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Measuring and Assessing Traffic Congestion: a Case Study

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Measuring and Assessing Traffic Congestion

- **Difficulties** in measuring and assessing traffic congestion in practice discussed.
- Modelling lessons learned from the **case study** of a highly congested corridor in Melbourne presented.

Westbound approach of the intersection of Alexandra Parade and Wellington Street

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Important aspects of observing and modelling congested networks

- Determine demand flow data: Turning volume counts and SCATS volume data under congested conditions give capacity flows (underestimate demand)
- Allow for the impact of lane blockage (queue spillback) in reducing saturation flow rates and intersection capacities
- Account for residual demand (queue) for highly congested conditions that last for long periods

Study Location and Data Collection: Intersection of Alexandra Parade and Wellington Street

Long queues on the westbound approach of the intersection during AM peak periods.

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Study Location and Data Collection: Intersection Saturation Flow Surveys

- Several saturation flow surveys conducted.
- ARR 123 saturation flow survey method extended for recording the lane blockage times and taking these into account in saturation flow and lost time calculations.
- Definition of Lane Blockage (reducing effect on saturation flow) needs to be clear.

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SATURATION FLOW AND LOST TIME SURVEY for cases with LANE BLOCKAGE

LANE 3 — 26 February 2014 between 8:52-11:30 am

COUNTS

Cycle Number	Departures from Queue (vehs)			Saturation Time (s)	Green Time (s)	Blockage Time (s)	
	First Interval	Middle Interval (Saturated)	Last Interval			First Interval	First and Middle Intervals
	1	2	3	4	5	7	8
1	3	26	1	92	90	0	29.7
2	4	23	1	74	102	0	26.4
3	2	22	1	51	110	0	26.2
4	3	20	1	72	109	0	29.2
5	5	19	0	78	105	0	26.1
6	3	16	1	90	118	0	46.7
7	3	13	1	113	112	0	43.2
8	3	17	1	116	116	0	42.3
9	4	15	1	90	110	0	36.6
10	3	24	2	91	120	0	22.8

PROCESSING

Cycle Number	Departures from Queue (vehs)			Saturation Time (s)	Green Time (s)	Middle Interval Time (s)	Blockage Time (s)	
	First Interval	Middle Interval (Saturated)	Last Interval				First Interval	Middle Interval
	1	2	3	4	5	6	7	8
1	3	26	1	92	90	82	0	29.7
2	4	23		74	102	64	0	26.4
3	2	22		51	110	41	0	26.2
4	3	20		72	109	62	0	29.2
5	5	19		78	105	68	0	26.1
6	3	16		90	118	80	0	46.7
7	3	13	1	113	112	103	0	43.2
8	3	17	1	116	116	106	0	42.3
9	4	15		90	110	80	0	36.6
10	3	24		91	120	81	0	22.8

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Study Location and Data Collection: Saturation Flow Survey results

Lane	2	3	4
Survey conducted on 26 Feb 2014			
Full saturation flow rate (veh/h)	1768	1724	1829
Reduced saturation flow rate (veh/h)	1400	1326	1223
Implied lane blockage	21%	23%	33%
Start loss (s)	2.3	3.2	2.8
End gain (s)	1.2	1.4	1.2
Average saturated green time (s)	72.2	78.1	82.5
Average displayed green time (s)	108.1	109.6	110.5
Effective green time (s)	107.0	107.7	108.9
Full saturation flow rate adjusted for HVs	1813	1767	1875
Basic saturation flow rate adjusted for short lanes, s_b	1916	1813	1685
Survey conducted on 19 Sep 2013			
Reduced saturation flow rate (veh/h)	811	849	890
Lane blockage implied by *Sep 2013* saturation flow rates compared with full saturation flow rates measured on 26 Feb 2014	54%	51%	51%

Study Location and Data Collection: Intersection and Freeway Data

- Intersection traffic data obtained from VicRoads including SCATS volume, operational parameters and timing data for the intersection.

  SCATS volume data represent the stop-line capacity flow rates under oversaturated conditions.

- VicRoads volume data from freeway detectors used for establishing demand flow rates.

- Saturation flow and lane blockage data obtained from special surveys at the intersection.

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Study Location and Data Collection : Eastern Freeway upstream of Wellington St and Hoddle St intersections

Queues extend upstream onto the Eastern Freeway section.
Demand flows determined from VicRoads freeway volume data upstream of the queues on the freeway.

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Study Location: Queues extending to Eastern Freeway

Queue lengths in the range **1.9 km to 3.7 km** (95th percentile queue = **3.5 m**) observed in floating car surveys with GPS video equipment.

Queues extend as far as the Chandler Highway interchange.

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SIDRA INTERSECTION Analyses: Demand Flows

- **Demand flows** for each 15-min interval by finding the percentage of total freeway traffic that travels to the Wellington Street intersection.
- **Residual demand (queue)** accumulated during the 6.00 - 7.45 AM period also included in determining an adjusted demand flow rate.

41	Eastern Freeway WestBound Between Chandler Highway and Hoddle Street - Detector 14003											
42	5-Mar-14			Demand flows (Freeway)		Capacity flows (SCATS)			Residual			
43		Flow (veh/15 min) (from "Detector Site 14003", col AN)	Flow split (Freeway to Alexandra Pde	Demand flow (veh/15-min)	Cumulative demand (veh)	Capacity flow (veh/15-min)	Cumulative capacity (veh)	x =Dem /Cap	Residual (veh)	Cumulative residual (veh)	Cumulative residual (m)	
44	05:00 - 05:15	246	0.68	167	167	158	158	1.05	9	9	61	
45	05:15 - 05:30	412	0.64	263	429	242	400	1.08	21	29	210	
46	05:30 - 05:45	732	0.60	442	871	403	803	1.10	39	68	492	
47	05:45 - 06:00	937	0.60	559	1430	512	1315	1.09	47	115	832	
48	06:00 - 06:15	1357	0.59	798	2228	715	2030	1.12	83	198	1429	
49	06:15 - 06:30	1658	0.50	826	3053	606	2636	1.36	220	**417**	**3017**	
50	06:30 - 06:45	1632	0.38	624	3677	609	3245	1.02	15	432	3125	
51	06:45 - 07:00	1467	0.37	550	4227	548	3793	1.00	2	434	3140	
52	07:00 - 07:15	1281	0.40	509	4736	614	4407	0.83	0	329	2376	
53	07:15 - 07:30	1340	0.41	555	5290	516	4923	1.07	39	367	2655	
54	07:30 - 07:45	1162	0.39	455	5745	413	5336	1.10	42	409	2959	
55	**07:45 - 08:00**	**1071**	0.45	**480**	6225	433	5769	1.11	47	**456**	**3299**	
56	08:00 - 08:15	923	0.48	446	6671	329	6098	1.35	117	573	4141	
57	08:15 - 08:30	930	0.39	362	7032	377	6475	0.96	0	557	4029	
58	08:30 - 08:45	919	0.41	379	7411	359	6834	1.06	20	577	4174	

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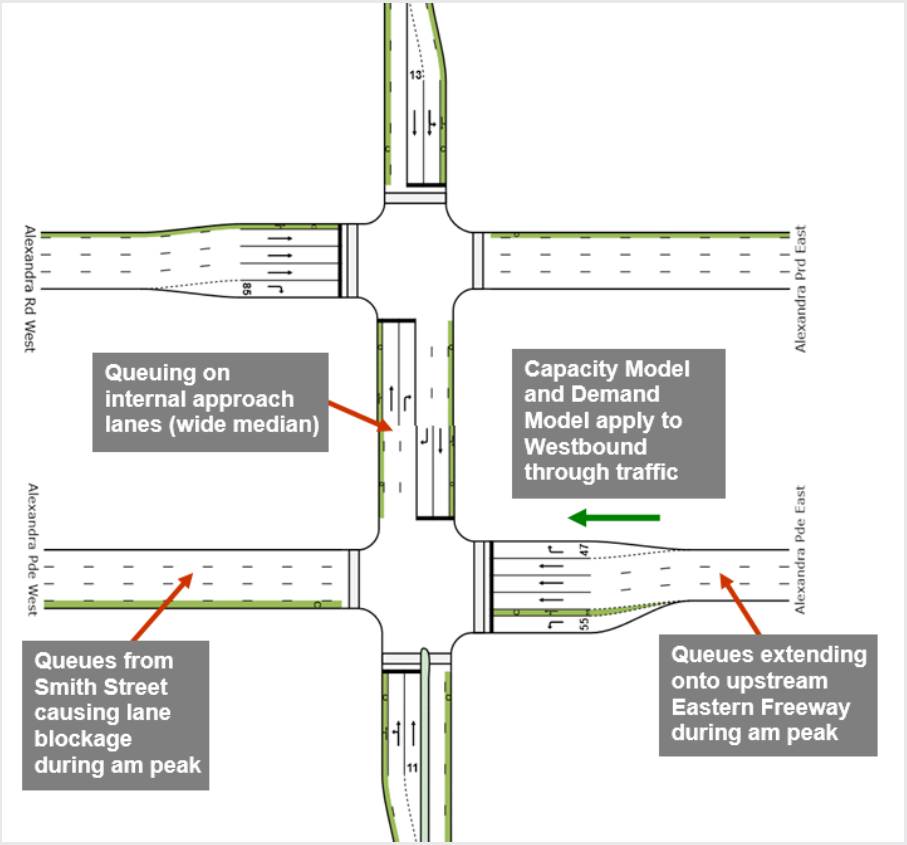
SIDRA INTERSECTION Analyses: Capacity and Demand Flows

- A detailed paired intersection (network) model developed using SIDRA INTERSECTION 6
- Capacity Model using SCATS volume data: calibrated for Degree of Saturation = 1.0 (volume = capacity)
- Demand Model for realistic queue length estimates.



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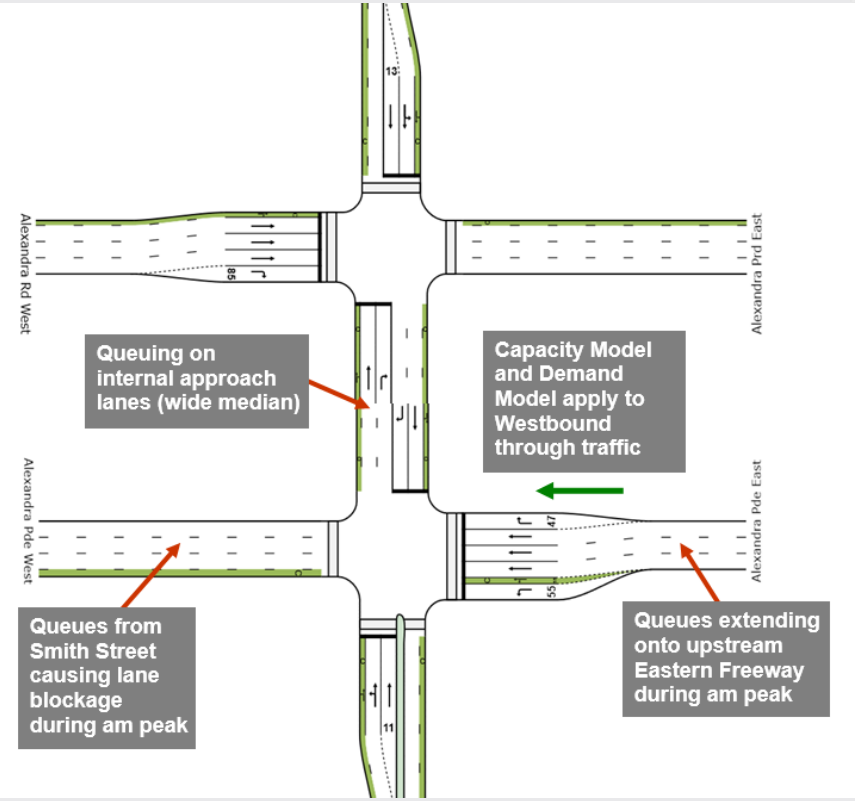
SIDRA INTERSECTION Analyses: Capacity Flows

- Analyses for the intersection peak 15-min peak period (7.45 - 8.00 AM) using data for 4 Mar 2013 and 5 Mar 2014.
- Capacity flows for each 15-min interval from SCATS intersection data.
- Westbound lanes blocked frequently by queues extending from the downstream Smith Street intersection: lane blockage values in the range 50 – 60%.
- Low saturation flow rates (50 – 60% capacity loss) as a result.



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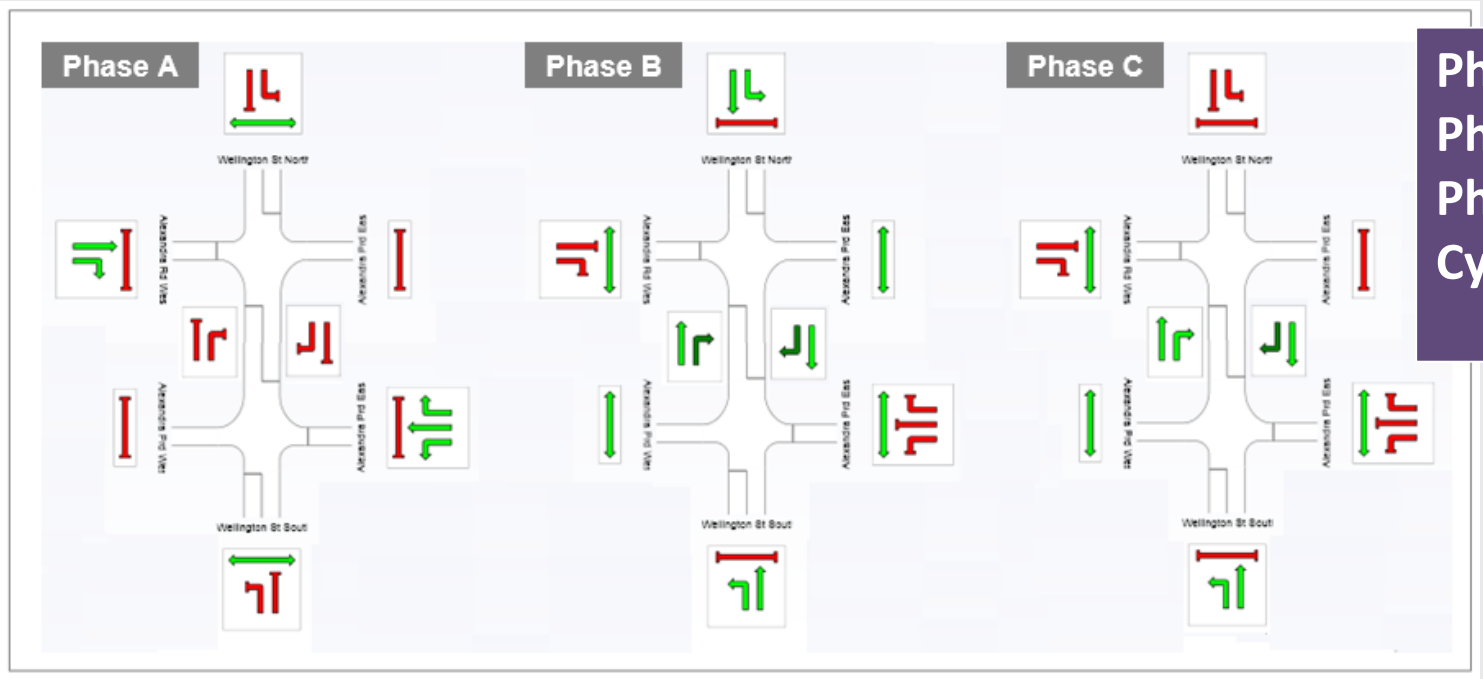
SIDRA INTERSECTION Analyses:
Signal Phasing

Phase Times from SCATS and confirmed in the field:



Phase A = 110 s
Phase B = 40s
Phase C = 10s
Cycle Time = 160 s

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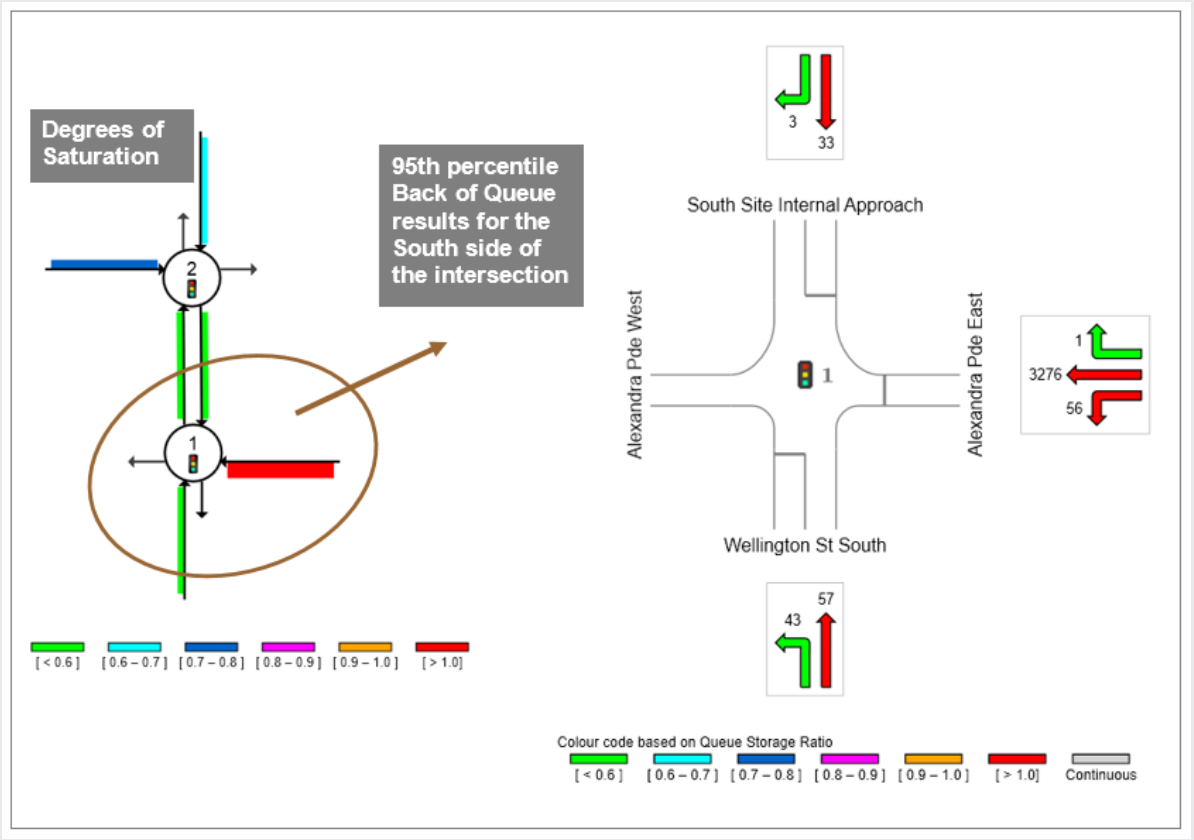
SIDRA INTERSECTION Outputs

Network display showing **degrees of saturation** and the movement display showing **95th percentile back of queue** values (metres) for the South side of the intersection



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Concluding Remarks

- Capacity Model underestimated queue lengths.
- Demand Model provided better reflection of the observed conditions.
- Important to use demand flows rather than the stop-line capacity flows based on SCATS data or turning volume counts under congested conditions.
- The impact of residual demand (queue) accumulated during long periods of highly congested conditions on intersection performance is also important.

Concluding Remarks

- Intersection saturation flow surveys indicated the impact of queue spillback (lane blockage) on reduced saturation flows, and therefore intersection capacities and performance.
- The estimated 95th percentile back of queue values for westbound lanes for the 7.45 - 8.00 AM peak period were 2.9 to 3.3 km which is close to the observed value of 3.5 km.
- The analysis assumed equal lane utilisation which would tend to underestimate queue lengths.

Concluding Remarks: Recommended Research

- Method to establish the true **demand flow rates for networks** of closely-spaced intersections with queue interactions between intersections.
- Saturation flow rates and the related SCATS MF parameter with a view to **lane blockage effects** under congested network conditions.

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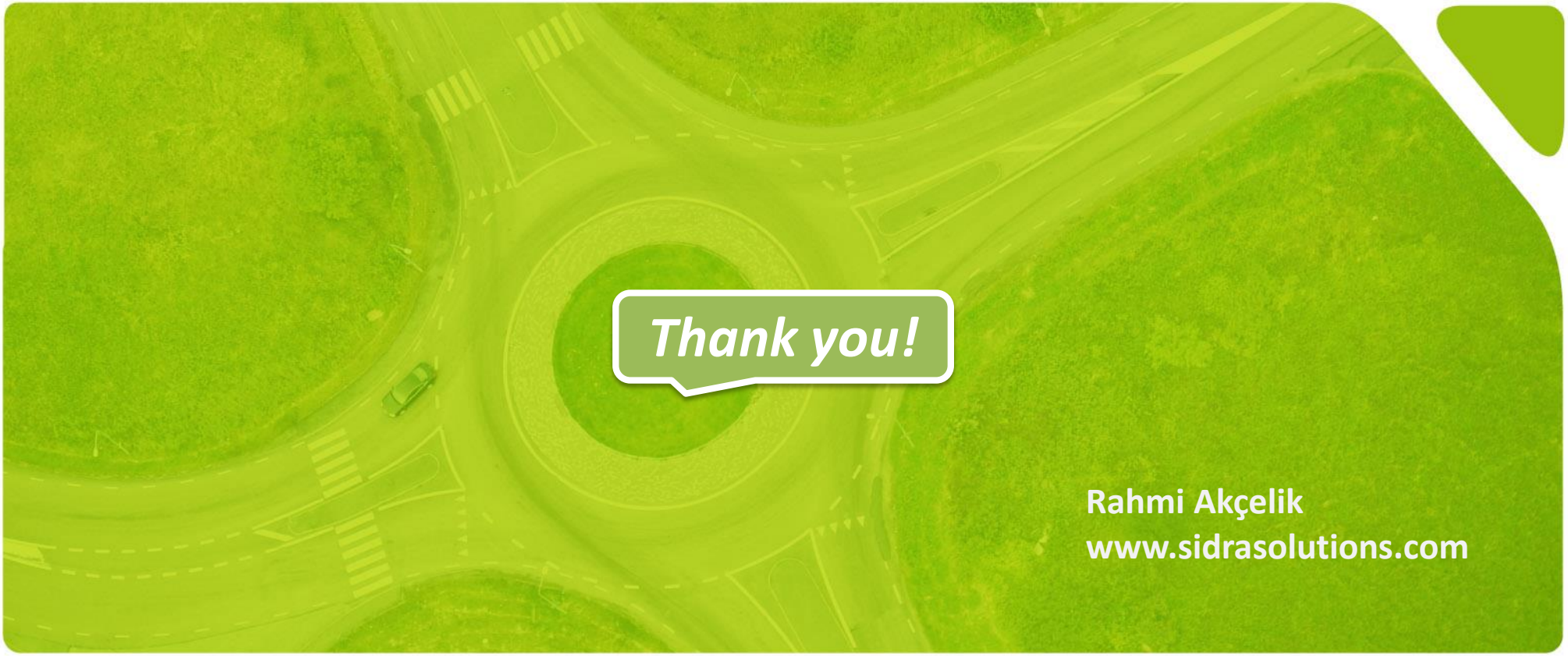
END OF PRESENTATION



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