Lessons Learnt from Avian Radar Trial at Toronto Pearson International Airport

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Background

- Sicom Systems Ltd. conducted a trial of its Accipiter® Avian Radar at Pearson International Airport (YYZ) during 7-11 November 2005 with the collaboration of the Greater Toronto Airport Authority (GTAA) and Falcon Environmental Services.

- The Accipiter® Radar was conveniently located on the roof of the GTAA building where radar data was recorded almost continuously.

Background …

- The authors have analyzed the radar data collected, and have shared the results with the GTAA and Falcon.
- One hope for this presentation, is that sharing results with the broader community will lead to increased knowledge and improved effectiveness concerning the use of avian radars for wildlife and bird aircraft strike hazard (BASH) management at airports.

Abstract

⌘ Lessons learnt from the trial conducted at Toronto Pearson International Airport in November 2005 are reported.

⌘ YYZ, Canada's largest airport, illustrates special requirements due to its proximity to metropolitan Toronto

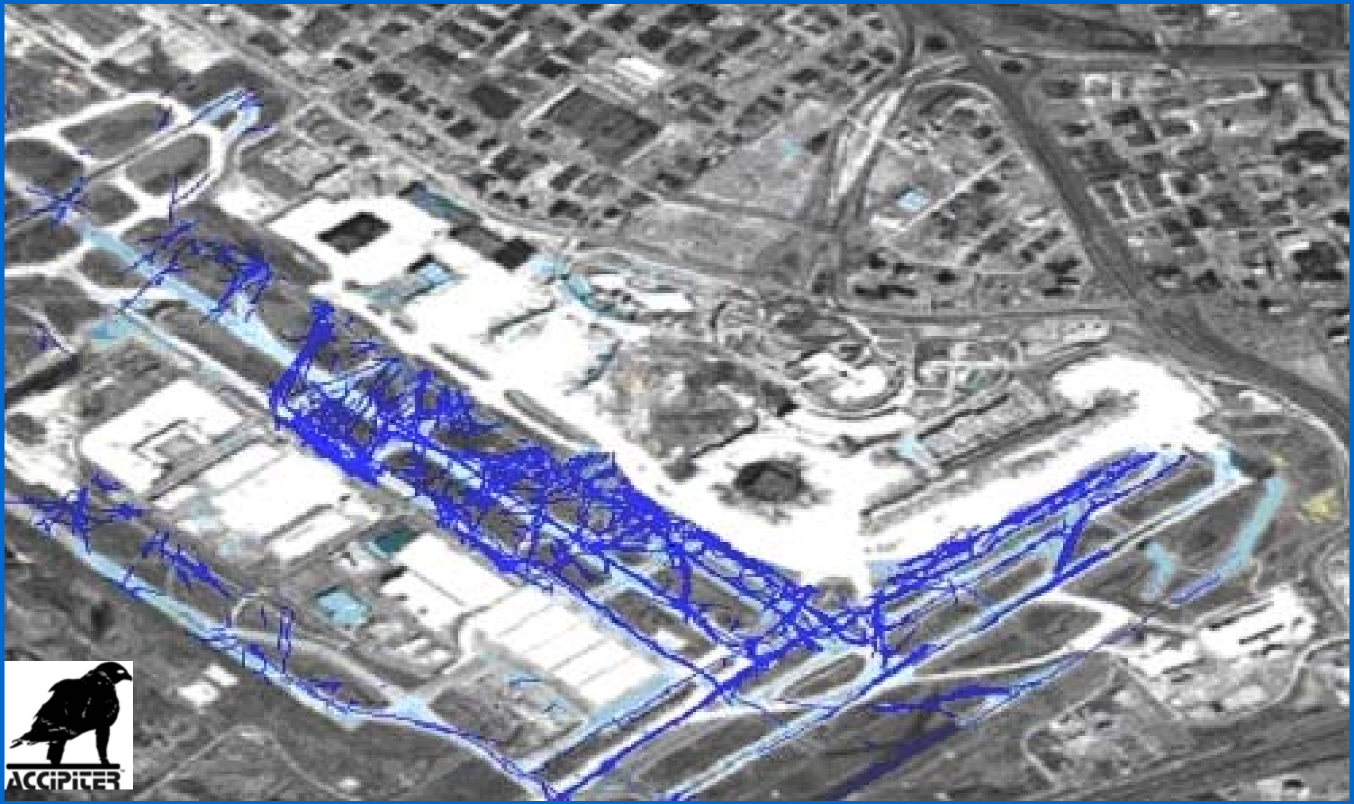
Abstract …

1. Assessment of desirable application requirements that take into account current wildlife management (WM) practices
2. Assessment of special radar system requirements for large airports
3. Restrictions on siting and operation of radars
4. Proximity of dense, urban vehicular traffic and impact on radar signal and track processing

1. Application Requirements to Support WM Practices

- Early warning of birds approaching airport
- ***Real-time tracking of*** birds and ***aircraft***
- Rapid review of overnight bird movements to identify stop-overs
- ***Generation of*** bird ***and aircraft "traffic pattern" maps***
- Integration of radar target data into wildlife management operations:
  - Availability to users
  - Integration with WM databases

1. Application Requirements to Support WM Practices: Generation of aircraft traffic pattern maps (1 hour) …



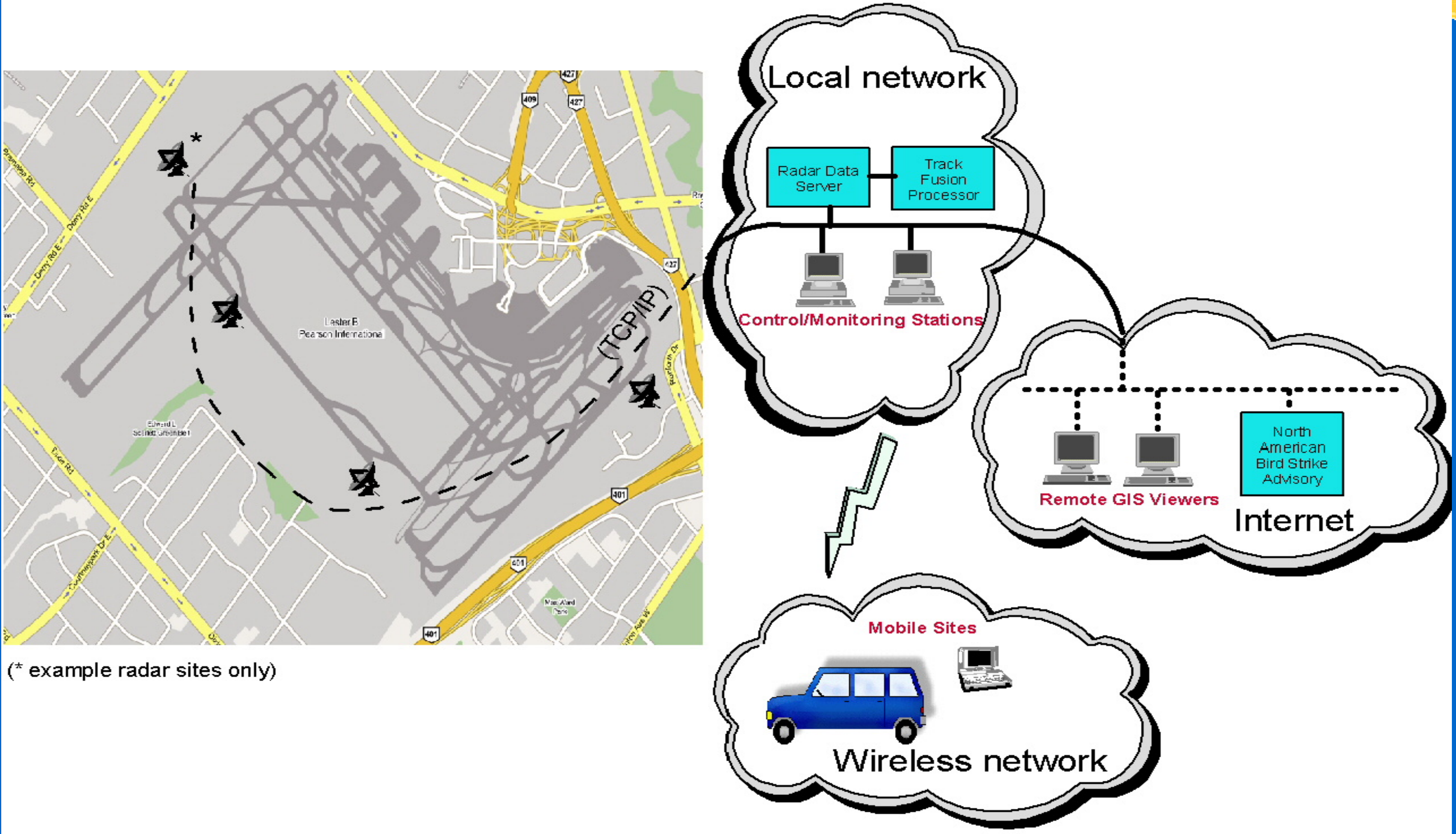
1. Application Requirements to Support WM Practices: Generation of aircraft traffic pattern maps (1 hour) …

Vehicular traffic filtered out – see later

2. Special Radar System Requirements for Large Airports

- Multiple runways and large airfield lead to requirement for multiple radars
- Multiple radars lead to requirement for multi-radar integration and fusion
  - Radar network with real-time streaming of radar target data to centralized repository
  - Significant demands on real-time tracking, and target data distribution
  - Fusion needed for common operating picture (COP) for situational awareness

2. Special Radar System Requirements for Large Airports …



(* example radar sites only)

3. Restrictions on Siting and Operation of Avian Radars:

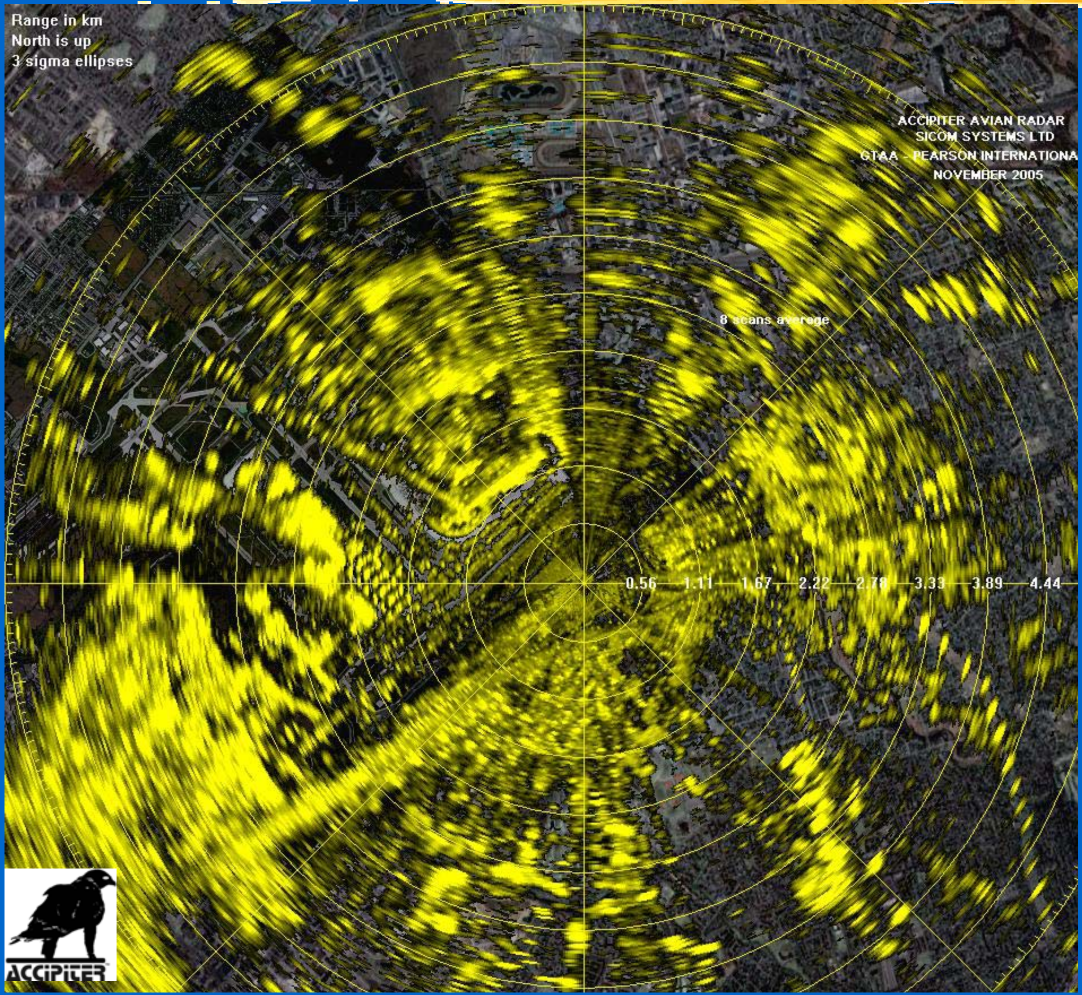
Accipiter® Radar on Roof of GTAA Building

3. Restrictions on Siting and Operation …

Accipiter®'s Field of View

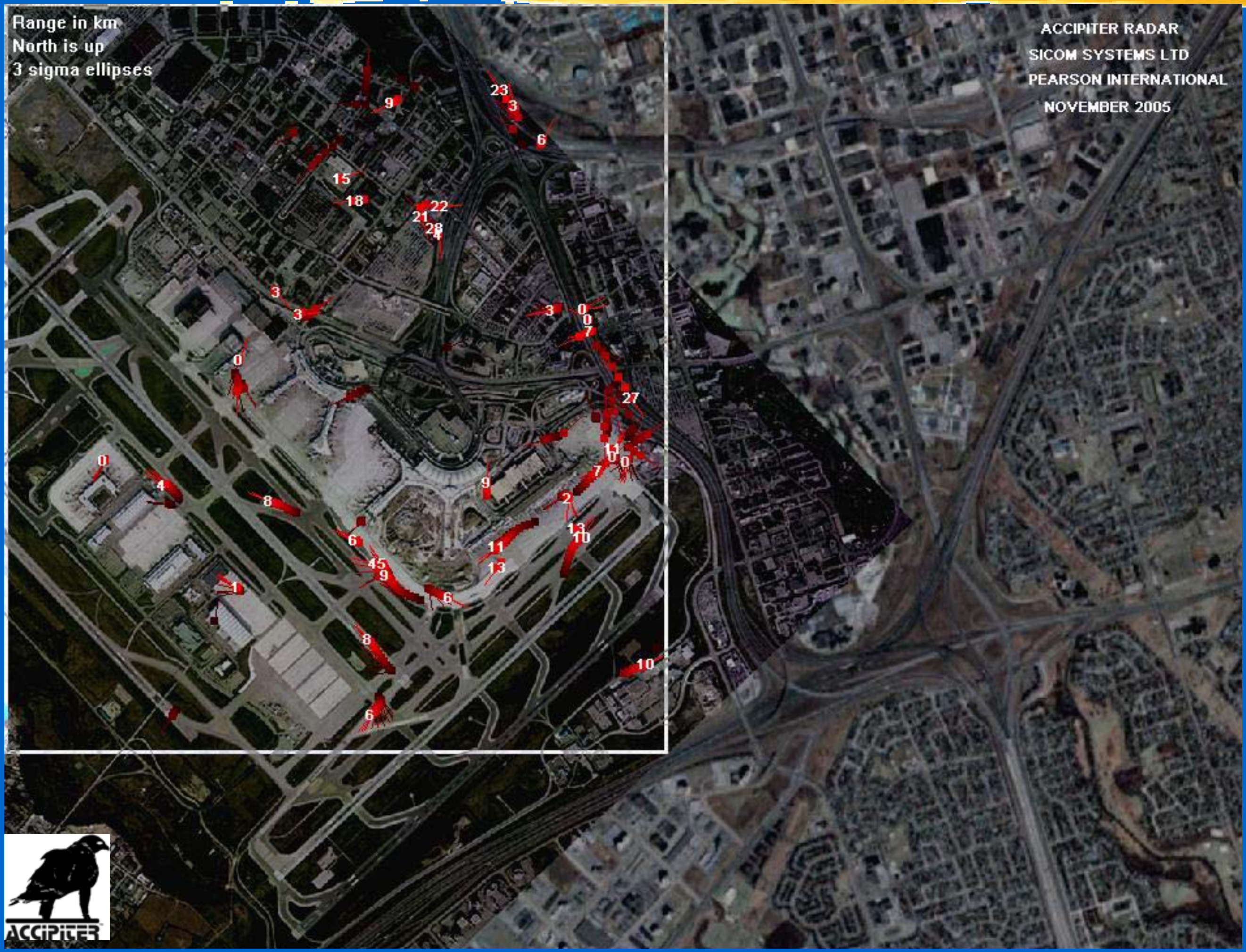
3. Restrictions on Siting …

Radar video – strong ground / urban clutter everywhere



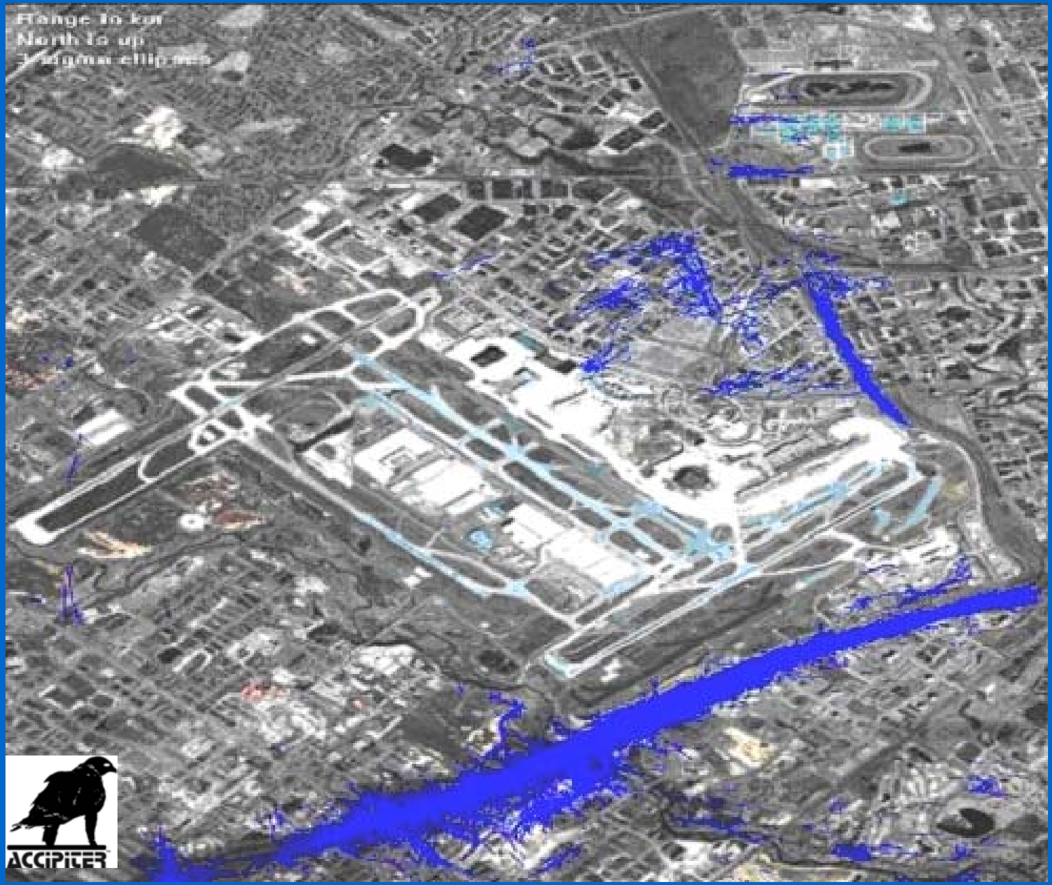
3. Restrictions on Siting …

Sophisticated methods to track targets in clutter



4. Proximity of Dense, Urban Vehicular Traffic:

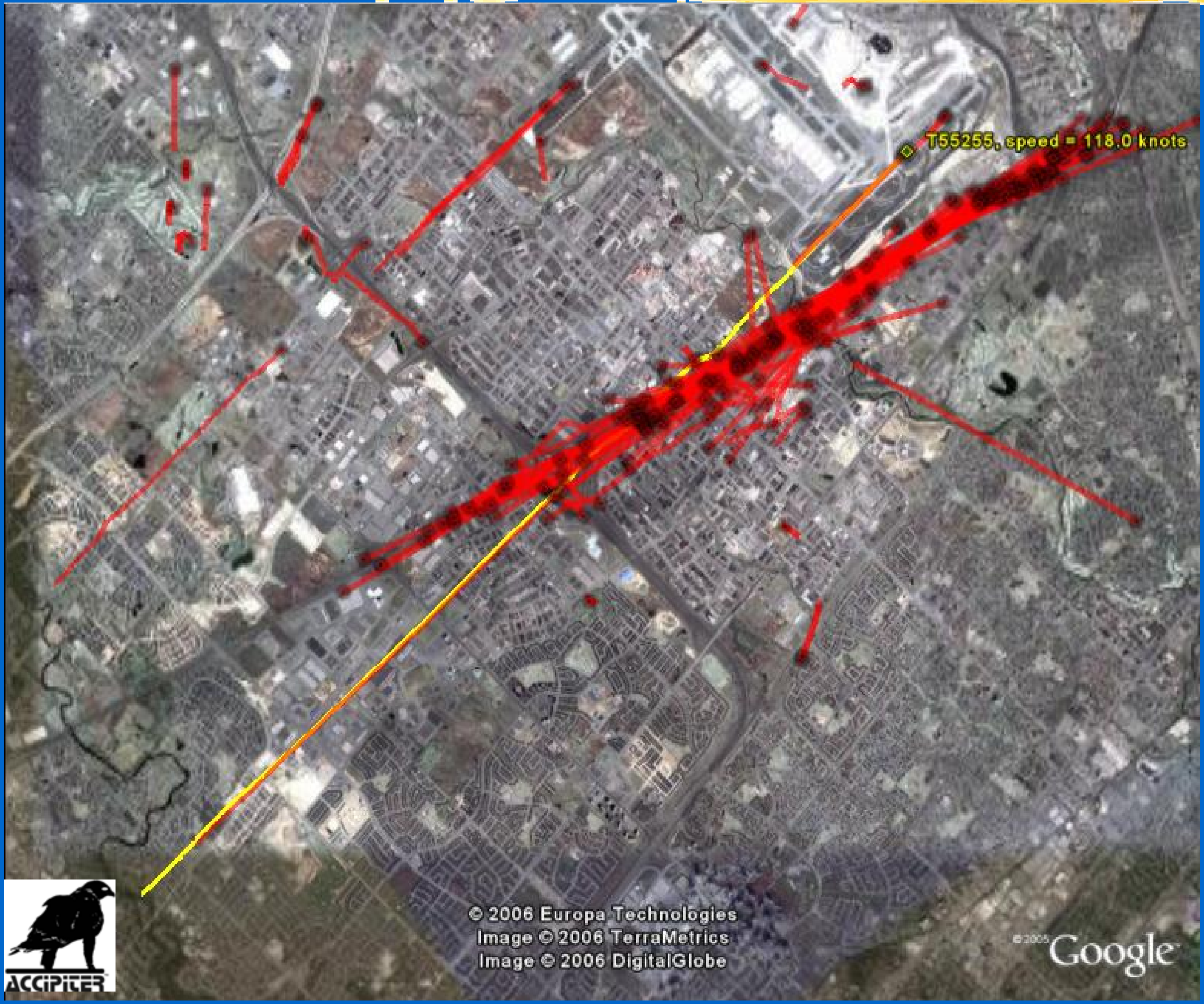
Vehicular traffic pattern map shown (1 hour)



- Vehicles steal precious computing resources which can degrade real-time performance.
- Vehicles steal track capacity.
- Vehicles can degrade aircraft and bird tracks that fly over or near roadways.
- Sophisticated approaches are needed to deal with vehicles for optimum performance.

4. Proximity of Dense, Urban Vehicular Traffic:

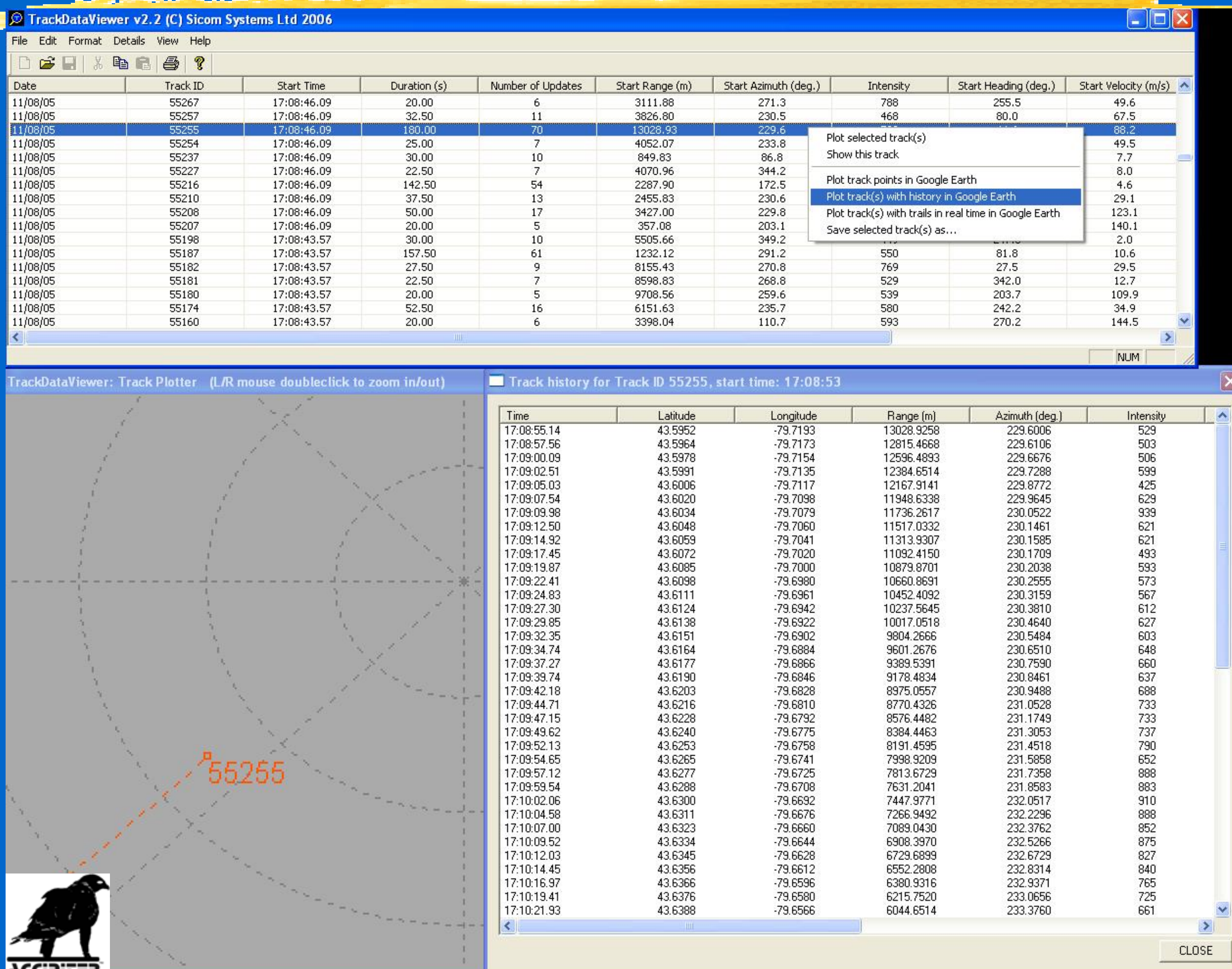
Aircraft crossing Hwy 401 …



- Aircraft track ID55255 shown in yellow
- Vehicle tracks and other tracks shown in red
- Maintaining aircraft track as it crosses Hwy 401 for landing is necessary for BASH applications

4. Proximity of Dense, Urban Vehicular Traffic:

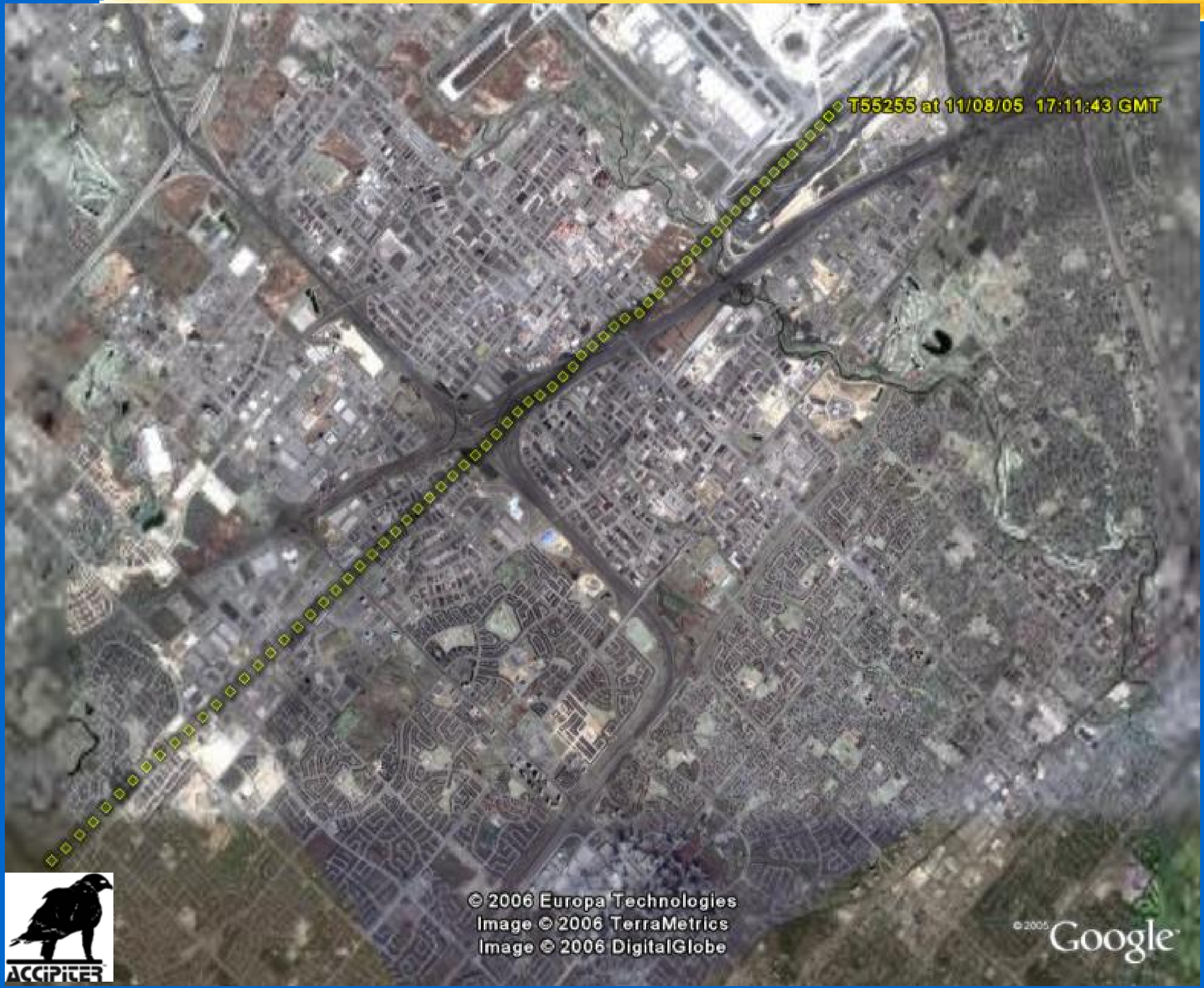
Aircraft ID55255 crossing Hwy 401 …track states shown



Date	Track ID	Start Time	Duration (s)	Number of Updates	Start Range (m)	Start Azimuth (deg.)	Intensity	Start Heading (deg.)	Start Velocity (m/s)
11/08/05	55267	17:08:46.09	20.00	6	3111.88	271.3	788	255.5	49.6
11/08/05	55257	17:08:46.09	32.50	11	3826.80	230.5	468	80.0	67.5
11/08/05	55255	17:08:46.09	180.00	70	13028.93	229.6	[illegible]	[illegible]	88.2
11/08/05	55254	17:08:46.09	25.00	7	4052.07	233.8	[illegible]	[illegible]	49.5
11/08/05	55237	17:08:46.09	30.00	10	849.83	86.8	[illegible]	[illegible]	7.7
11/08/05	55227	17:08:46.09	22.50	7	4070.96	344.2	[illegible]	[illegible]	8.0
11/08/05	55216	17:08:46.09	142.50	54	2287.90	172.5	[illegible]	[illegible]	4.6
11/08/05	55210	17:08:46.09	37.50	13	2455.83	230.6	[illegible]	[illegible]	29.1
11/08/05	55208	17:08:46.09	50.00	17	3427.00	229.8	[illegible]	[illegible]	123.1
11/08/05	55207	17:08:46.09	20.00	5	357.08	203.1	[illegible]	[illegible]	140.1
11/08/05	55198	17:08:43.57	30.00	10	5505.66	349.2	[illegible]	[illegible]	2.0
11/08/05	55187	17:08:43.57	157.50	61	1232.12	291.2	550	81.8	10.6
11/08/05	55182	17:08:43.57	27.50	9	8155.43	270.8	769	27.5	29.5
11/08/05	55181	17:08:43.57	22.50	7	8598.83	268.8	529	342.0	12.7
11/08/05	55180	17:08:43.57	20.00	5	9708.56	259.6	539	203.7	109.9
11/08/05	55174	17:08:43.57	52.50	16	6151.63	235.7	580	242.2	34.9
11/08/05	55160	17:08:43.57	20.00	6	3398.04	110.7	593	270.2	144.5

Time	Latitude	Longitude	Range (m)	Azimuth (deg.)	Intensity
17:08:55.14	43.5952	-79.7193	13028.9258	229.6006	529
17:08:57.56	43.5964	-79.7173	12815.4668	229.6106	503
17:09:00.09	43.5978	-79.7154	12596.4893	229.6676	506
17:09:02.51	43.5991	-79.7135	12384.6514	229.7288	599
17:09:05.03	43.6006	-79.7117	12167.9141	229.8772	425
17:09:07.54	43.6020	-79.7098	11948.6338	229.9645	629
17:09:09.98	43.6034	-79.7079	11736.2617	230.0522	939
17:09:12.50	43.6048	-79.7060	11517.0332	230.1461	621
17:09:14.92	43.6059	-79.7041	11313.9307	230.1585	621
17:09:17.45	43.6072	-79.7020	11092.4150	230.1709	493
17:09:19.87	43.6085	-79.7000	10879.8701	230.2038	593
17:09:22.41	43.6098	-79.6980	10660.8691	230.2555	573
17:09:24.83	43.6111	-79.6961	10452.4092	230.3159	567
17:09:27.30	43.6124	-79.6942	10237.5645	230.3810	612
17:09:29.85	43.6138	-79.6922	10017.0518	230.4640	627
17:09:32.35	43.6151	-79.6902	9804.2666	230.5484	603
17:09:34.74	43.6164	-79.6884	9601.2676	230.6510	648
17:09:37.27	43.6177	-79.6866	9389.5391	230.7590	660
17:09:39.74	43.6190	-79.6846	9178.4834	230.8461	637
17:09:42.18	43.6203	-79.6828	8975.0557	230.9488	688
17:09:44.71	43.6216	-79.6810	8770.4326	231.0528	733
17:09:47.15	43.6228	-79.6792	8576.4482	231.1749	733
17:09:49.62	43.6240	-79.6775	8384.4463	231.3053	737
17:09:52.13	43.6253	-79.6758	8191.4595	231.4518	790
17:09:54.65	43.6265	-79.6741	7998.9209	231.5858	652
17:09:57.12	43.6277	-79.6725	7813.6729	231.7358	888
17:09:59.54	43.6288	-79.6708	7631.2041	231.8583	883
17:10:02.06	43.6300	-79.6692	7447.9771	232.0517	910
17:10:04.58	43.6311	-79.6676	7266.9492	232.2296	888
17:10:07.00	43.6323	-79.6660	7089.0430	232.3762	852
17:10:09.52	43.6334	-79.6644	6908.3970	232.5266	875
17:10:12.03	43.6345	-79.6628	6729.6899	232.6729	827
17:10:14.45	43.6356	-79.6612	6552.2808	232.8314	840
17:10:16.97	43.6366	-79.6596	6380.9316	232.9371	765
17:10:19.41	43.6376	-79.6580	6215.7520	233.0656	725
17:10:21.93	43.6388	-79.6566	6044.6514	233.3760	661

4. Proximity of Dense, Urban Vehicular Traffic:
Aircraft ID55255 shown in Google Earth™



- Aircraft track ID55255 maintained while crossing Hwy 401
- MHT/IMM tracking algorithm working well through dense vehicular clutter

Summary and Conclusions

- A one week trial was successfully conducted at Toronto Pearson International Airport in November 2005 using an Accipiter® Avian Radar.

- Analysis of the radar data collected has demonstrated several issues which are reported here.

Summary and Conclusions …

- Large airports with multiple runways will require multiple radar sensors and an integrated data management system that provides:
  - a centralized, real-time repository for radar sensor tracks;
  - real-time track integration and track fusion methods to deal with multiple tracks originating from the same target;
  - common operating picture (COP) displays to provide wide-area situational awareness for the airport and its surrounding areas; and
  - interfaces to local WM databases and systems such as the NABSAS.

Summary and Conclusions …

- Restrictions on where avian radars can be located create another system design issue requiring radar engineering trade-offs including:
  - clutter mitigation techniques employed
  - type of antennas employed
  - coverage patterns optimized for each radar
  - number of radars
  - firm track range achievable for biological targets of interest (i.e. the maximum range at which the target can be reliably tracked)

Summary and Conclusions …

- *Aircraft* tracking is often neglected in presentations and papers concerning avian radars, even when BASH is a stated focus.
- Aircraft tracking results presented here demonstrate:
  - aircraft can be reliably tracked both at far range and near-range, even through taxiing to the gate;
  - traffic pattern maps can be reliably and readily generated
  - dense, urban, vehicular traffic is a significant challenge to tracking aircraft (and birds) but sophisticated methods are available to meet this challenge.

Acknowledgements

- Sicom Systems Ltd. and the authors are grateful to John Meehan and the GTAA for providing the opportunity to carry out this trial at Toronto Pearson International Airport.

- Sicom also thanks Falcon Environmental Services and its staff for their professional assistance during the trial, and Bruce MacKinnon of Transport Canada for his encouragement.

Questions ?

⌘Thank you