A Systematic Traffic Balance Method in Network Levels

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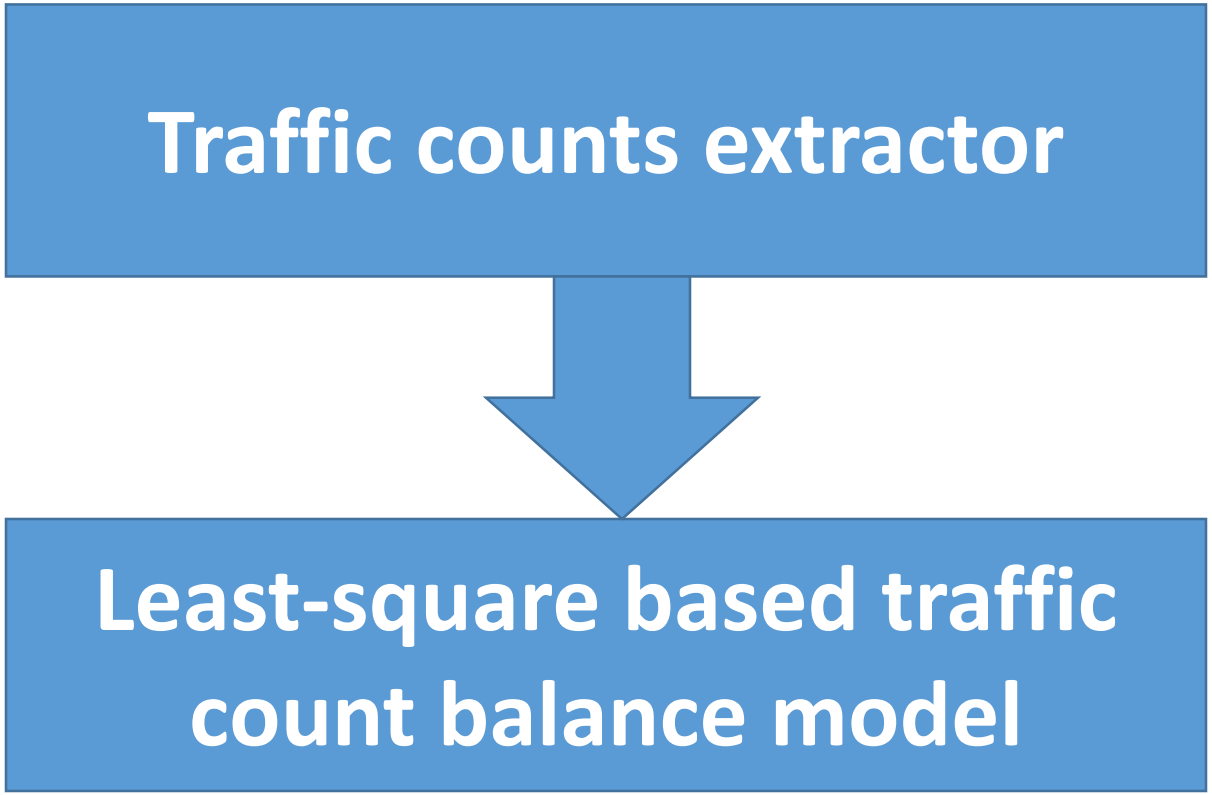
Introduction

- Traffic counts are critical information for model calibration and validation
- There are significant amount of inconsistencies in traffic counts
  - Collected in different day/month/year
  - Collected by different agencies
  - Collected by faulty devices
  - Standardized by different local factors
  - Etc…
- It is necessary to reconcile the traffic counts
  - Improving model performance
  - Better OD estimation

Current traffic count balance practices

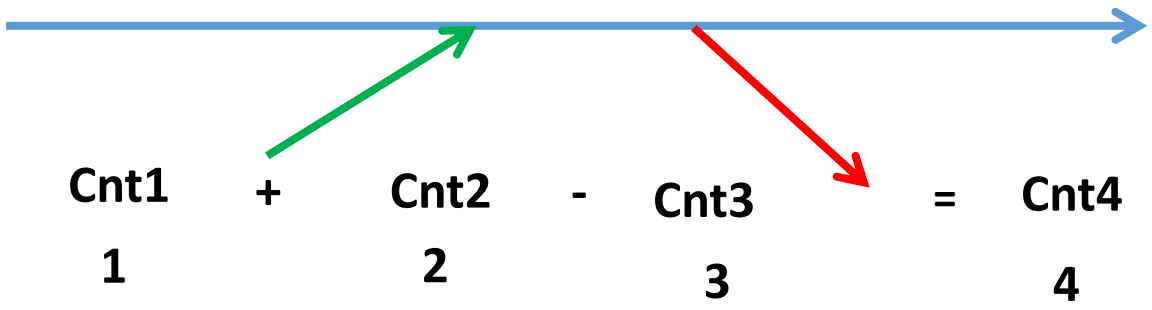
- Excel spreadsheet method
- Geocount on-line tool (https://geocounts.com/)
- Weakness:
  - Time consuming for organizing counts in topological orders
  - Tremendous manual work on balance and no unique solution (Spreadsheet)
  - Single corridor level balance
  - No batch mode option(one directional corridor/one time period)

Proposed traffic balance method framework



Traffic count extractor I (Corridor Level)

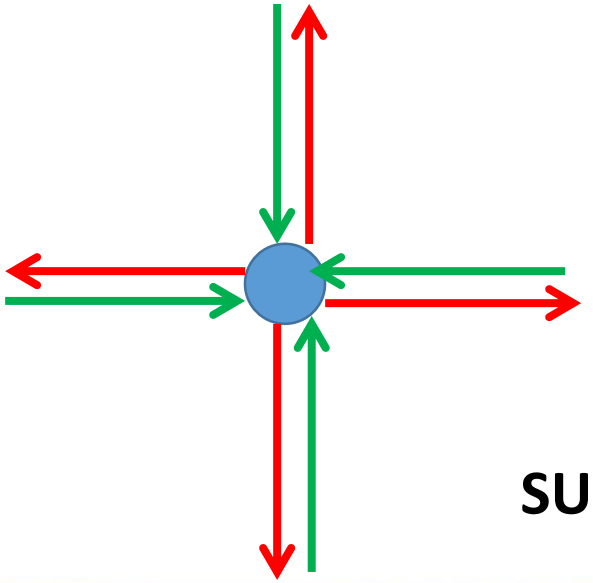
- Methodology
  - Based on Depth-First-Search Algorithm (DFS)
  - Output link counts in a proper topological order
  - Users need to fill up missing ramp counts with the counts from other sources



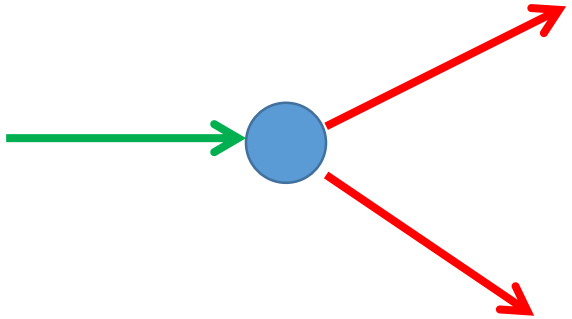
Basic segment

Traffic count extractor II (Node Level)

- Methodology
  - Identify all the nodes in network with complete observed counts in all the connected links
  - The nodes could be intersections/normal connection nodes



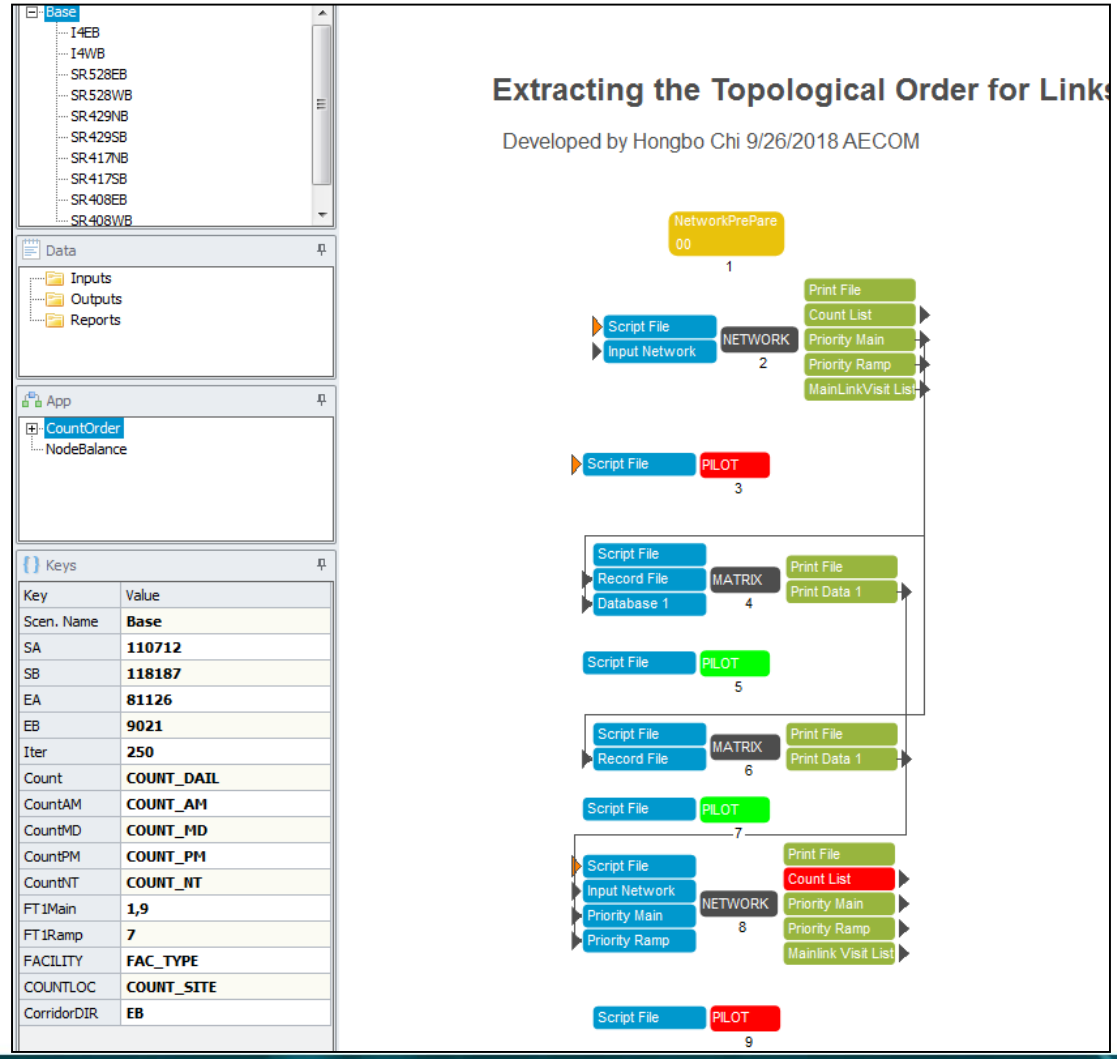
Basic segment



SUM(In Counts)=SUM(Out Counts)

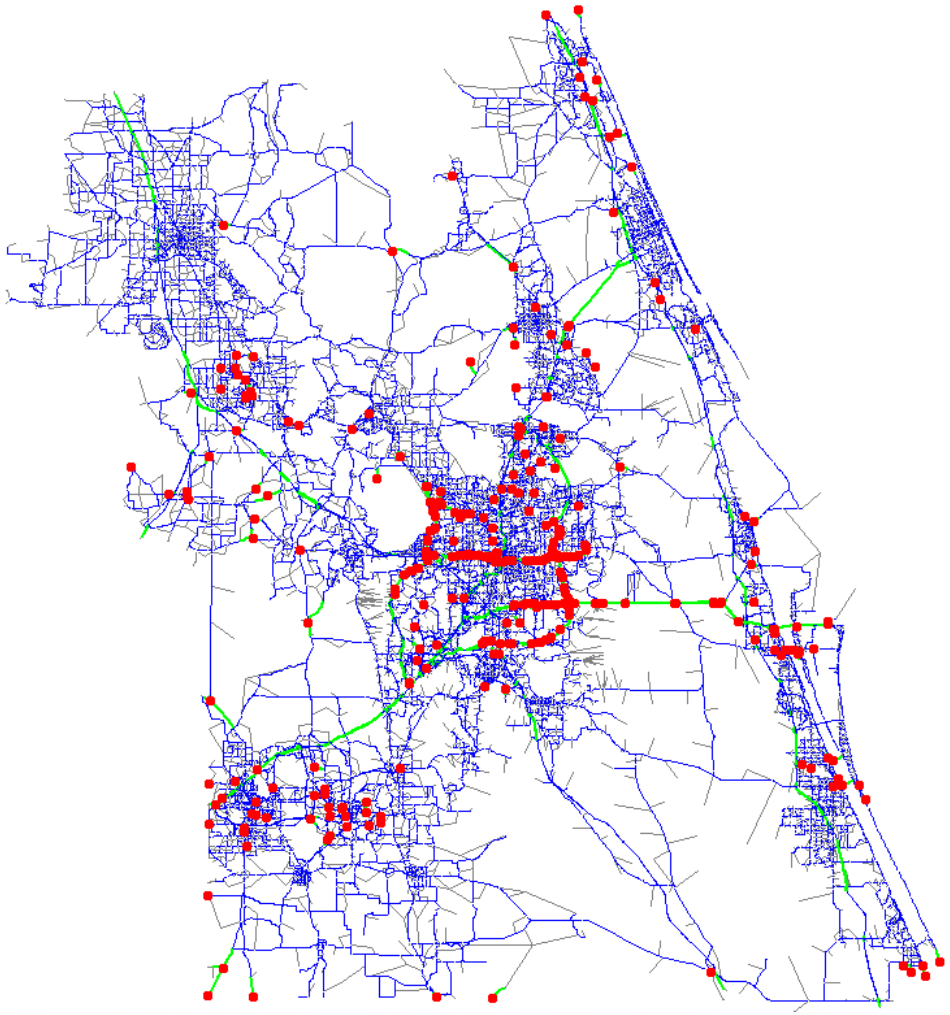
Traffic count extractor(Interface)

- Corridor level:
  - Starting/Ending links
  - Facility type for main line and Ramp
- Node level:
  - Automatically extracting all qualified nodes and link counts from networks



Traffic count extracting result

- Corridor level
  - 10 corridors (20 directional corridors)
  - 1,129 Links with counts
  - 339 basic segments
- Node level
  - 373 nodes
  - 1,295 links with counts
  - 373 basic segments



Traffic balance model

Assumption: Traffic counts reflect most of the real traffic information, therefore the adjustment (Adj%) should be minimized

$$Obj = Min(\sum W * ((Count_{Bal} - Count_{Obs})/Count_{Obs})^2)$$

$Subject\ to$:

Count $conservation\ constraint\ by\ location$

$Count\ conservation\ constraint\ by\ time$

$W_{daily} > W_{tod}$
$W_{mainline} > W_{ramp}$
$W_{ttms} > W_{ptms}$

GAMS software is used for the optimization: free for the problem with up to 300 variables and 300 constraints. A free trial license can also be requested.

Advantage:

- **Count confidence level**
- **Batch mode (TOD), faster**
- **Convex problem, global solution**

Single corridor results (I4 Eastbound)

Missing Count

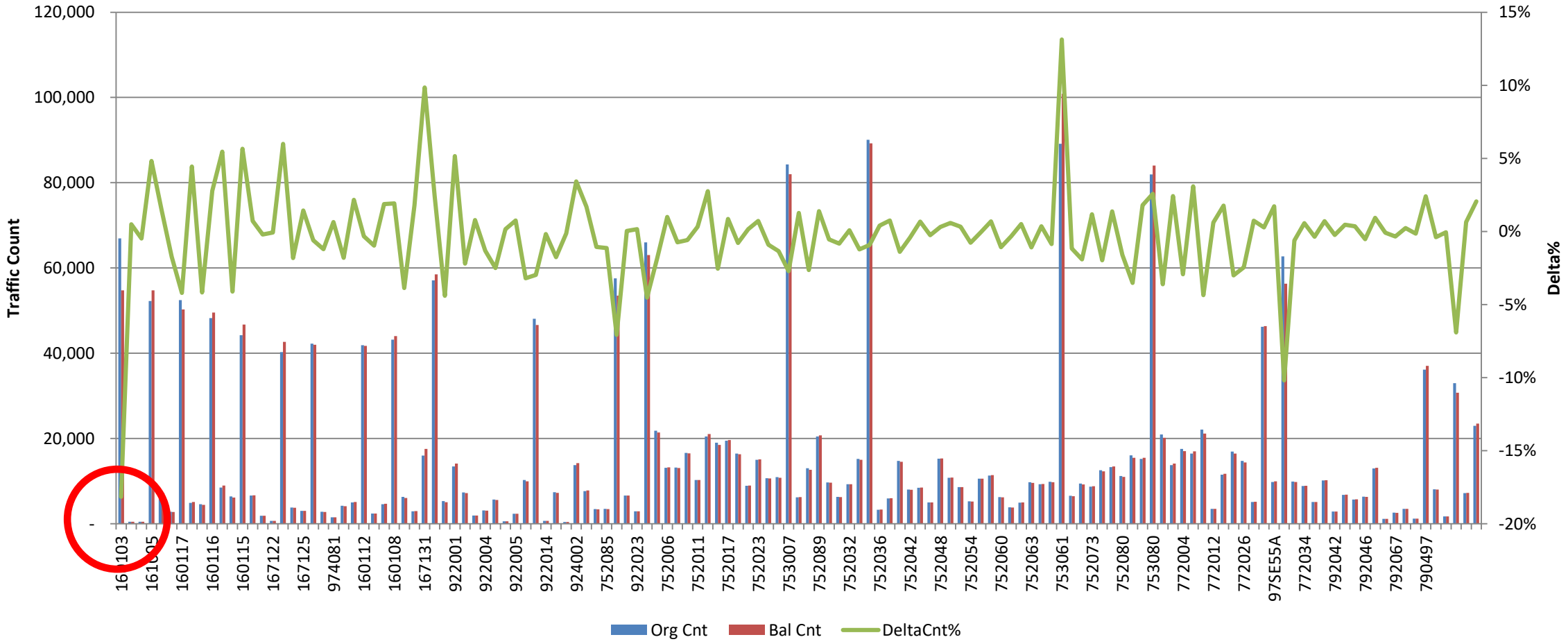
Balanced Count

Input count data

Order	Station	Direction	Type	A	B	CNT_15	CNTAM	CNTMD	CNTPM	CNTNT	aily_GAMS	CNTAM_Bal	CNTMD_Bal	CNTPM_Bal	CNTNT_Bal		
1	[illegible]	EB	M	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	54,778	8,965	17,384	11,779	16,650	(12,149)	-18%
2	974009	EB	Off	81185	81113	450	0	0	0	0	452	83	142	94	133	2	0%
3	974008	EB	On	81141	81088	450	0	0	0	0	448	81	141	93	132	(2)	0%
4	161005	EB	M	81088	81173	52256.02	7481.92	16961.01	11051.9	16761.19	54,774	8,964	17,383	11,778	16,649	2,518	5%
5	167101	EB	Off	81173	81247	7145.11	1601.65	1744.82	1575.9	2222.74	7,248	1,578	1,774	1,603	2,292	103	1%
6	167102	EB	On	81247	81125	2800	0	0	0	0	2,752	524	859	572	797	(48)	-2%
7	160117	EB	M	81125	81189	52485.68	8428.16	17493.84	11952.72	14610.96	50,278	7,911	16,467	10,747	15,154	(2,208)	-4%
8	167110	EB	Off	81189	80358	4900	0	0	0	0	5,118	885	1,636	1,100	1,496	218	4%
9	167113	EB	On	81075	81112	4600	0	0	0	0	4,408	848	1,358	887	1,316	(192)	-4%
10	160116	EB	M	81112	81200	48222.72	7225.92	15585.44	10331.36	15080	49,568	7,873	16,189	10,533	14,973	1,346	3%
11	167115	EB	Off	88043	81196	8500	0	0	0	0	8,964	1,359	2,899	1,994	2,713	464	5%
12	167116	EB	On	81066	88248	6400	0	0	0	0	6,137	1,277	1,878	1,205	1,776	(263)	-4%
13	160115	EB	M	81084	81165	44240.56	7317.44	14089.92	10084.88	12748.32	46,741	7,792	15,169	9,744	14,037	2,500	6%
14	167120	EB	Off	81165	80365	6600	0	0	0	0	6,647	1,028	2,119	1,568	1,933	47	1%
15	167121	EB	On	80365	81056	1900	0	0	0	0	1,896	361	593	379	563	(4)	0%
16	167122	EB	On	81172	81056	700	0	0	0	0	699	130	219	143	207	(1)	0%
17	160114	EB	M	81110	81211	40275.04	6868.16	13110.24	8415.68	11880.96	42,689	7,255	13,862	8,698	12,873	2,414	6%
18	167123	EB	Off	81211	81161	3800	0	0	0	0	3,731	617	1,188	848	1,079	(69)	-2%
19	167125	EB	On	81057	81098	3000	0	0	0	0	3,043	595	945	589	914	43	1%
20	160113	EB	M	81098	81186	42259.36	7145.84	13686.4	8393.84	13033.28	42,001	7,234	13,619	8,440	12,708	(258)	-1%
21	974082	EB	Off	81186	81123	2800	0	0	0	0	2,766	466	877	612	811	(34)	-1%
22	974081	EB	On	81207	81097	1500	0	0	0	0	1,510	287	471	304	448	10	1%
23	167051	EB	Off	81181	81175	4200	0	0	0	0	4,124	666	1,314	940	1,204	(76)	-2%
24	167053	EB	On	81060	81105	5000	0	0	0	0	5,108	1,055	1,575	947	1,530	108	2%
25	160112	EB	M	81105	81164	41865.2	7646.08	13787.28	8134.88	12296.96	41,728	7,442	13,475	8,139	12,672	(137)	0%
26	167061	EB	Off	81164	81169	2400	0	0	0	0	2,377	409	757	521	689	(23)	-1%
27	167063	EB	On	81073	81121	4600	0	0	0	0	4,686	945	1,429	879	1,432	86	2%
28	160108	EB	M	81121	88182	43210.96	8028.8	13436.8	7952.88	13792.48	44,037	7,979	14,146	8,498	13,415	826	2%
29	167130	EB	Off	81176	81191	6300	0	0	0	0	6,056	964	1,932	1,377	1,782	(244)	-4%
30	167132	EB	On	80029	81082	2900	0	0	0	0	2,952	569	920	590	874	52	2%
31	167131	EB	On	81202	81082	16000	0	0	0	0	17,575	4,120	5,316	2,903	5,236	1,575	10%
32	160111	EB	M	81109	81163	57123.04	12041.12	17297.28	9846.72	17937.92	58,508	11,704	18,450	10,613	17,742	1,385	2%
33	167081	EB	Off	88355	70412	5300	0	0	0	0	5,066	854	1,582	1,099	1,532	(234)	-4%
34	922001	EB	On	70335	70359	13429.97	3682.46	3947.08	2305.83	3494.6	14,123	4,129	4,102	2,324	3,568	693	5%
35	979001	NB	Off	70441	70342	7359.68	1300.37	2360.94	1844.28	1854.09	7,198	1,243	2,298	1,828	1,829	(162)	-2%
36	979002	SB	On	70449	70369	1935.84	542.82	673.62	374.96	344.44	1,951	552	678	375	345	15	1%
37	922004	EB	Off	70431	70385	3116.86	950.41	960.51	537.32	668.62	3,076	921	952	536	666	(41)	-1%
38	922006	EB	Off	70407	70364	5700.44	1771.54	1766.49	600.95	1561.46	5,558	1,671	1,738	600	1,549	(143)	-3%
39	922030	EB	On	70415	70374	583.44	64.26	180.54	124.44	214.2	584	64	181	125	215	1	0%

I_4EB PPT / Interface / BalTemplate / BalNodeTemplate / CombTemplate / I_4EB / I_4WB / SR528EB / SR528WB / SR408EB / SR408WB / SR429NB / SR429SB / SR417NB / SR417SB

I4 EB traffic balance result (Daily)

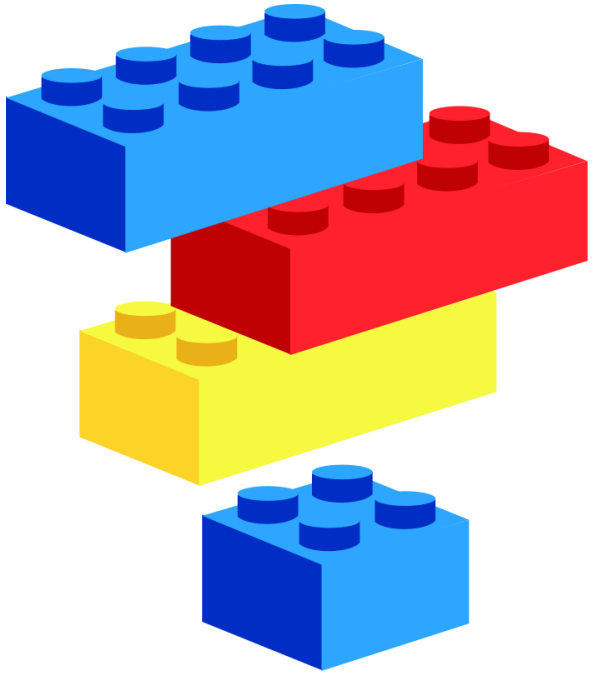


Abnormal counts detection

Order	Station	Direction	Type	A	B	Org Cnt	Bal Cnt	DeltaCnt%
1	160103	EB	M	88212	81185	66,927	54,778	-18%
2	974009	EB	Off	81185	81113	450	452	0%
3	974008	EB	On	81141	81088	450	448	0%
4	161005	EB	M	81088	81173	52,256	54,774	5%
5	167101	EB	Off	81173	81247	7,145	7,248	1%
6	167102	EB	On	81247	81125	2,800	2,752	-2%
7	160117	EB	M	81125	81189	52,486	50,278	-4%

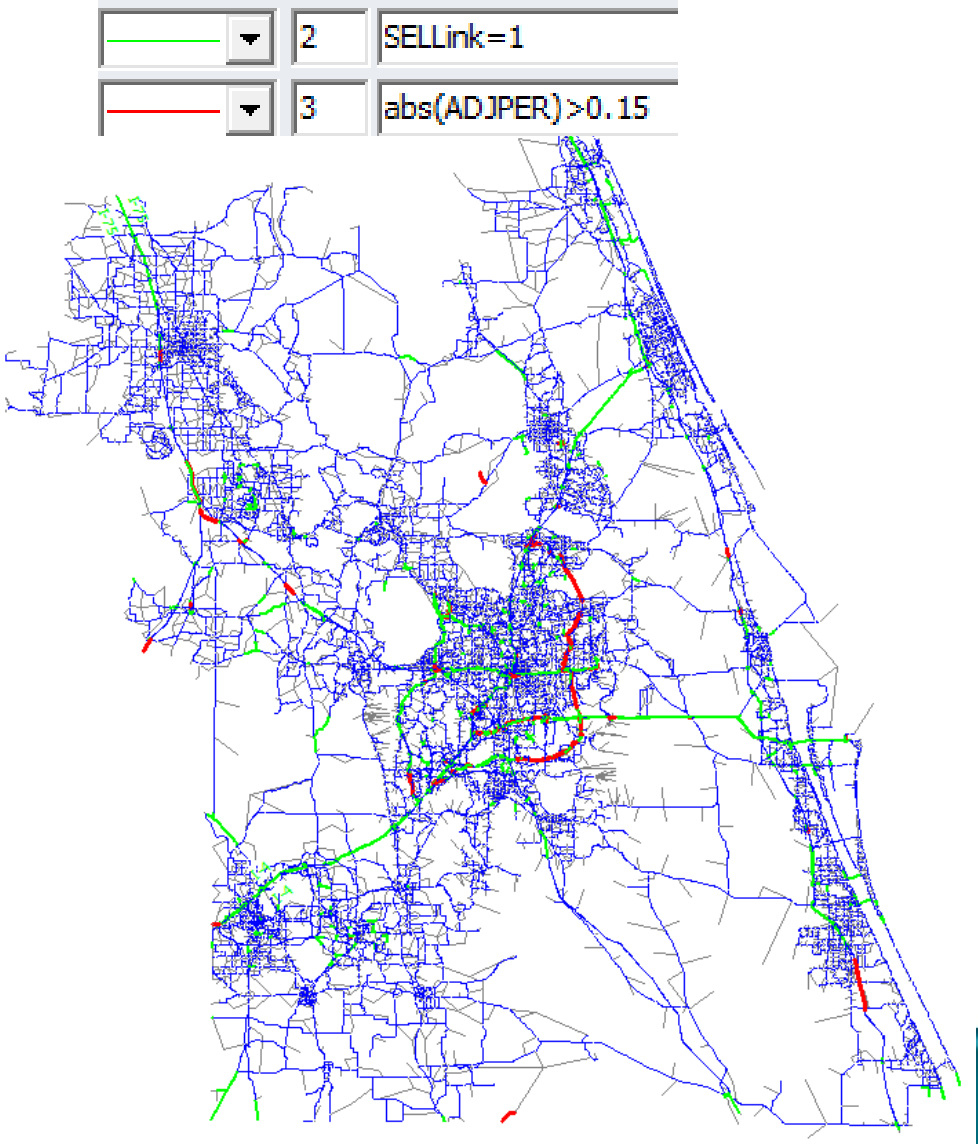
Network level traffic balance

- **Assemble** all the corridor level and node level count data together into one balance model
  - Model can be easily scaled up due to its structure
  - Special treatment for the shared links from different systems
  - Some weight factor adjustment might need
- **Problem Scale: 10,120 variables and 712 constrains**
- Performance:
  - Computation is efficient, finished within 10 mins
  - Systematic consistent count balance result in network level



CFRPM network level balance result (Daily)

abs(Adj)%	Numbe of Links	Percentage
0%-10%	2,891	86%
10%-20%	286	8%
20%-30%	96	3%
30%-40%	44	1%
40%-50%	19	1%
50%-60%	17	1%
60%-70%	18	1%
70%-80%	2	0%
80%-90%	3	0%
90%-100%	4	0%



Summary

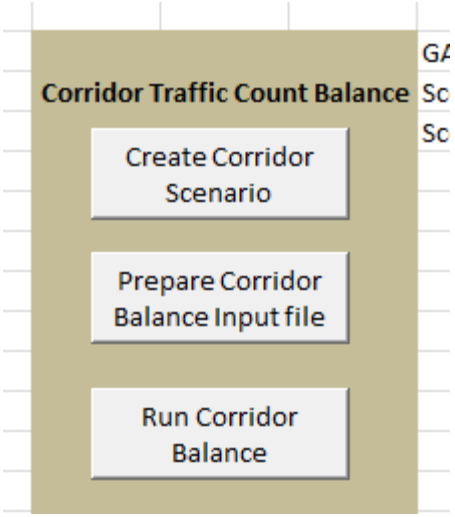
- A systematic method framework for traffic balance in network level
  - Link count extractor
  - Rigorous mathematic model for traffic balance
  - Efficient and effective way to solve the network-level traffic balance problem
- Future studies
  - Looking for some mathematic solver from open-sourced software packages
  - Improve the traffic count extractor for network levels
  - How to deal with the missing counts more effectively

Single Corridor/Node level balance

- Help user to make sure the link topological order is correct.
- Help user to identify the abnormal traffic count (large adjustment), and correct them

Traffic Balance Model (Interface)

- Create corridor Scenarios (Copy the templates)
- Prepare Corridor balance input file (input files for GAMS)
- Run the traffic balance program and copy the result back to the spreadsheet.



Weight factors (Confidence Information)

Corridor level weight factors

Description For Corridor	Main/Ramp	Daily/TOD	W/WO TOD	WeightValue
Daily Mainline (W TOD)	1	1	1	4
Daily Mainline (WO TOD	1	1	0	2
Daily Ramp (W TOD)	0	1	1	3
Daily Ramp (WO TOD)	0	1	0	2
TOD Mainline(W TOD)	1	0	1	3
TOD Mainline(WO TOD)	1	0	0	0.5
TOD RAMP (W TOD)	0	0	1	2
TOD RAMP (WO TOD)	0	0	0	0.5

Node level weight factors

Description For Node	Daily/TOD	WeightValue
Daily Count	1	2
TOD Count	0	1