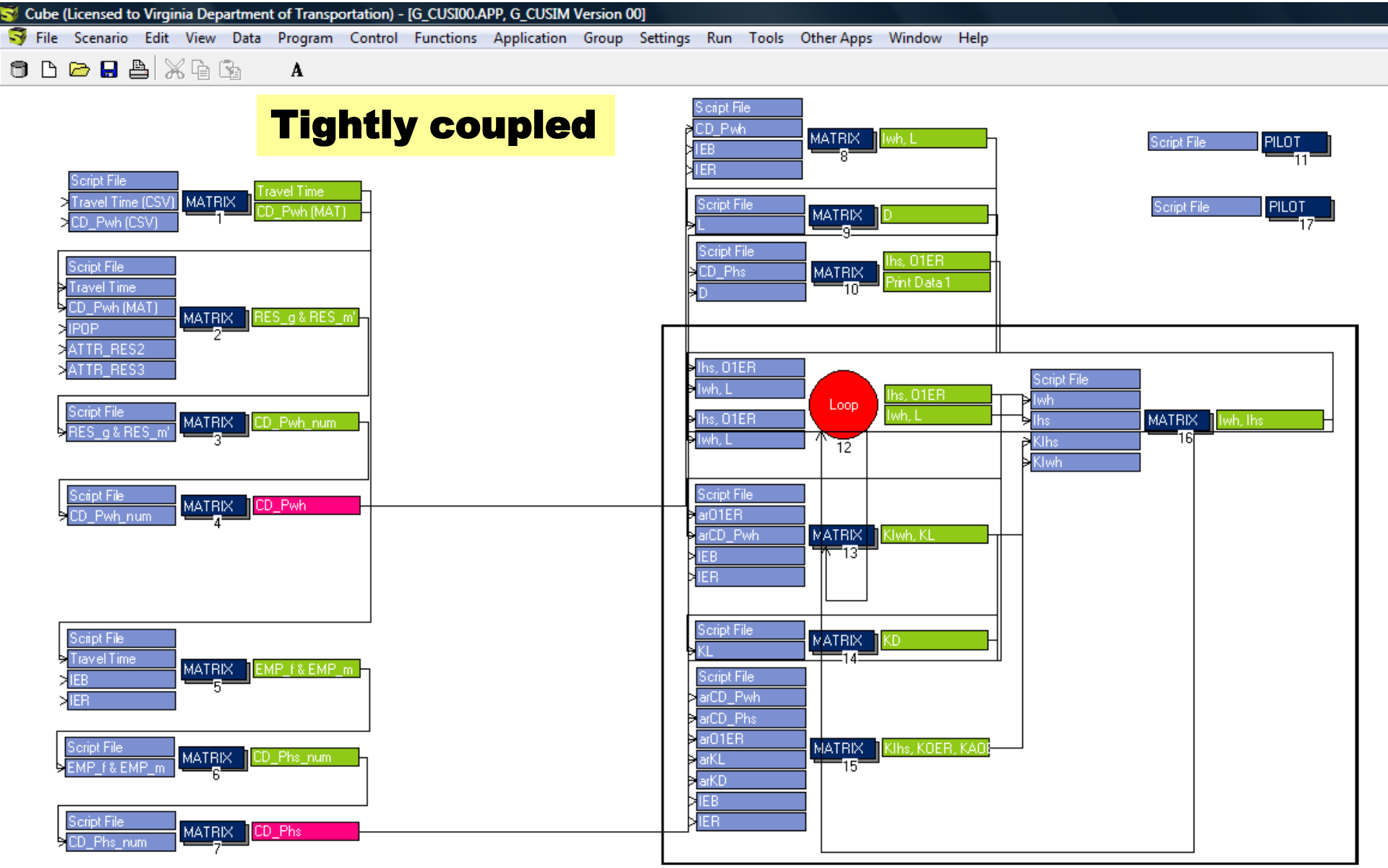
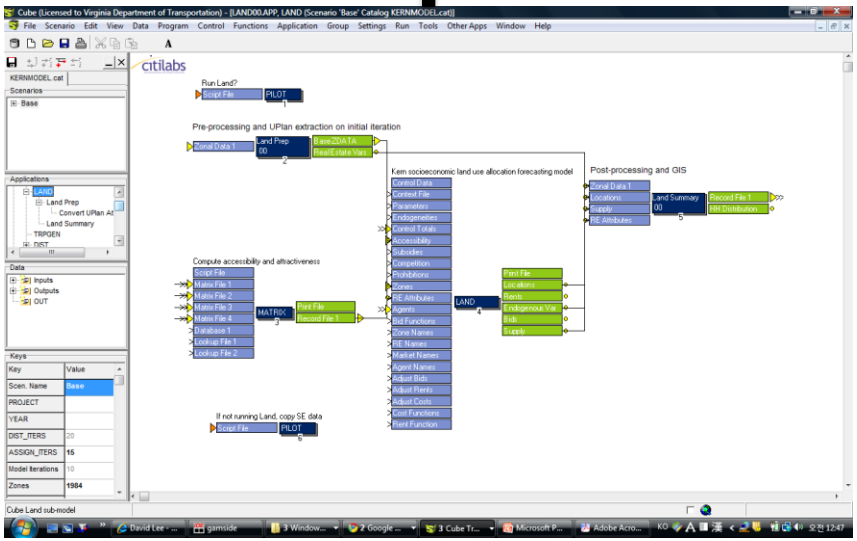
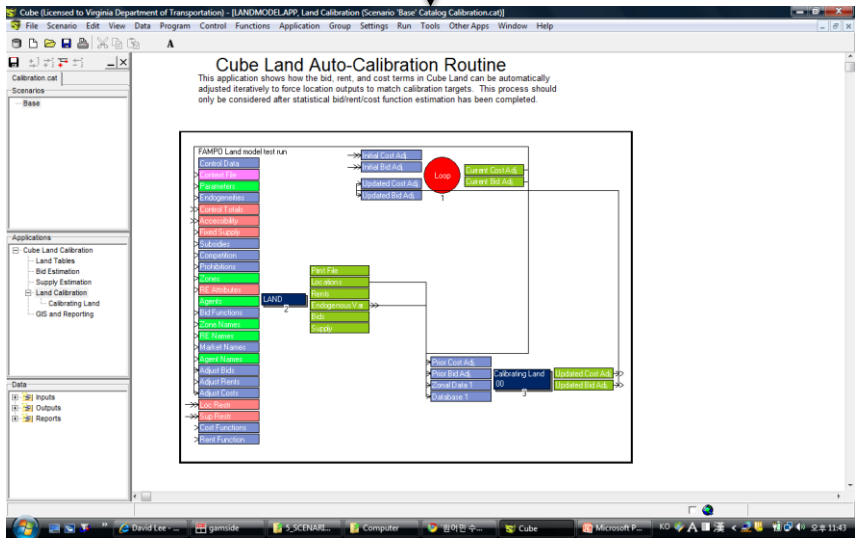


Transfer of Land Use Modeling Methods / Structure

Kern's MODEL



FAMPO's MODEL



Universal Parameters Structures

Integrated LU/T (w/ CUBE Land)

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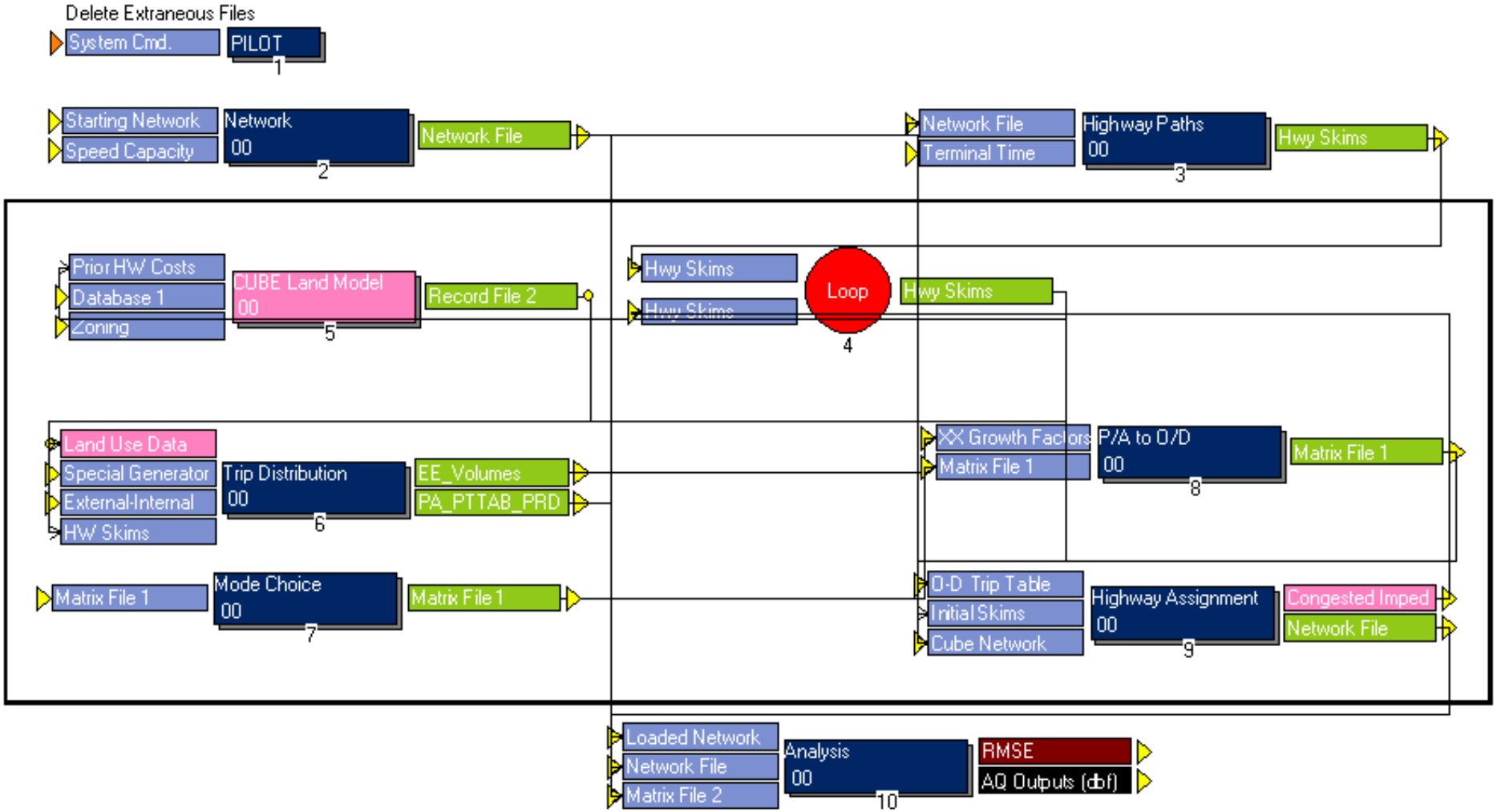
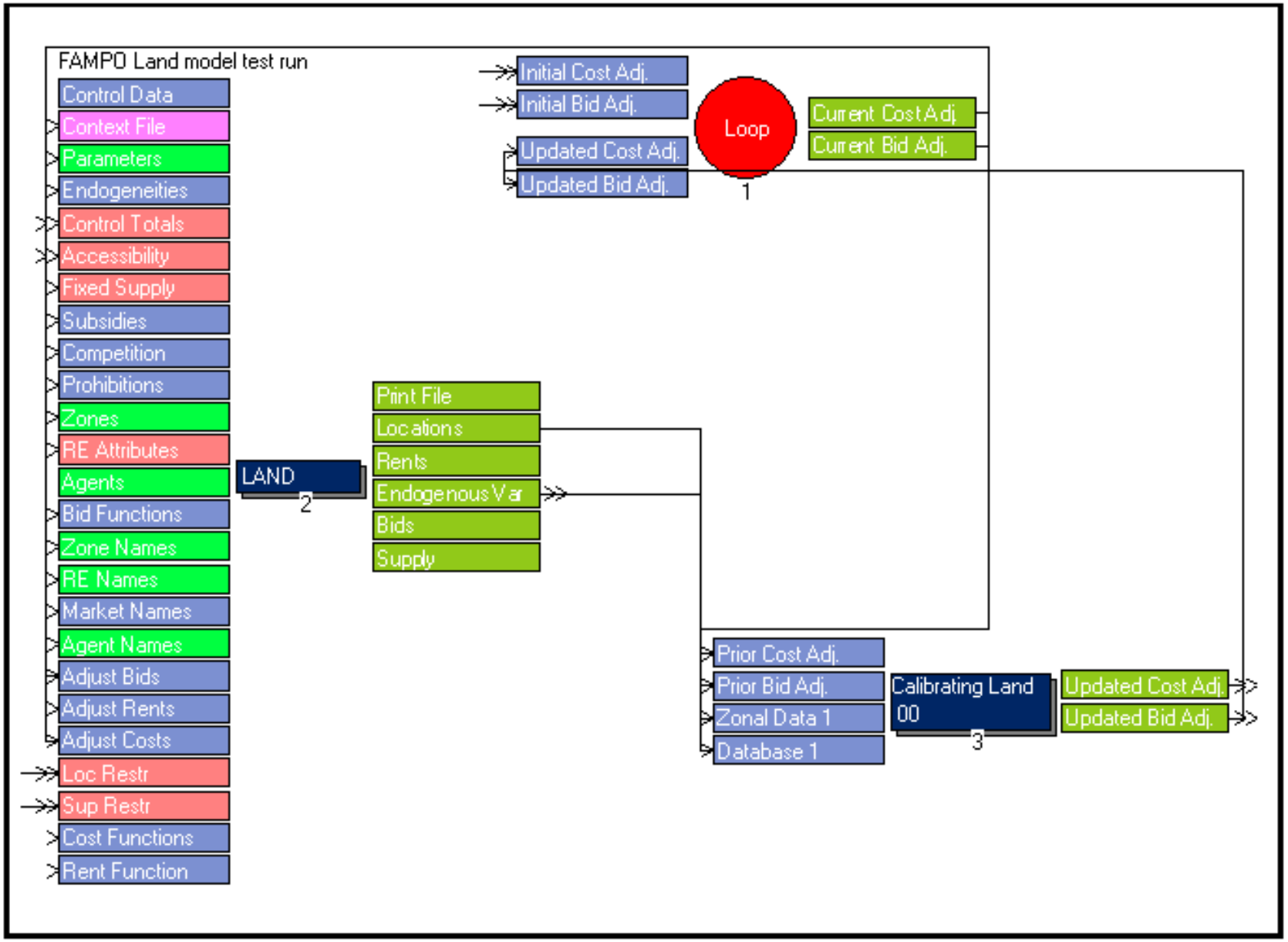


CUBE Land Calibration

D. Lee 2011



CUBE Land Calibration

FAMPO
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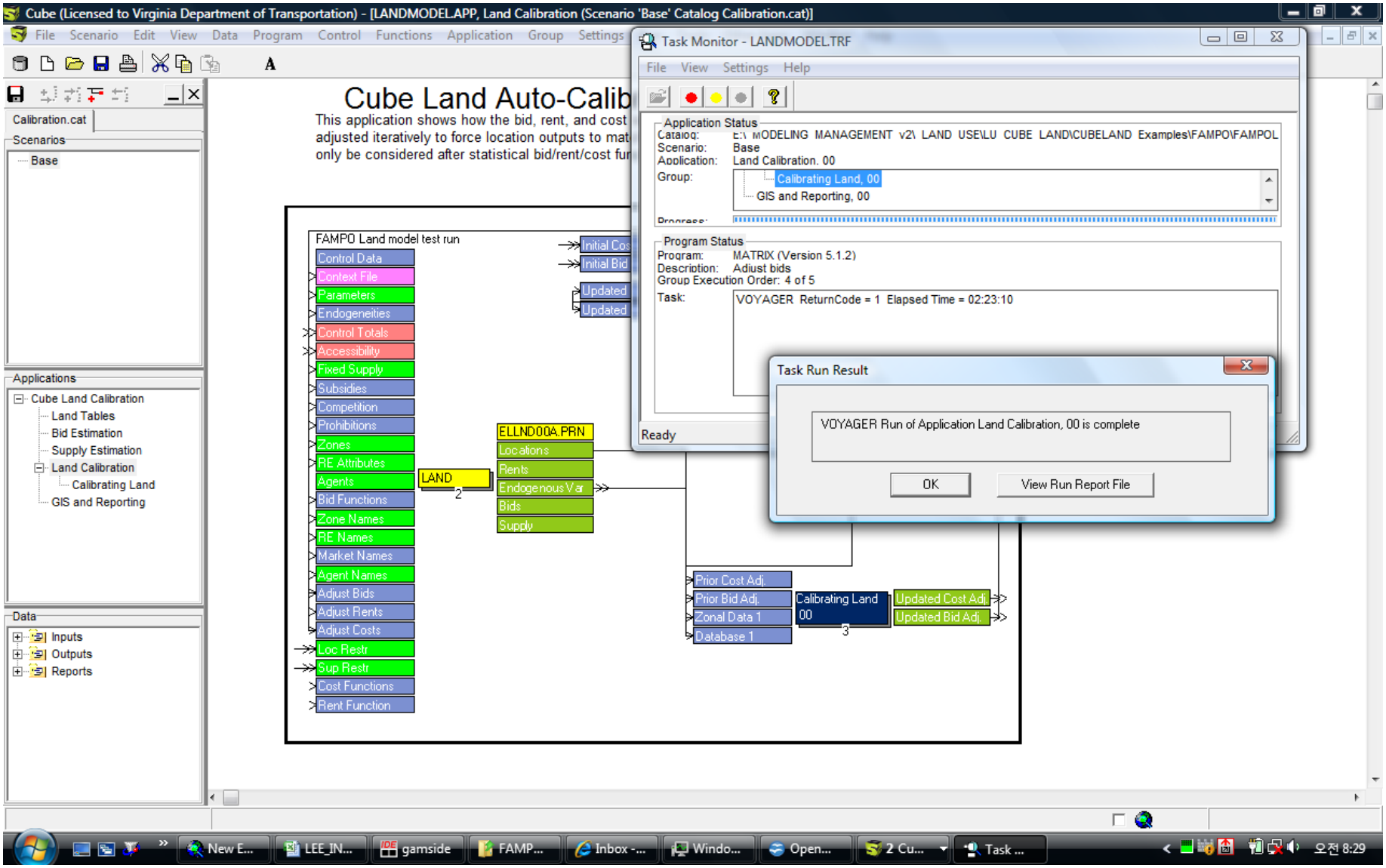
D. Lee 2011



Connecting TDFM w/ Air Conformity

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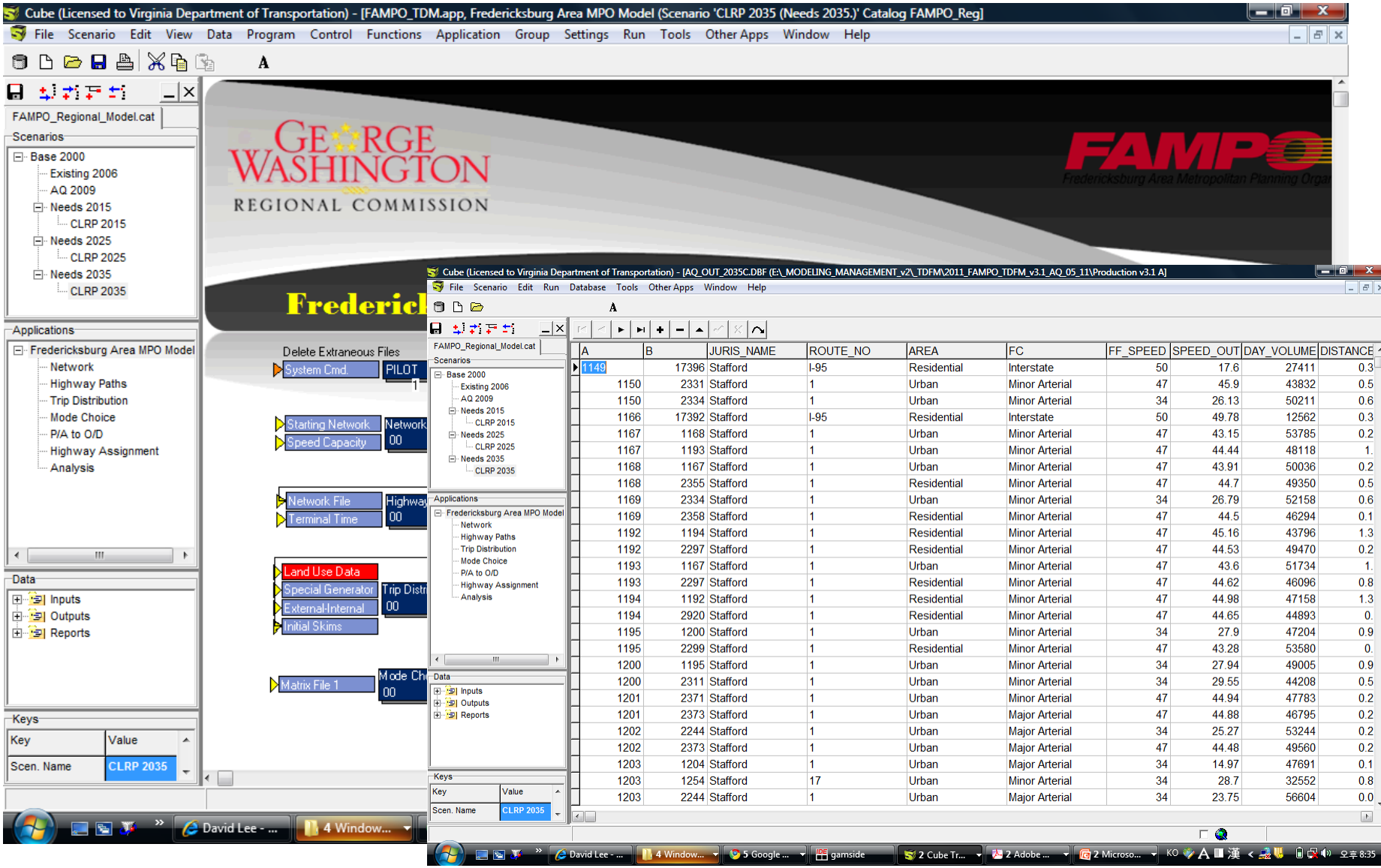

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Control Totals

- Macro Model VEC/EMSI
- Control Total Forecasting Input-Output

Using CUBE Voyager as an Integration Tool

- Travel Time
- Zonal Data

Land Use Visioning

- Community Viz
- Sketch Planning Scenario/Visioning Suitability Index

What Community Want to See

vs.

Land Use Forecasting

- CUSIM
- Spatial Interaction Competing Destinations
- CUBE Land
- Economic Based Land Use Forecasting Model

What is most likely to Be

Travel Demand Forecasting

- CUBE Voyager
- FAMPO TDFM 3.0/4.0

Air Conformity

- MOBILE/MOVES
- Air Conformity

Bi-Coastal Comparison and Transfer of Land Use Modeling Methods

Speed Data-Ing ??
If Got to be done, better be done earlier than later

Troy Hightower, Kern COG

Colby Brown, Citilabs

David J.-H. Lee, FAMPO / GWRC