Noise Annoys: Improved Reliability of Highway Travel Time Benefits

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Introduction

- When economic appraisal exhibits noise:
  - There is uncertainty in the measure of benefits
  - Comparison between options is not reliable
  - Overall value for money is not reliable (nor is comparison against other schemes)
- MVA examined the root cause of noise
- Developed tools to quantify the relative scale and spatial distribution of noise compared to benefits
- Considered solutions to reduce noise and took forward the preferred solution
- Used the same tools to measure the noise reduction and the improved benefit reliability

Context

- Notional scheme for testing: simple capacity increase (road widening)
- Modelling suite: SATURN highway assignment with fixed demand matrix
- Concentrated on highway travel time savings
- Other benefits (user operator costs, noise, carbon, air quality etc) not considered
- Scheme costs were not considered
- Worked in partnership with Mouchel and Atkins (for developing new SATURN functionality)

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Identifying the Problem (1)

- Benefits should be:
  - plausible (size and location);
  - stable (or change as expected); and
  - measurable compared to noise

- We tested a range of scheme options and found that benefits were:
  - inconsistent between options;
  - inconsistent between time periods for the same option;
  - did not always change as expected;
  - and we had no way to measure the scale of the benefits against model noise (TAG 10.9.24 only partly addresses this)

Identifying the Problem (2)

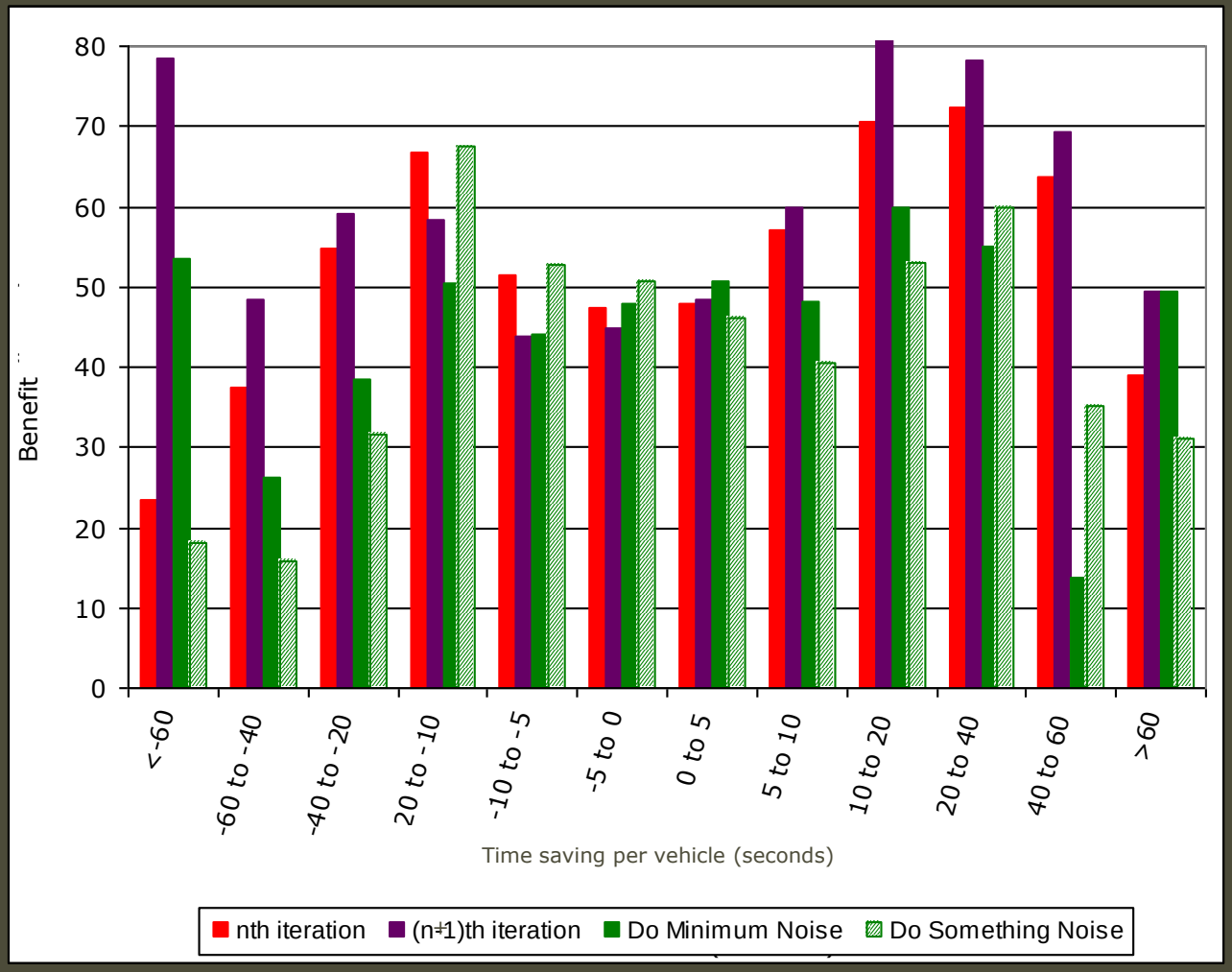
- Further analysis showed:
  - changes in flows, delays and speeds from implementing the scheme in areas where they were not plausible;
  - and therefore implied benefits (or disbenefits) at nodes where the scheme would not be expected to have a measurable effect;
  - changes in flows, delays and speeds between the (n) and (n+1) assignment of the same scenario
  - and therefore implied benefits (or disbenefits) between the (n) and (n+1) assignment of the same scenario

Quantifying the noise

Benefits using the (n) or (n+1) iteration				
		Benefits	Disbenefits	Net Benefits
DoMin vs DoSome	(n) iteraton	351	-281	69
	(n+1) iteration	390	-333	56
Implied Benefits between (n) and (n+1) iteration				
(n) vs (n+1)	DoMin	277	-261	16
	DoSome	266	-236	29

- Implied benefits (and disbenefits) from running an extra assignment iteration are of a similar scale to the scheme benefits

Visualising the scale of the noise compared to the benefits



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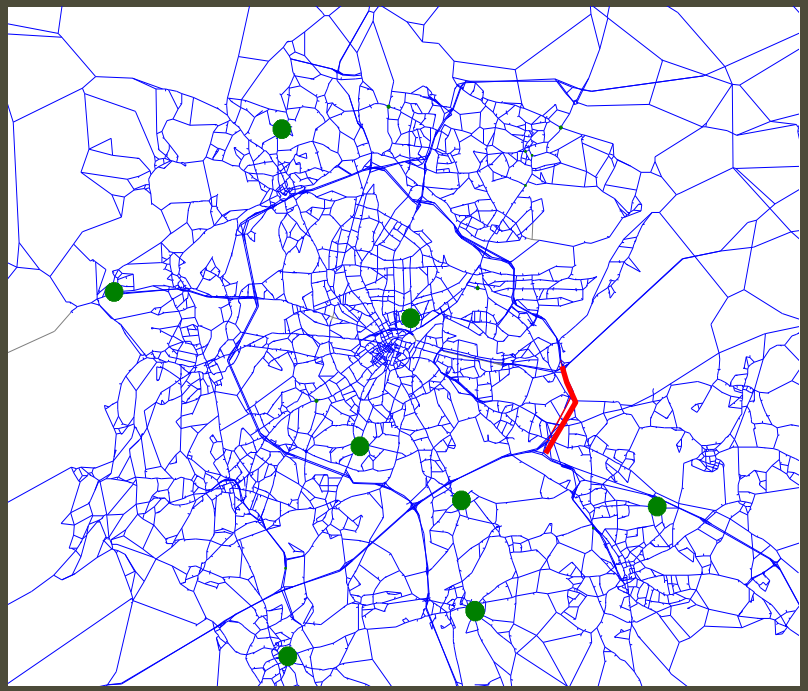
The Solution
Step 1: Improved Convergence

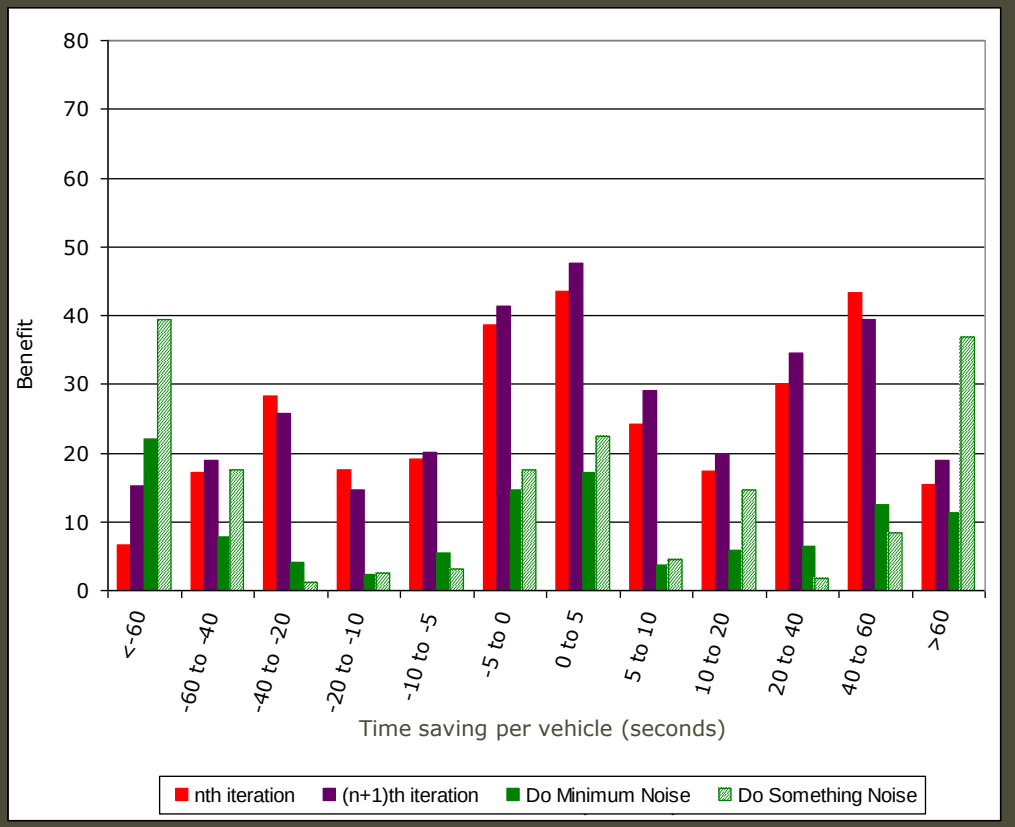
- Use %GAP as the stopping criteria
- Increase NITS, NITS_M and NITA_M

	Weaker convergence		Tighter convergence	
	10.8.22		10.9.24	
	DoMin	DoSome	DoMin	DoSome
Percentage of links with flow change < 1%	99.7% 99.7% 99.8% 99.7%	99.5% 99.8% 99.8% 99.8%	99.1% 99.2% 99.3% 98.9%	99.3% 99.3% 99.4% 99.5%
%GAP	0.14%	0.16%	0.01%	0.01%
Assignment Delta / number of iterations	0.18 / 2	0.15 / 2	0.01 / 22	0.01 / 30
Loops	17	16	120	120
Run time (minutes)	50	49	117	111

Improved Convergence Results

Benefits using the (n) or (n+1) iteration				
		Benefits	Disbenefits	Net Benefits
DoMin vs DoSome	(n) iteraton	174	-127	47
	(n+1) iteration	189	-136	53
Implied Benefits between (n) and (n+1) iteration				
(n) vs (n+1)	DoMin	57	-56	1
	DoSome	89	-81	7





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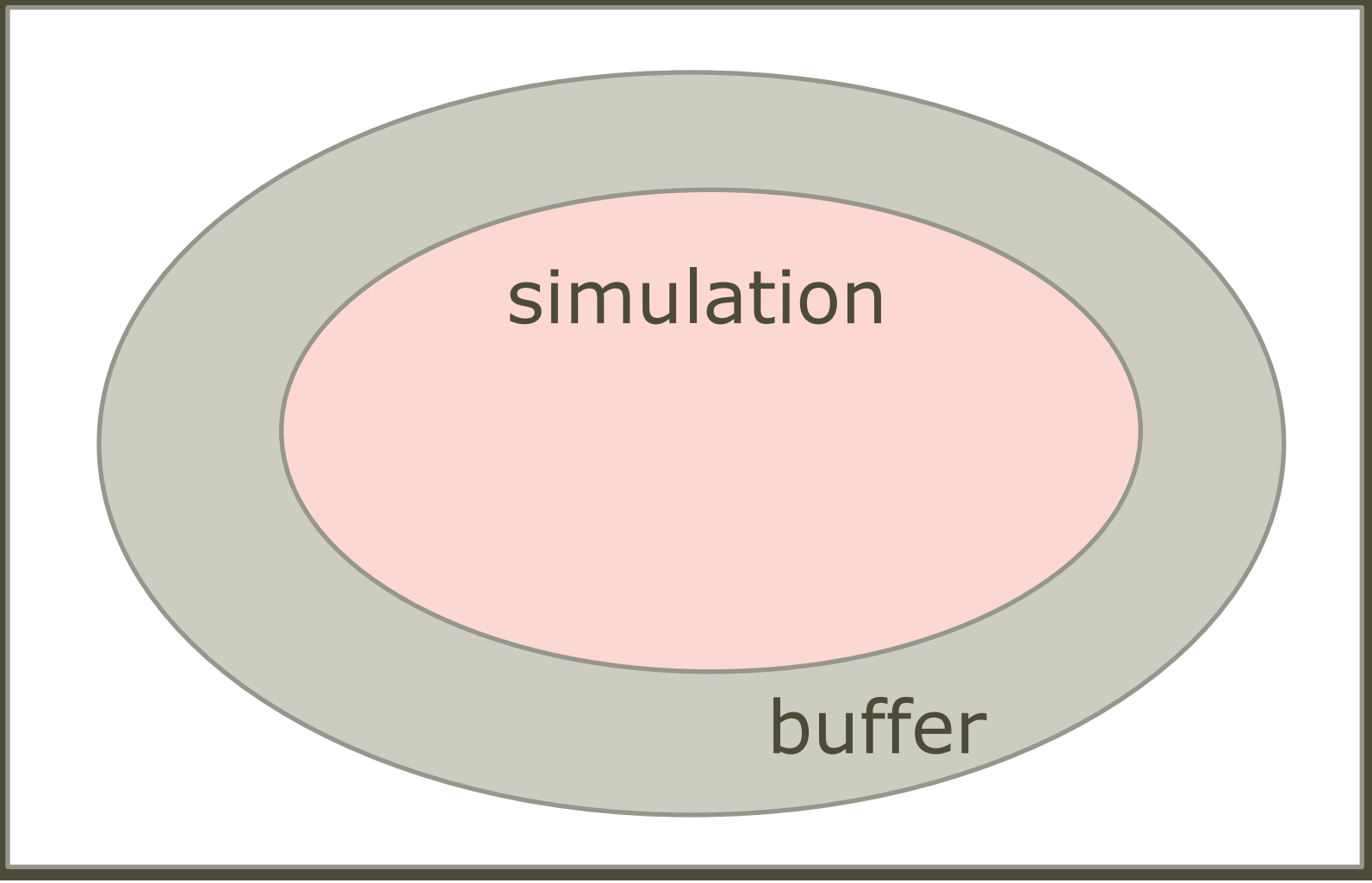
The Solution
Step 2: Consider More Radical Solutions

Options:

1. Further refinements to junction coding
2. Add 'unrealistic' capacity at junctions with large delays
3. Modify the shape of the flow-delay curves in SATURN
4. Allow turn flow-delay curves to be fixed outside an Area of Influence
5. Allow link flow-delay curves to be fixed outside an Area of Influence

Option 4 and 5 required new functionality in SATURN. See Section 15.1 of the SATURN 11.1 User Manual for details on Fixed Cost Function (FCF).

Area of Influence for FCF



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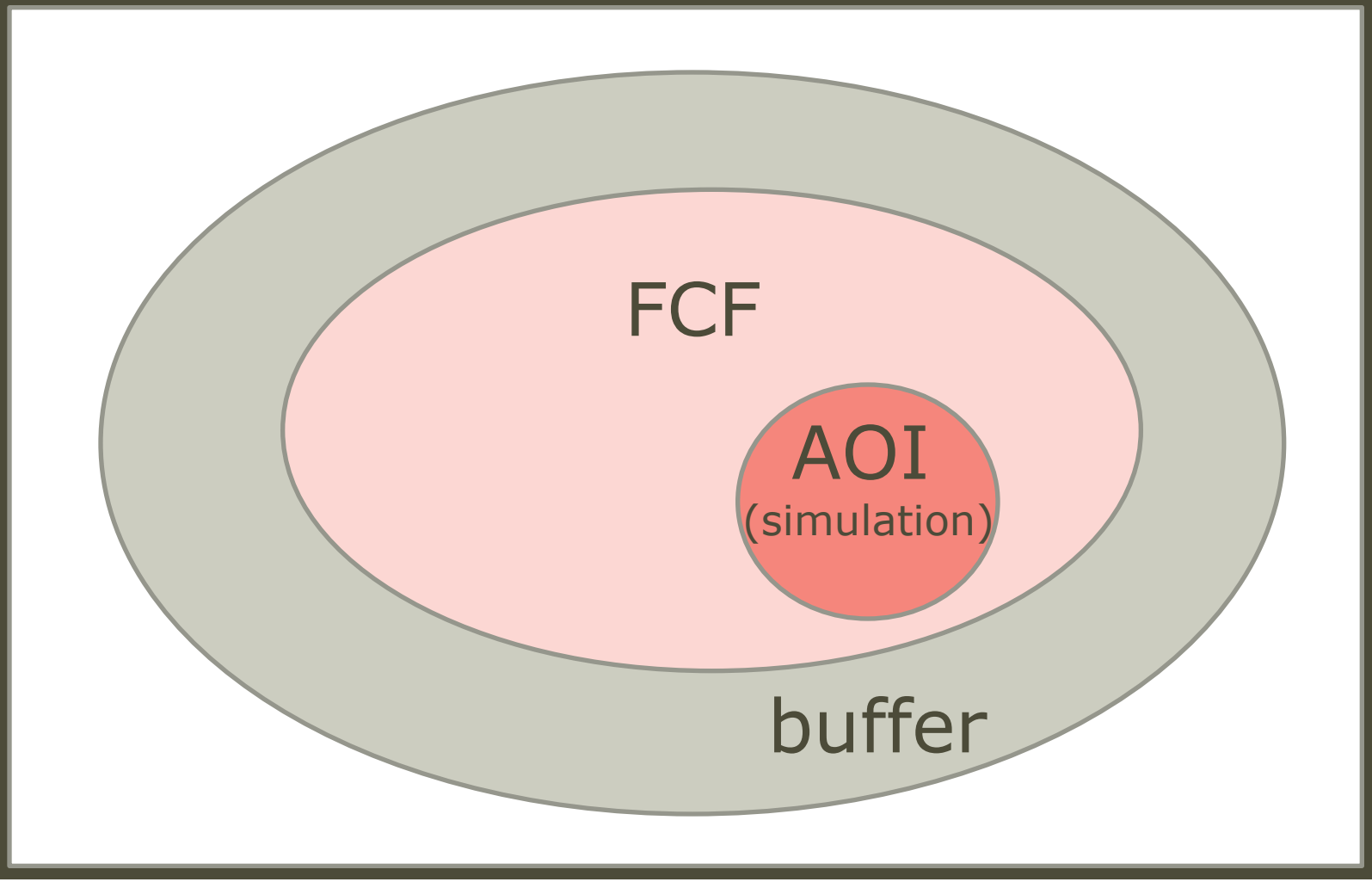
Area of Influence for FCF



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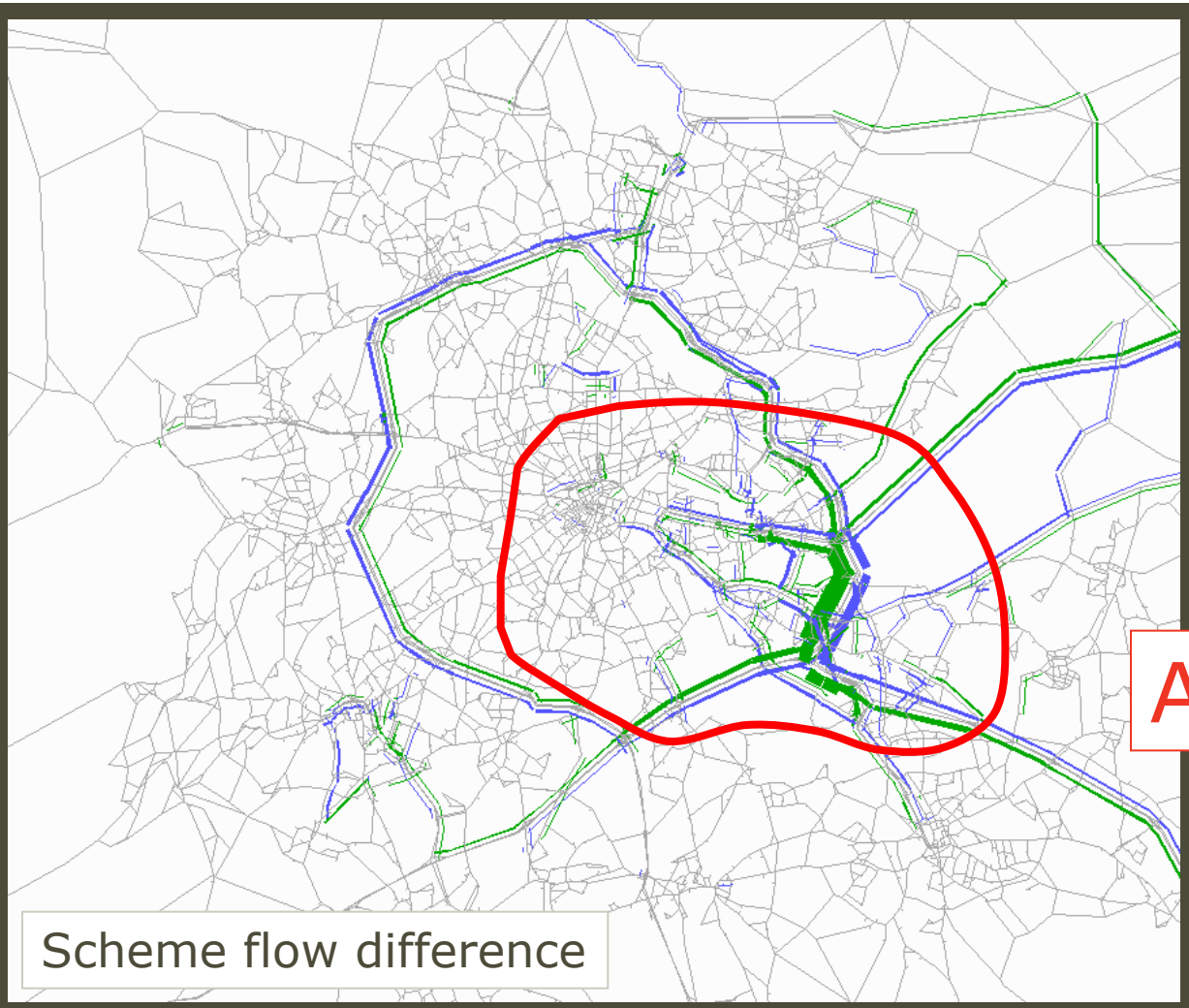
Area of Influence for FCF



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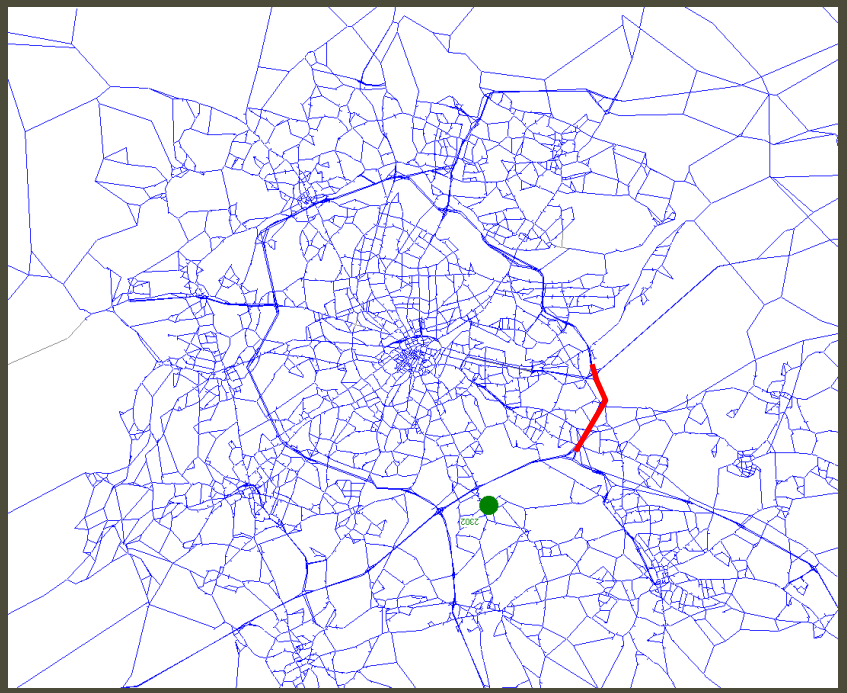
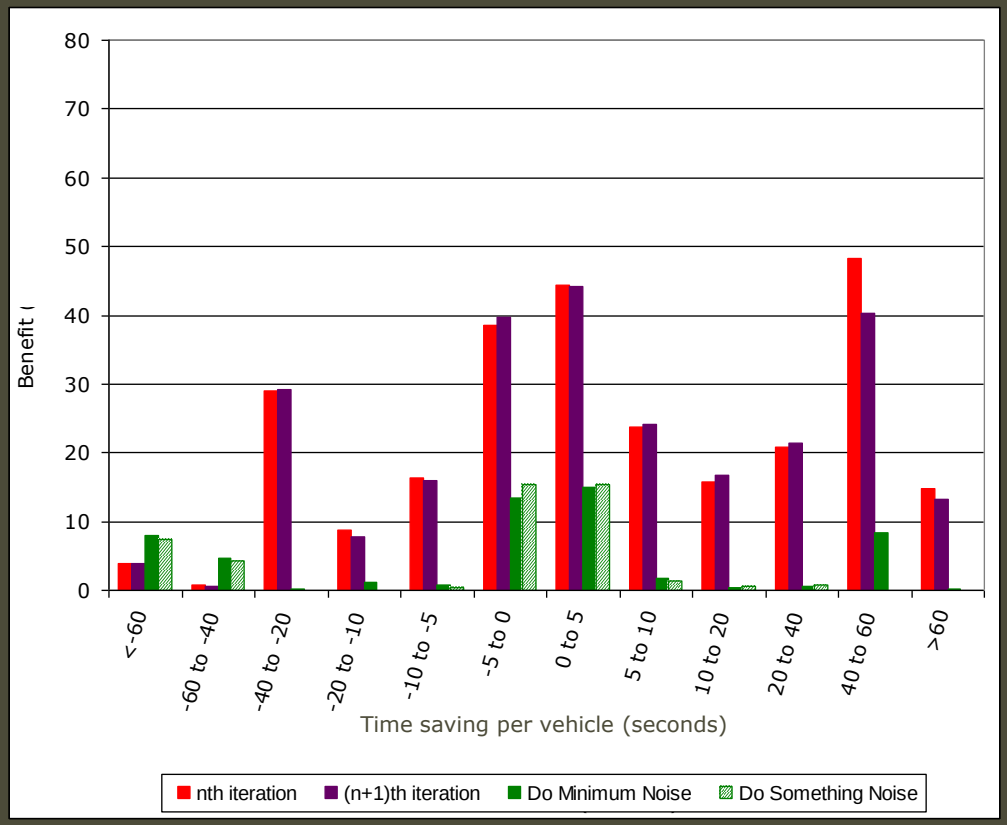
FCF Option 4 Results

Benefits using the (n) or (n+1) iteration				
		Benefits	Disbenefits	Net Benefits
DoMin vs DoSome	(n) iteraton	168	-97	71
	(n+1) iteration	160	-97	63
Implied Benefits between (n) and (n+1) iteration				
(n) vs (n+1)	DoMin	26	-28	-2
	DoSome	18	-28	-10





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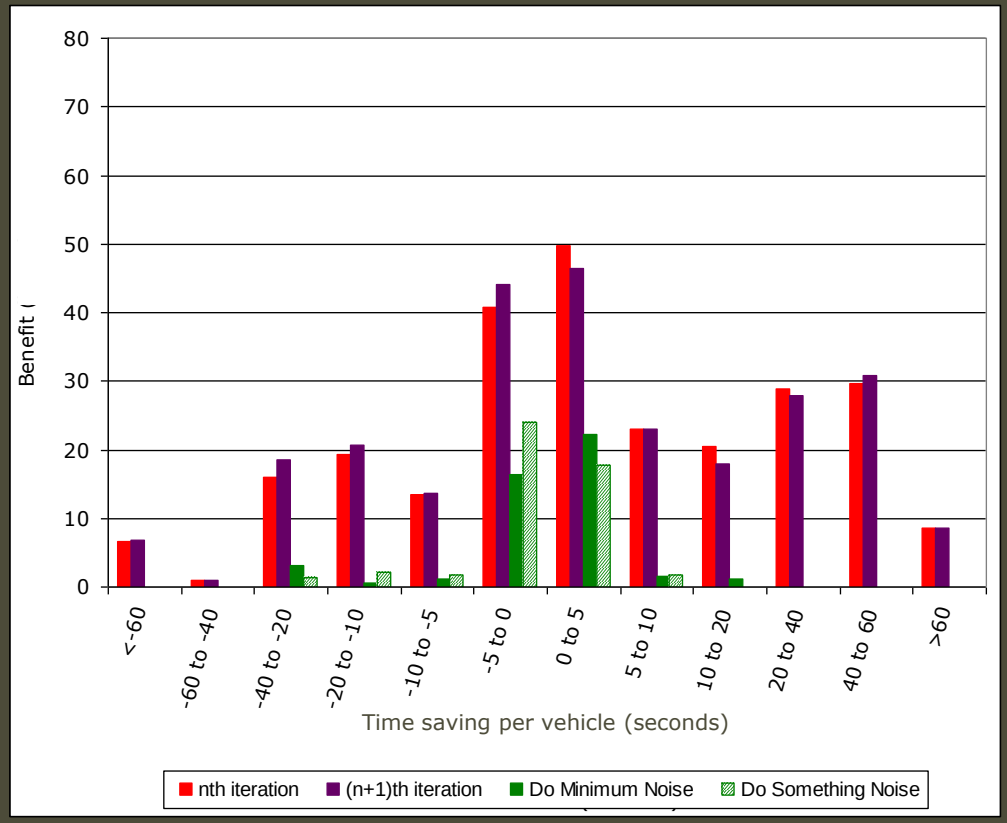
FCF Option 5 Results

Benefits using the (n) or (n+1) iteration				
		Benefits	Disbenefits	Net Benefits
DoMin vs DoSome	(n) iteraton	160	-97	63
	(n+1) iteration	155	-105	50
Implied Benefits between (n) and (n+1) iteration				
(n) vs (n+1)	DoMin	25	-21	4
	DoSome	20	-29	-9



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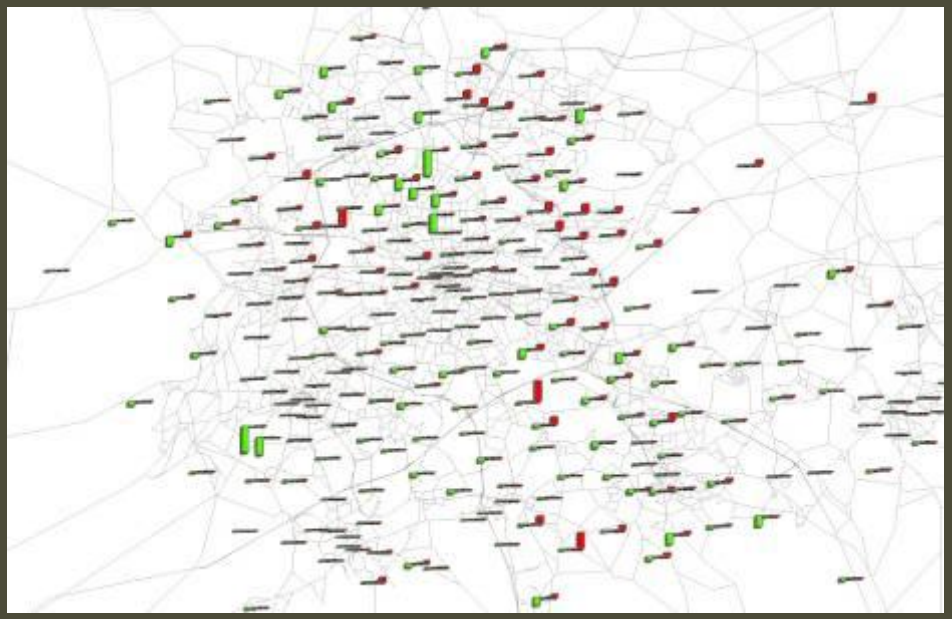
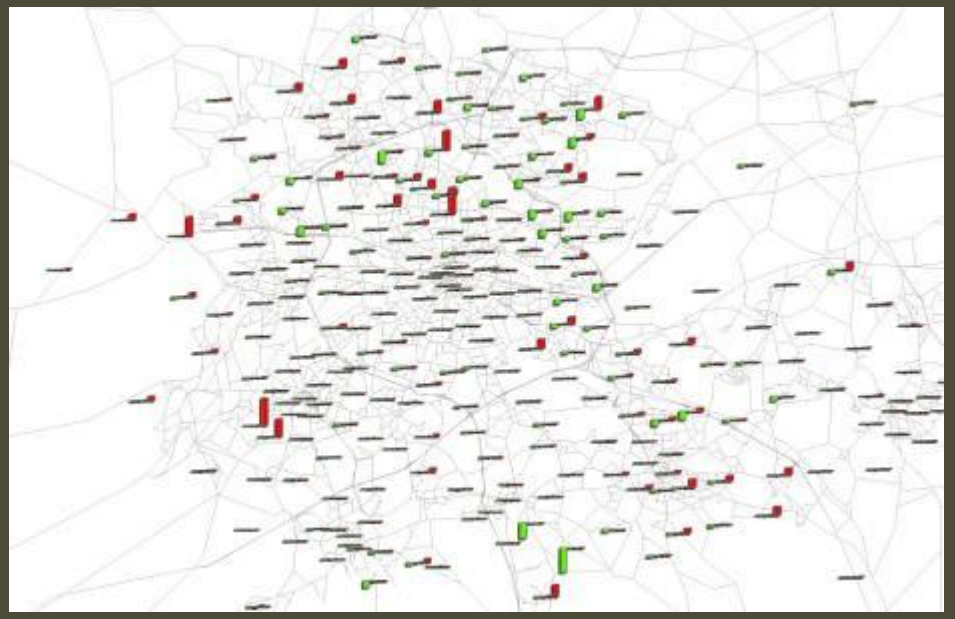
Spatial Representation of Benefits and Noise

Weaker Convergence

Benefits



Noise



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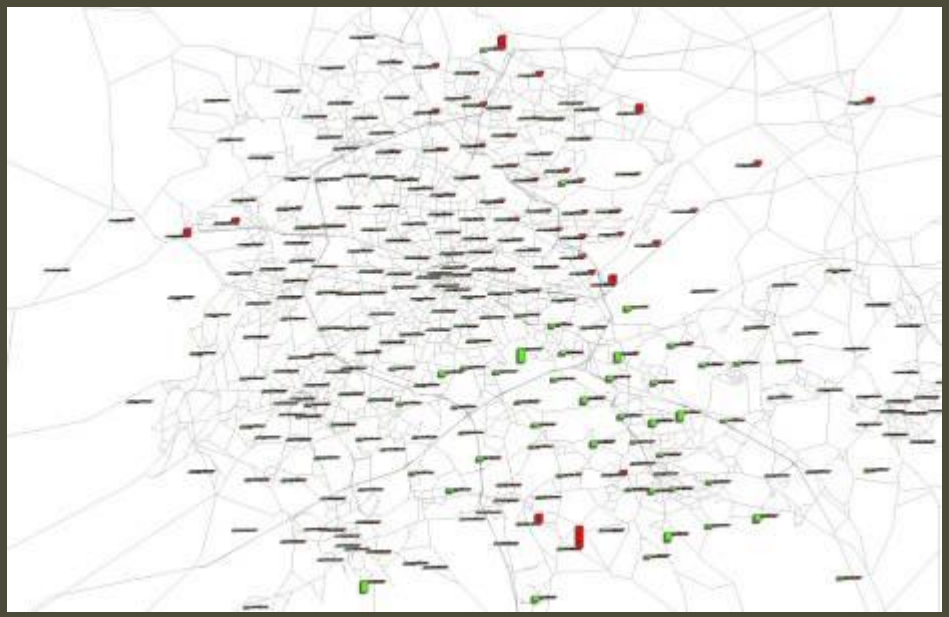
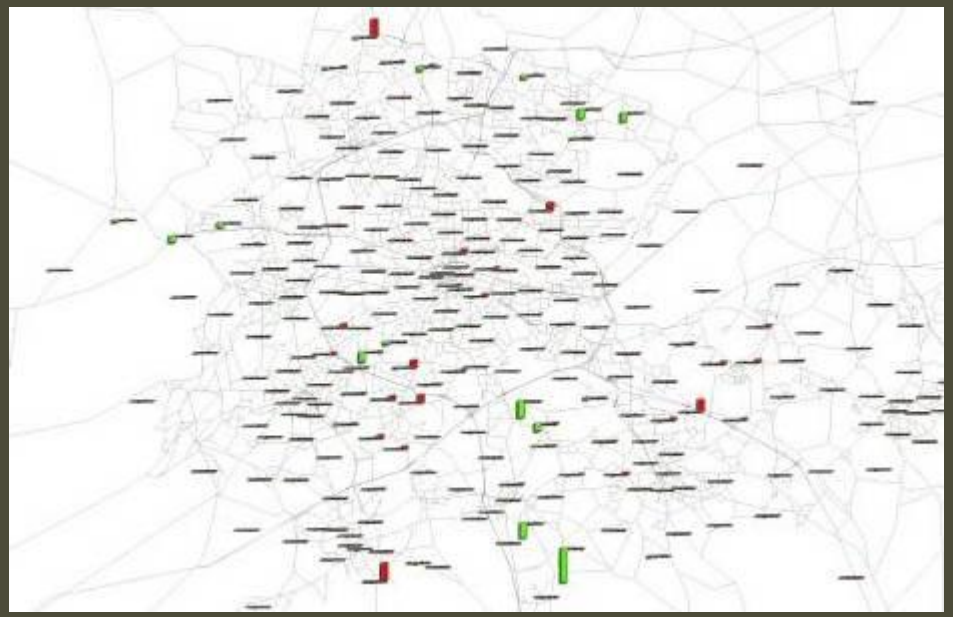
Spatial Representation of Benefits and Noise

Tighter Convergence

Benefits



Noise



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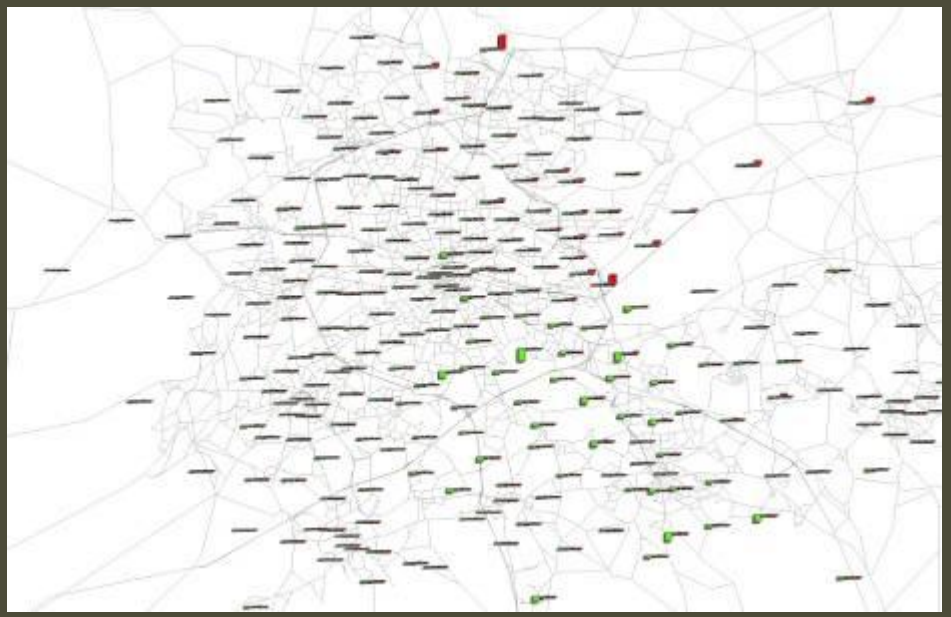
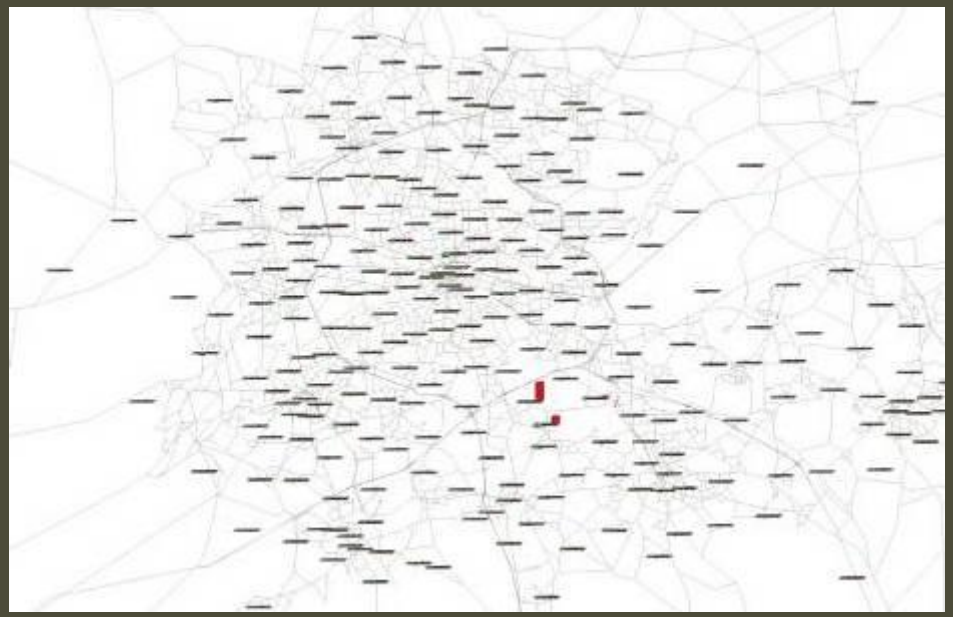
Spatial Representation of Benefits and Noise

FCF Option 4

Benefits



Noise



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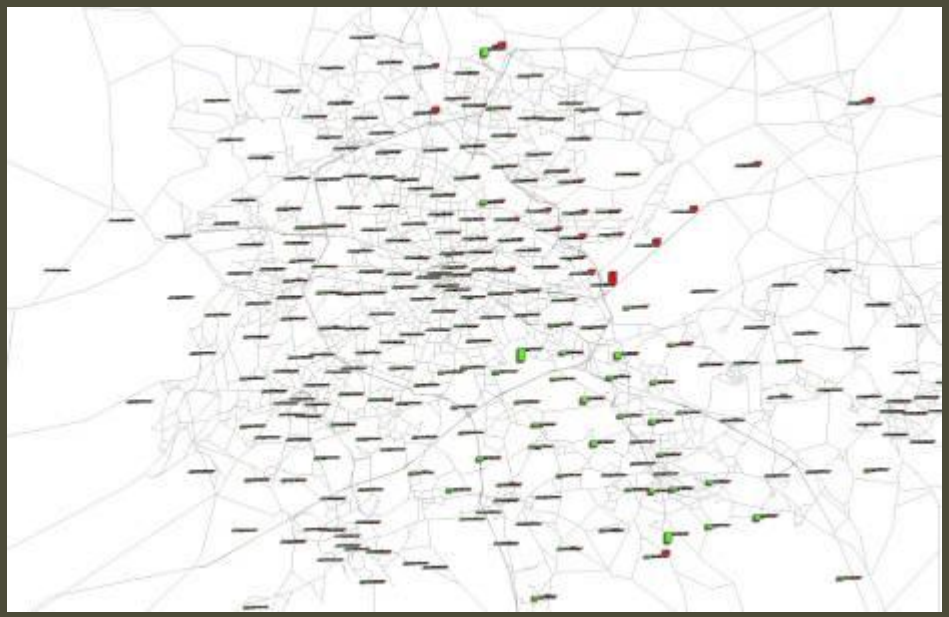
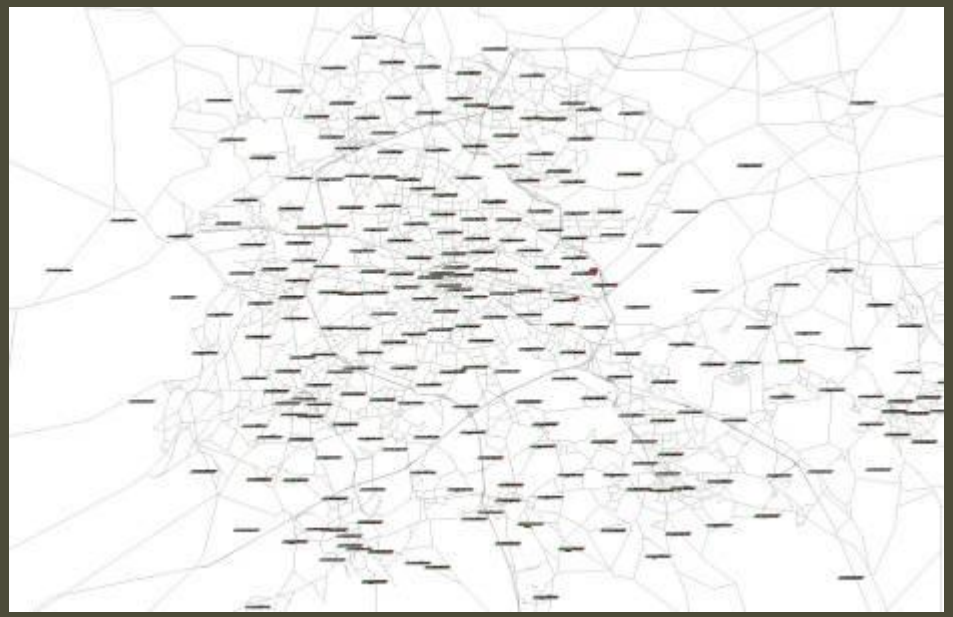
Spatial Representation of Benefits and Noise

FCF Option 5

Benefits



Noise



Conclusions and Next Steps

- Summary and Conclusions:
  - Appraisal noise can lead to uncertainty in the measure of highway travel time benefits and unreliability in the comparison against other options and other schemes
  - Noise is due to the instability in assignment convergence at nodes close to capacity and often remote from the scheme
  - MVA developed tools to quantify and visualise the relative scale and spatial distribution of noise compared to benefits
  - We then developed solutions to significantly reduce noise, including working with Atkins to develop the new FCF functionality in SATURN
  - Measures of highway travel time benefits are now more reliable

- Next Steps:
  - Test Option 4 and 5 using real forecasts and a real scheme
  - Integrate approach into the Variable Demand Model

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