

# Adapting Traffic Queue Simulation to Large Scale Pedestrian Evacuation Simulation

### **GITEWS**

- Geotechnologies – Early Warning Systems
- not very detailed for specific cities
- more general: how to warn, how to advise people, how to prepare hospitals, ...
- Last-Mile is a subpart of GITEWS

### **Last-Mile**

- detailed for one city, namely Padang
- inundation dynamics, local vulnerabilities, critical infrastructure
- mobility behavior of inhabitants
- simulation of evacuation
- 5/2007 – 4/2010 (3 years)

### **Socioeconomic Vulnerability Indicators**

- Institute for Environment and Human Security, United Nations University Bonn

### **Inundation Scenarios, Flow Analysis**

- Franzius-Institute for Hydraulic Waterways & Coastal Engineering Civil and Geodesy Faculty, University Hannover

### **Geodatabase Information System & Vulnerability**

#### **Assessment**

- Chair for Remote Sensing, Geographical Institute, University Würzburg

### **Evacuation Analysis and Traffic Optimization**

- TraffGo HT GmbH, Germany
- Chair for Transport Systems Planning and Transport Telematics, Technical University Berlin

### **Highly-resolved 3D-model of Padang**

- Remote Sensing Solutions GmbH
- Deutsches Zentrum für Luft- und Raumfahrt (DLR)
- Institute for Computer Science, Computer Graphics, University Bonn

### Padang

- About 800,000 Inhabitants
- Located at the West Coast of Sumatra (0°57'0"S 100°21'11"E)
- Area 694.96 km<sup>2</sup>
- Elevation about 3 m
- Density 1090/km<sup>2</sup>

### Needs for MATSim

- Streetnetwork
- Population



## Creating Street Network from Satellite Imagery

### Satellite Imagery

- Street network of the city of Padang
- Classified in arterial and side roads
- Consists of polygons

### Street Network

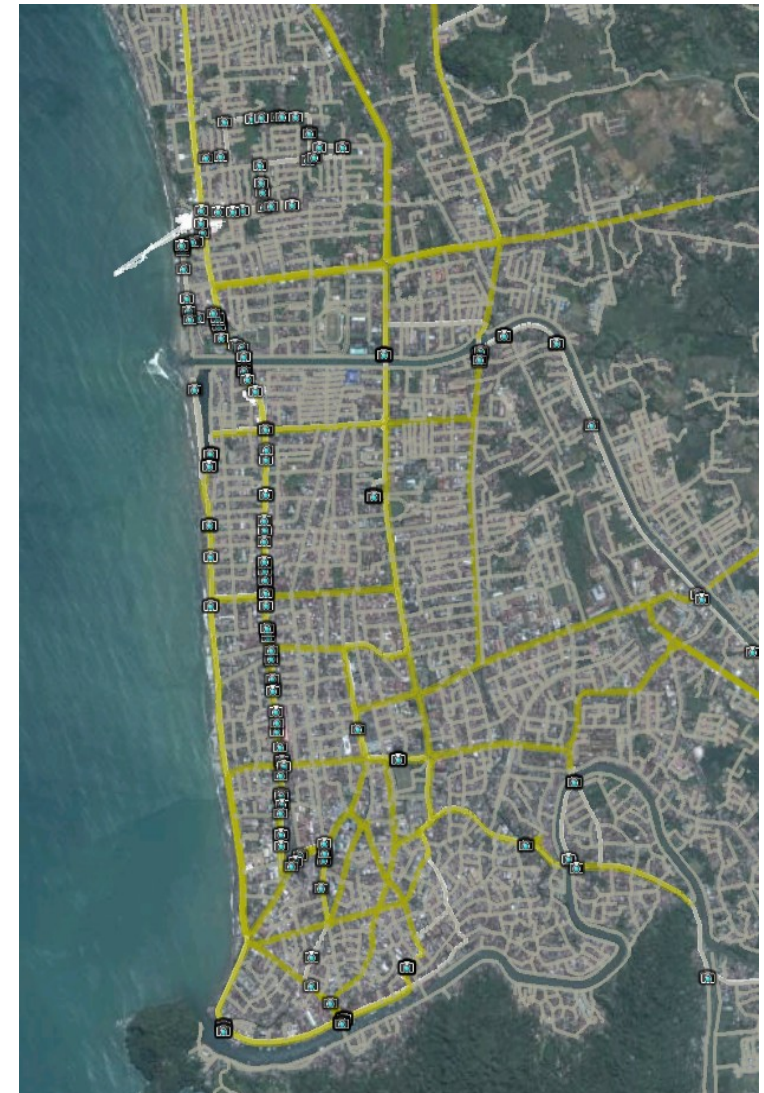
- Length and width of links can be extracted automatically
- Conversion needs to be manually checked



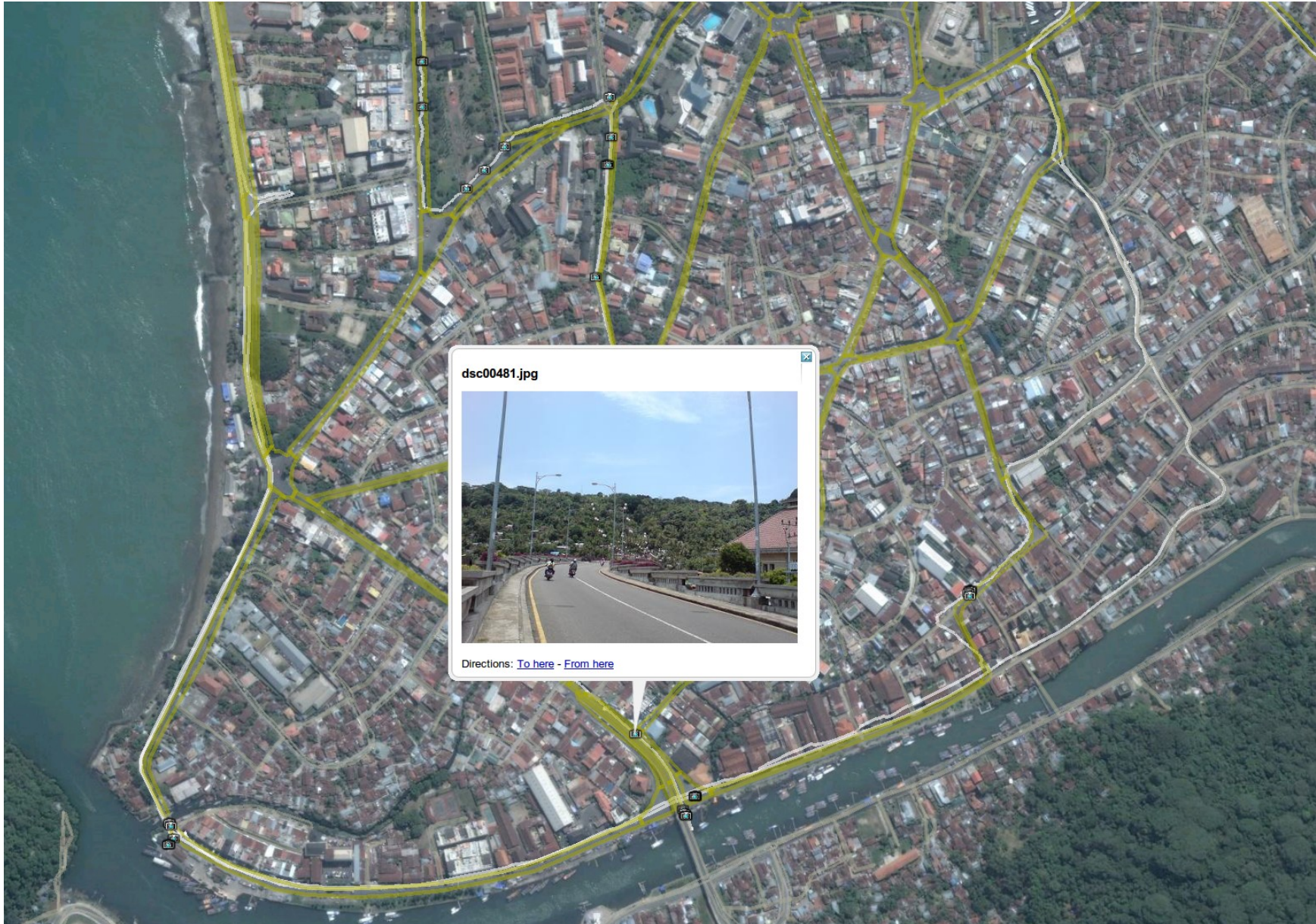
## Creating Street Network from Satellite Imagery

### Validating the satellite imagery

- On site examining
- Geo-encoded pictures of bridges and other potential bottlenecks



## Creating Street Network from Satellite Imagery



### **Results?**

- Still work in progress ...

### **Other characteristics for pedestrian simulation**

- Flow rate for pedestrians about 1.3 people/m/s on walkways
- Density at maximum flow rate 2-4 people/m<sup>2</sup>
- No data for large scale pedestrian simulation available

### **Description of the agents**

- Demographic data (age, sex, income, ...)
- Activities during day (place, time, duration)
- Paths in the network connecting two activities not needed

### **Data obtained so far**

- OD Matrix for the population of Padang
- Data is not translated yet

### **Missing data**

- Population distribution
- Location of evacuation areas (hills, shelters, ...)
- Inundation estimation (endangered area)
- Missing data should be obtained from project partners

ZONA ASAL	ZONA TUJUAN																																							BANGKITAN	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39		
1		6,269	8,436	6,722	2,414	4,854	1,861	6,100	6,750	6,214	3,742	2,901	7,289	2,965	3,285	3,634	3,030	2,268	4,045	3,166	3,442	4,555	1,484	562	4,326	6,570	2,904	992	9,598	2,385	498	1,862	4,483	1,625	3,044	359	1,269	1,142	834	137,881	
2	8,796		975	1,831	761	734	361	1,189	803	947	1,686	992	2,410	923	709	761	1,231	394	402	522	364	365	278	431	464	1,660	525	338	1,368	615	308	455	294	919	308	292	541	473	557	36,972	
3	6,961	489		1,172	552	397	283	1,609	832	612	272	475	521	665	676	326	226	252	793	280	404	1,381	298	404	342	1,304	334	268	2,088	1,040	496	334	593	605	967	260	485	385	330	29,930	
4	12,128	2,746	3,959		2,700	4,396	1,829	5,791	4,070	3,501	3,133	2,675	2,536	3,462	1,883	3,452	4,012	2,300	1,057	1,402	1,130	2,275	1,614	1,017	1,968	2,019	1,425	873	5,593	1,384	1,907	1,690	1,931	3,061	616	245	508	984	340	96,861	
5	7,216	1,145	725	1,819		940	259	2,230	1,483	1,120	988	1,416	3,492	1,235	533	2,231	768	1,742	415	489	291	370	738	533	319	824	324	414	2,740	1,890	640	599	2,183	810	945	351	105	265	206	44,391	
6	7,331	1,219	744	2,305	503		767	954	1,578	507	312	1,451	1,522	601	335	433	358	549	679	767	1,538	261	243	375	1,049	431	503	216	244	254	400	356	299	603	804	233	961	282	238	32,207	
7	3,611	472	599	253	356	962		1,391	568	208	262	204	503	412	226	448	302	253	406	1,313	3,645	342	321	592	616	324	876	260	2,237	317	380	467	219	259	226	899	121	83	83	25,039	
8	12,457	1,181	3,846	3,279	1,067	1,578	1,491		3,576	2,142	350	570	2,342	4,997	1,385	1,998	1,197	534	940	1,452	1,631	2,617	824	754	1,607	3,431	1,652	295	5,047	2,228	633	712	1,136	1,989	1,060	281	201	61	123	72,262	
9	8,670	652	1,952	2,923	708	597	403	2,863		1,927	497	908	824	1,183	1,759	2,699	570	568	648	603	340	1,274	845	243	624	1,217	256	443	1,448	736	503	482	1,020	1,445	408	422	84	128	125	43,181	
10	10,223	2,147	4,406	7,763	4,127	2,521	1,506	8,191	5,413		2,249	1,536	373	2,275	2,668	2,095	1,433	1,563	1,099	997	843	1,068	1,941	870	536	554	1,649	1,262	2,826	733	1,000	2,779	2,806	2,155	449	735	104	170	146	82,879	
11	4,200	699	702	1,556	398	287	865	460	556	338		617	651	278	351	425	374	338	262	334	284	264	751	376	250	249	587	305	231	407	214	243	1,468	382	777	433	288	115	163	144	21,341
12	4,597	425	1,261	2,189	1,409	880	219	878	770	225	797		1,825	669	348	243	301	425	330	346	286	311	267	333	350	778	213	290	328	302	245	467	344	524	607	347	258	181	161	24,727	
13	7,599	1,377	948	2,444	3,051	1,631	341	1,757	1,157	256	842	1,748		633	653	266	728	901	919	916	383	1,044	347	709	348	371	306	465	631	636	362	595	232	1,725	535	253	123	126	151	37,510	
14	9,968	1,613	1,030	1,784	721	357	219	2,522	629	685	451	543	795		2,178	1,735	1,165	344	543	276	390	1,890	451	358	630	3,366	1,200	269	3,216	719	228	433	686	637	746	397	287	189	85	38,725	
15	2,302	582	630	1,361	213	202	293	444	1,472	210	216	400	235	935		1,537	291	388	274	390	210	902	878	241	319	364	567	272	810	439	205	278	447	545	223	231	108	160	160	19,734	
16	6,348	709	1,329	3,000	1,585	352	330	2,707	2,739	908	244	526	884	550	1,513		652	526	508	322	265	1,243	2,294	249	357	1,200	757	656	1,224	474	353	1,322	1,359	285	535	375	304	171	200	39,356	
17	2,289	418	260	1,345	337	191	278	599	926	229	364	263	117	490	634	364		229	517	199	309	229	623	331	175	259	206	229	220	241	389	1,332	2,241	634	281	178	96	173	52	18,216	
18	3,638	347	847	1,640	1,005	235	219	3,087	893	549	653	340	1,420	367	453	271	433		666	381	342	630	755	632	423	761	390	288	474	361	264	599	1,004	1,920	890	369	190	159	256	27,989	
19	5,669	507	1,365	730	664	810	267	2,424	693	356	446	298	737	344	434	348	261	252		822	323	640	345	798	975	462	238	252	257	1,617	368	441	345	1,292	1,692	216	131	166	163	28,368	
20	4,594	437	594	856	592	529	1,633	2,635	754	307	201	280	620	310	286	287	304	221	688		322	310	198	498	221	492	349	464	235	240	239	323	201	419	641	326	92	131	218	22,046	
21	4,107	588	611	818	352	1,836	4,120	2,276	745	266	310	383	704	818	245	399	305	517	590	352		978	329	651	660	704	383	362	1,021	1,629	404	291	474	449	896	942	260	166	213	31,119	
22	6,227	441	2,674	1,026	664	440	384	2,873	1,245	631	783	932	2,652	2,514	1,256	1,220	653	484	347	2,288	1,059		1,238	327	1,084	9,661	2,626	435	7,829	3,974	520	1,112	2,092	1,059	375	267	316				
23	1,973	183	319	1,180	439	186	196	1,489	759	301	339	175	199	360	482	1,094	275	469	185	232	274	339		246	213	580	609	176	291	285	161	795	229	313	196	175	103				
24	3,037	477	1,030	1,483	723	267	430	1,757	362	773	428	246	659	324	315	311	355	868	1,043	428	601	1,271	247		377	671	236	268	1,098	1,954	232	253	329	1,355	901	367	123				
25	5,709	344	786	1,755	763	467	718	1,706	457	1,247	601	260	561	569	290	432	192	232	560	398	496	875	224	280		315	244	452	305	211	454	330	291	551	218	364	210				
26	4,588	359	1,262	1,157	351	1,028	242	1,568	1,262	646	411	534	313	2,487	479	432	462	381	542	351	246	2,490	272	263	336		2,266	368	5,161	3,025	1,647	667	351	420	429	332	90				
27	2,458	344	697	640	209	216	229	1,269	320	247	950	541	320	730	292	488	239	205	247	228	195	733	194	213	202	1,719		198	822	3,142	233	330	246	221	320	295	139				
28	2,693	192	409	588	168	417	204	173	395	290	1,311	190	272	814	177	1,384	635	343	523	422	404	611	255	227	203	648	531		2,131	432	215	1,443	298	293	252	291	145				
29	5,612	329	2,108	2,281	491	200	253	2,967	1,651	297	356	250	617	2,406	276	436	305	363	302	221	358	2,802	254	214	310	3,929	352	568		6,103	356	894	245	645	333	272	247				
30	2,915	485	1,092	732	852	256	262	1,919	682	467	278	276	1,023	1,715	410	442	305	275	273	537	418	2,006	416	243	301	4,448	3,083	343	11,581		796	919	422	479	274	350	123				
31	12,047	1,175	2,366	3,282	1,588	392	226	5,145	1,219	871	619	415	1,381	679	942	821	469	490	237	355	547	3,550	419	789	747	2,563	323	397	8,477	7,689		678	255	564	1,747	381	196				
32	3,629	1,401	516	1,039	513	192	392	930	693	629	621	237	306	483	599	674	1,889	324	309	202	242	1,039	1,391	218	499	334	466	621	1,525	240	392		3,308	500	314	377	296				
33	5,533	999	1,139	1,056	1,171	223	342	926	1,417	307	313	226	424	443	443	497	1,191	308	377	180	192	1,091	321	261	229	333	346	228	912	265	267	3,475		803	247	342	92				
34	4,419	940	1,728	3,031	811	748	280	2,359	1,153	728	251	575	1,929	1,173	407	607	944	2,837	1,175	269	683	613	431	1,224	1,027	379	365	274	2,118	818	676	793	653		2,485	372	126				
35	2,689	316	924	457	705	1,048	285	1,226	963	549	242	887	453	592	335	369	507																								

### **Prototypical Evacuation Simulation**

- Zurich by car
- Based on the old Zurich dilute simulation

### **Characteristics**

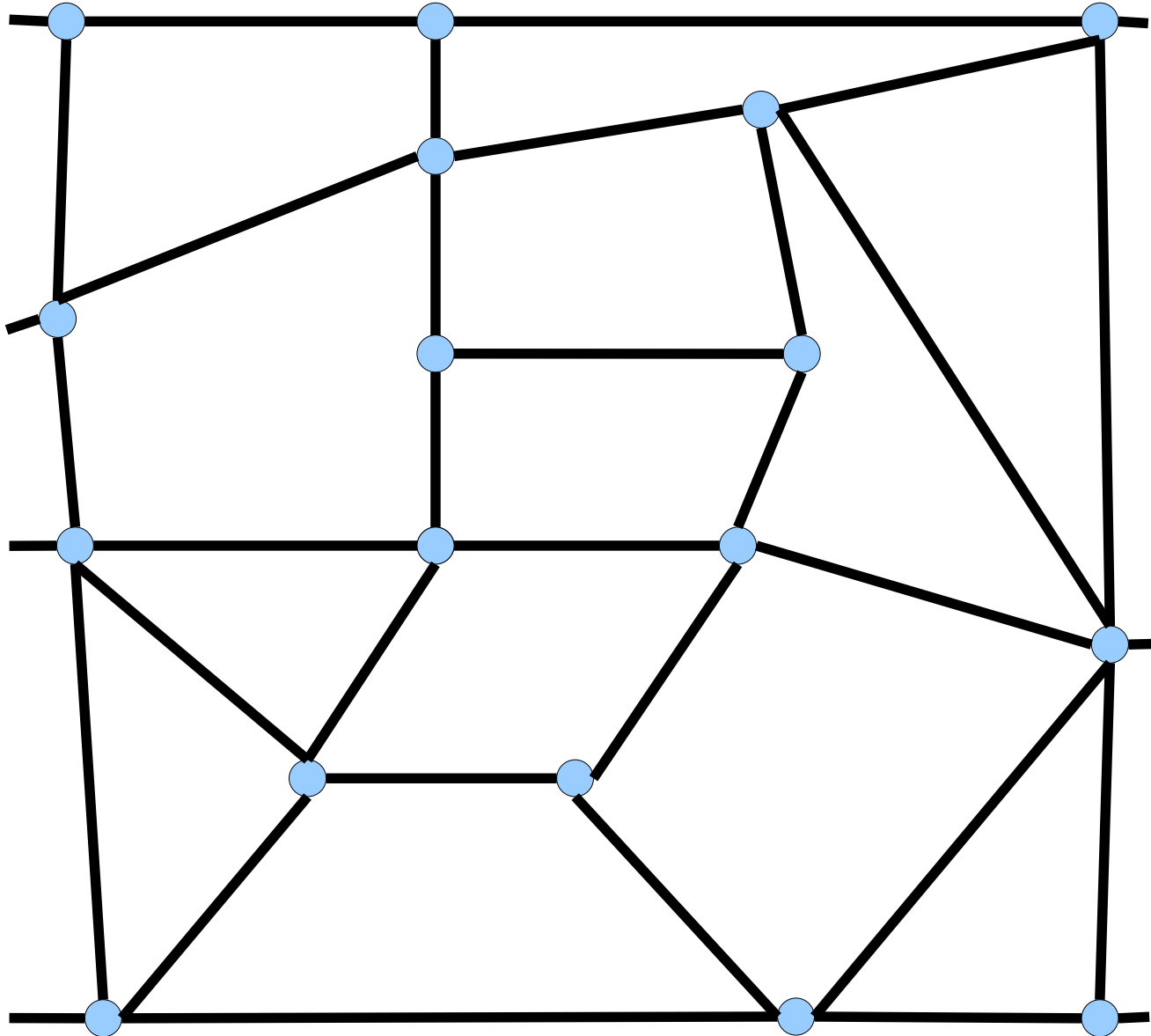
- Simulating the evacuation for a given time (e.g. evacuation at 9:00 am)
- Running iterations to achieve a Nash equilibrium

## Differences to common traffic simulation

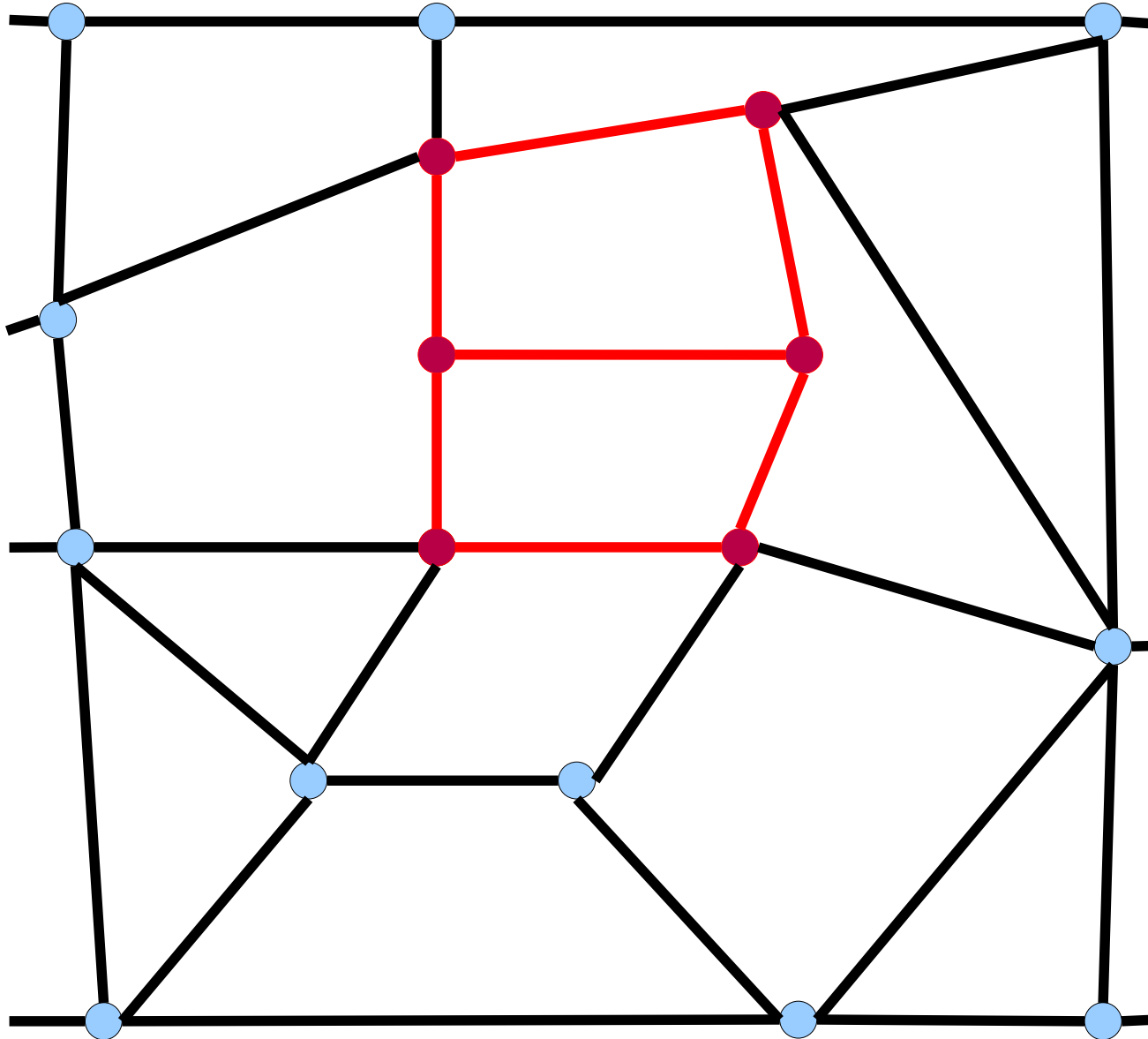
### **Adapting the network**

- Defining the evacuation area
- Deleting nodes outside the evacuation area (besides direct reachable nodes)
- Connecting all left nodes outside the evacuation area via evacuation links (with zero travel cost) to an evacuation node

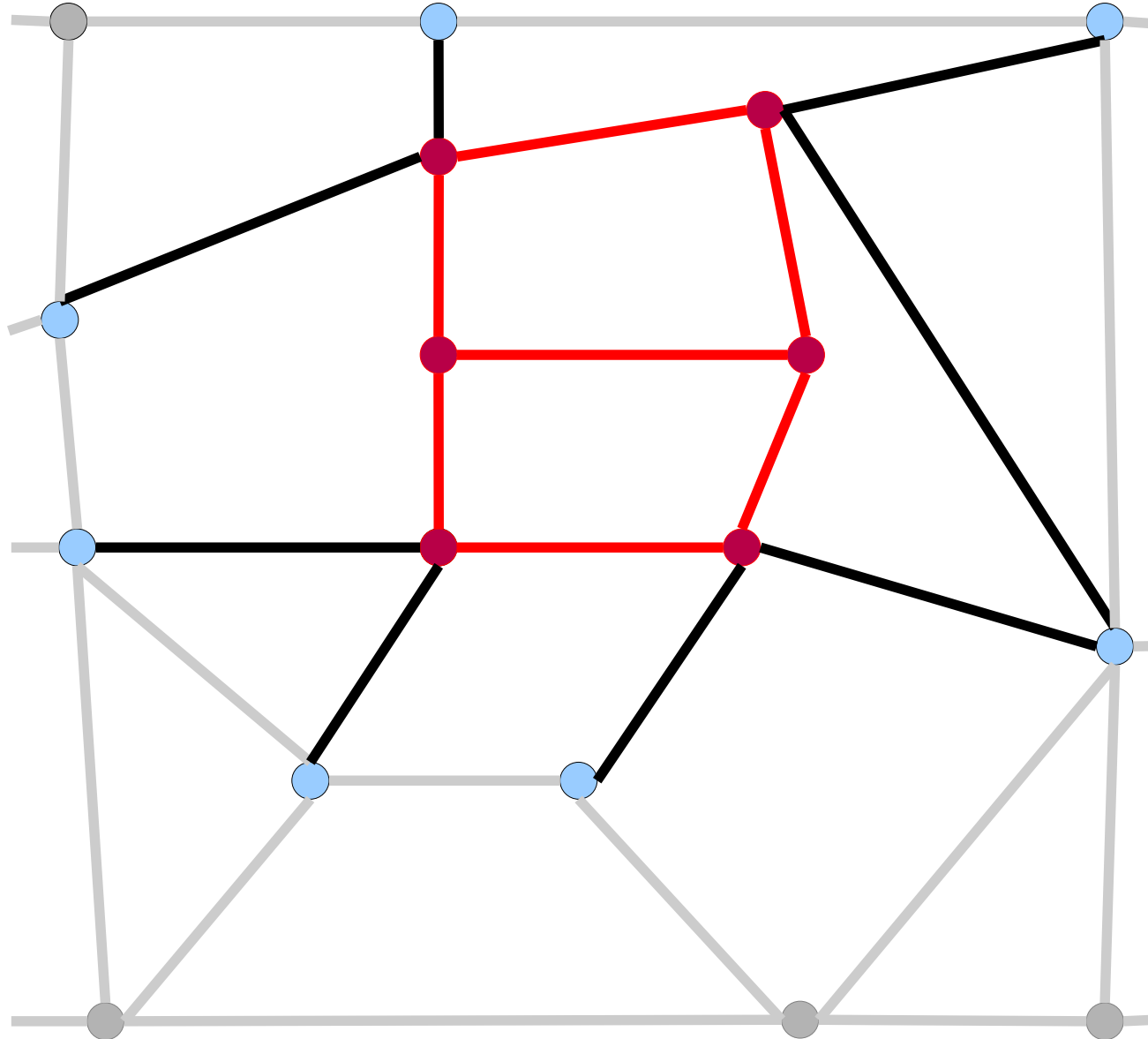
## Differences to common traffic simulation



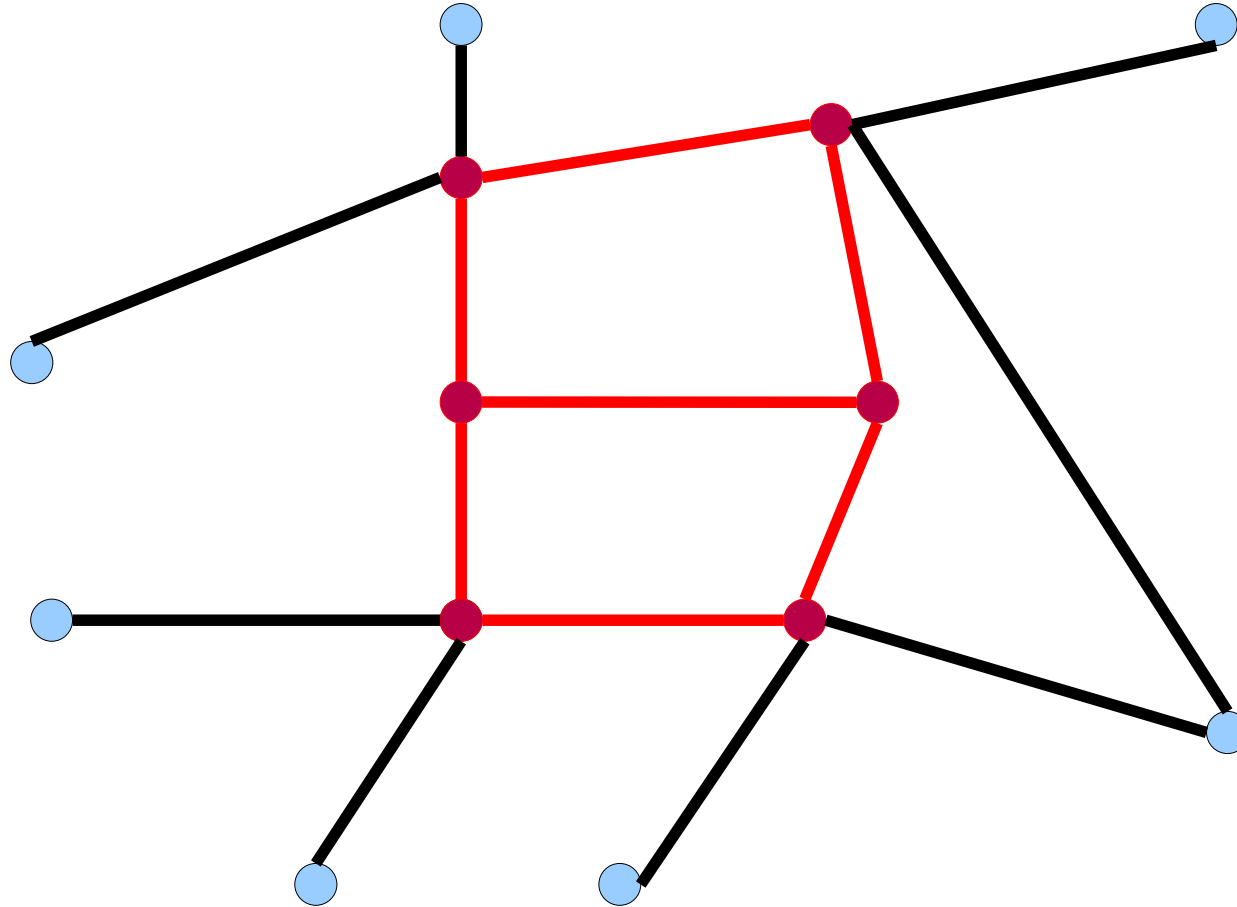
## Differences to common traffic simulation



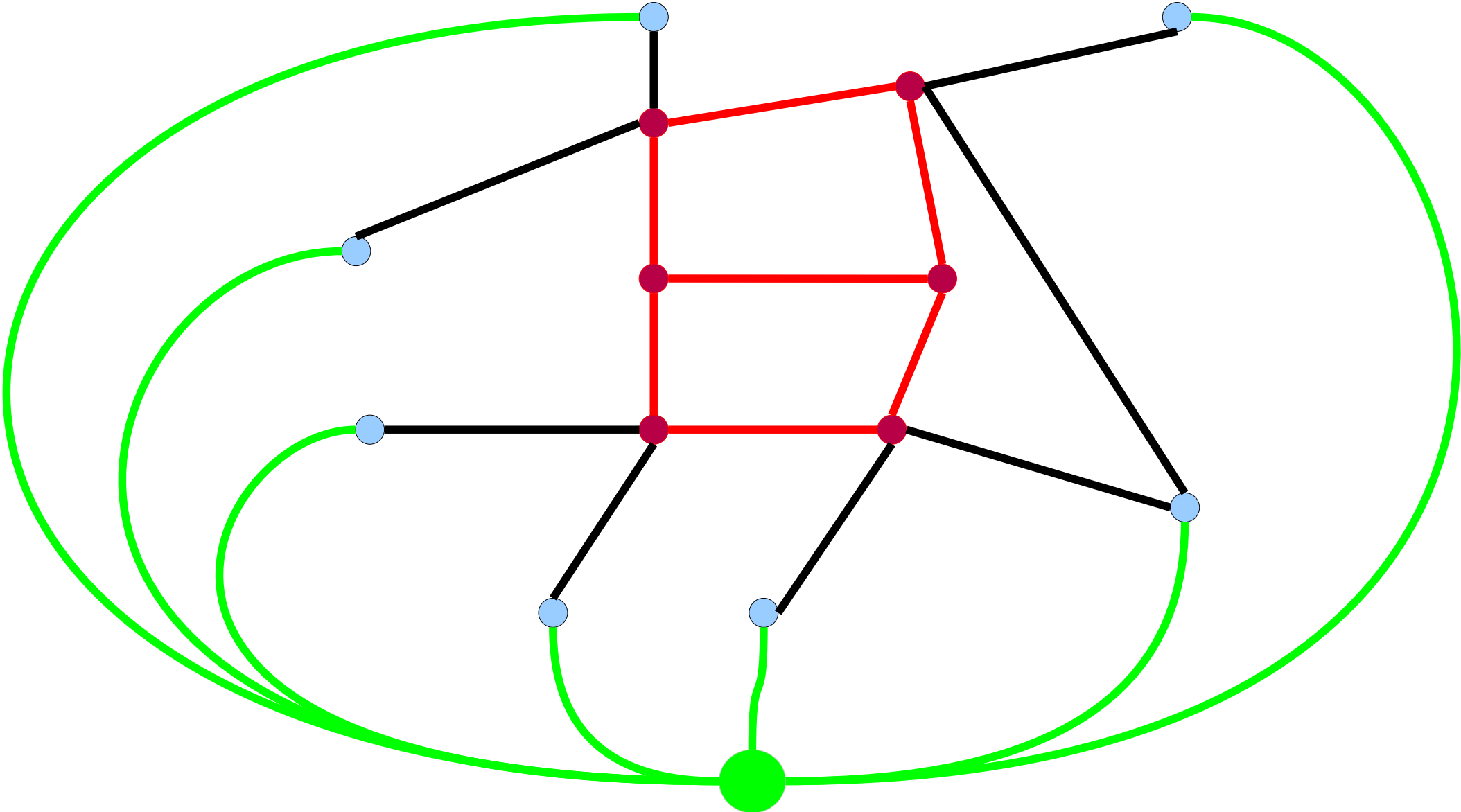
## Differences to common traffic simulation



## Differences to common traffic simulation



## Differences to common traffic simulation



## Differences to common traffic simulation

### Initial evacuation plans

- Deriving positions for a given time from events files (Events2Snapshot)
- Routing agents to evacuation node using Dijkstra's algorithm (assuming free speed)

### Running simulation

- Generic Queue Simulation started with initial evacuation plans and the adapted network

### **Network**

- Extract of the wider area of Zurich (from ARE network)

### **Population**

- 5% sample of dilute Zurich scenario about 5000 agents
- Position at 9 a.m.

### **Replanning**

- 10% RePlanning
- 90% BestScoreSelector

Demo

## **ExpBetaSelector**

- Inflated probability for similar paths
- Path overlap need to be taken into account (e.g. PSL)
- Overlap in time?

## **Shortest Path Router**

- „Sihltalstrassen-Problem“
- Probabilistic routing? (DC-Logit – extending Dial algorithm with commonality factor (Russo and Vitetta))

Aargau

1h

E41

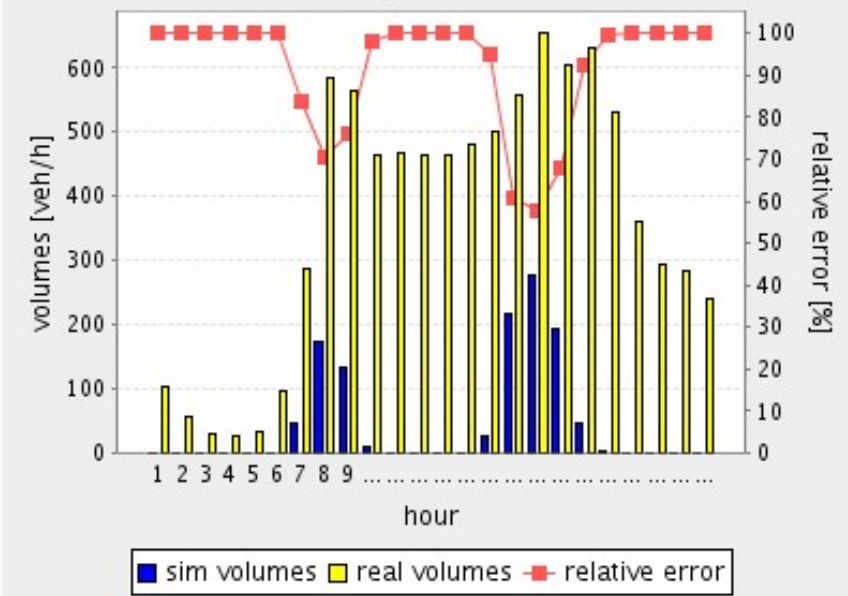
Zürich



### Link: 3495

24 h overview

link 3495, iteration: 100



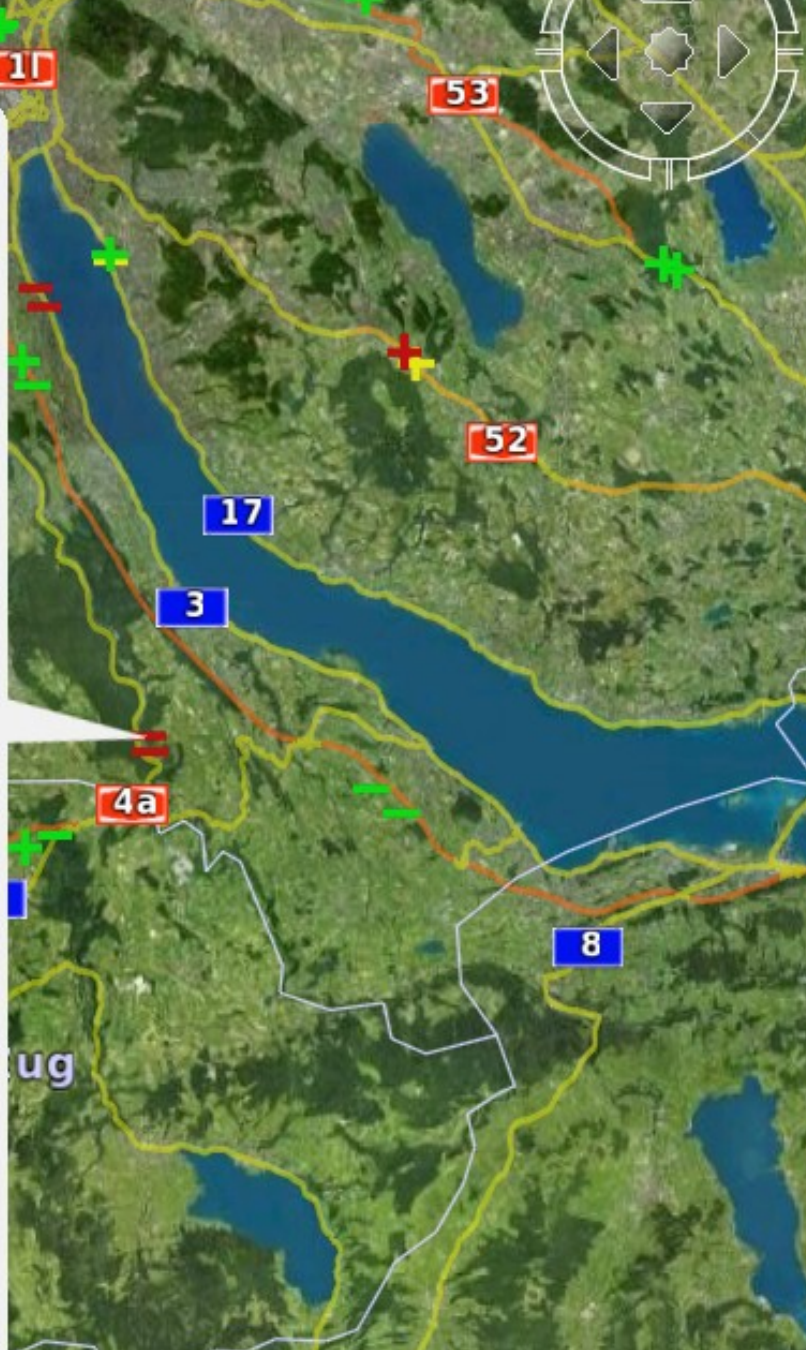
### Details from 08 o'clock to 09 o'clock

Astra Value: 563.39

MATSim Value: 134.0

Relative Error: 76.2154102841726

Directions: [To here](#) - [From here](#)



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2

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## **ExpBetaSelector**

- Inflated probability for similar paths
- Path overlap need to be taken into account (e.g. PSL)
- Overlap in time?

## **Shortest Path Router**

- „Sihltalstrassen-Problem“
- Probabilistic routing? (DC-Logit – extending Dial algorithm with commonality factor (Russo and Vitetta))
- No convincing results ... so far

Thank you for your attention!