


SMARTMICRO TEST REPORT.

**EVALUATION AND COMPARISON BETWEEN RADAR AND
ELECTROMAGNETIC TECHNOLOGÍES.**

PROJECT:	SMARTMICRO TEST REPORT	
DOCUMENT ELABORATION AND APPROVAL		COMPANY INFORMATION
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DATE:	June 2020	

CONTENT

1	GENERAL PRESENTATION	3
1.1	Objective.....	3
1.2	Previous definitions.	3
1.3	Products under test evaluation.	3
2	INTRODUCTION.....	4
2.1	Radar mounting area.....	5
2.2	Radar detection zone.	5
3	SMARTMICRO RADAR TRAFFIC INFORMATION.	6
3.1	Radar reports	6
4	ETDs TRAFFIC INFORMATION.	8
4.1	ETDs Reports.....	8
5	DATA COMPARISON AND ANALYSIS.	10
5.1	Previous considerations.....	10
5.2	Methodology.....	10
5.3	Data comparison.....	13
5.4	Results.	16
5.5	ETDs Data loss.....	17
5.6	Differences in Occupancy calculation.	18
6	CONCLUSIONS.....	21

1 GENERAL PRESENTATION

1.1 Objective.

The Report's objective is to evaluate the performance of the smartmicro radar compared to the measurements obtained from the electromagnetic instruments in a General Velásquez section, belonging to Autopista Central highway. For this, the performance of the smartmicro system is shown, compared and finally evaluated, taking as a basis of comparison, the data of the Electromagnetic instrument obtained during the test period, on April 22, 2020.

1.2 Previous definitions.

PMV	:	Variable messaging panel (In spanish: Panel de Mensajería Variable).
ETD	:	Electromagnetic Traffic Data Collection Station (In spanish: Estación de Toma de Datos de tráfico).

1.3 Products under test evaluation.

- Radar Technology.

Company : smartmicro

Model : UMRR-11 Type 45

Website : <https://www.smartmicro.com/>

Address : In den Waashainen 1, 138108 Braunschweig, Germany

- Electromagnetic inductive loop technology.

Product information not available.

2 INTRODUCTION

To perform the radar test evaluation, the equipment was installed for 24 hours, in order to obtain count data, classification and statistics. The installation was provisional in nature, without affecting the affected structures or facilities, in conjunction with Interexport personnel.

For this test, it was proposed to mount the smartmicro Radar on a PMV panel structure located on the General Velásquez Highway, between Avenida Lo Espejo and the Vespucio Sur highway, as indicated on the following map.



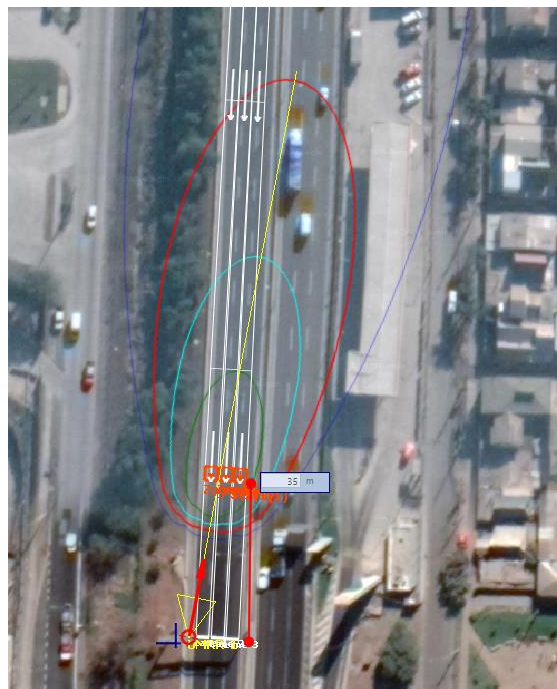
2.1 Radar mounting area.

The Radar mounting was done through metal clamps, as well as a quick installation for an easy removal, without any damage to the structure. The fixation was made in the structure, pointing to the north, as shown in the following image.



2.2 Radar detection zone.

The selected detection zone corresponds to the three lanes of the western track, all of them with normal vehicular flow to the highway, in a north-south direction.

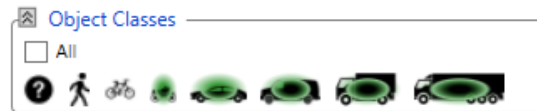


3 SMARTMICRO RADAR TRAFFIC INFORMATION.

The radar has available information for counting, classification and statistics of vehicle flow per lane.

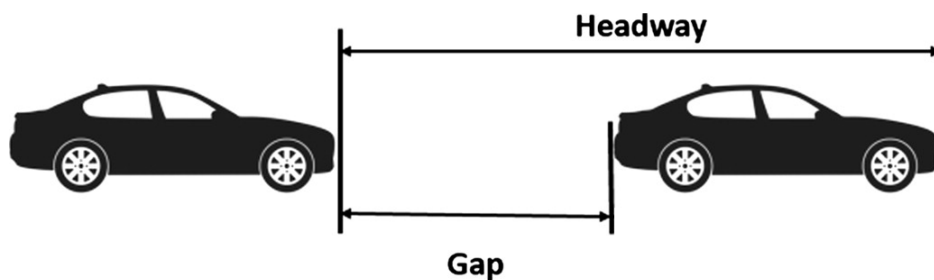
The classification is made up of the following items:

- 0: Indefinido (< 3.2m)
- 2: Humano (1.2 m)
- 3: Bicicleta, moto (+/- 2m)
- 5: Automóvil (4.4 a 5.4 m)
- 7: Transporte (5.6 a 9.4 m)
- 8: Camión corto (9.6 a 12 m)
- 9: Camión largo (> 12.2m)



Available statistics correspond to:

- Headway
- Gap
- 85p Speed
- Avg. Speed
- Volume
- Occupancy



3.1 Radar reports

For this test, the software was configured to automatically generate a CSV report every 5 minutes, where each report provides counting information, classification and statistics ordered by columns, reflecting the information for each lane and type of vehicle separately, in addition to the time stamp information. Each generating report is as follows:

Time	L	Class	Headway [s]	85p. Speed [nativ]	85p. Speed [m/s]	85p. Speed [km/h]	VELOCIDAD PROMEDIO		Gap [s]	Volume	% OCUPACIÓN
							Avg. Speed [nativ]	Avg. Speed [m/s]			
2020-04-22 14:59:05	1	0	24.86	0	0.0	0.0	0	0.0	0	0	0
2020-04-22 14:59:05	1	2	0	0	0.0	0.0	0	0.0	0	0	0
2020-04-22 14:59:05	1	3	0	24.9	24.9	89.6	27.09	27.1	0	4	0.45
2020-04-22 14:59:05	1	5	0	0	0.0	0.0	0	0.0	0	0	0
2020-04-22 14:59:05	1	7	0	17.5	17.5	63.0	23.6	23.6	0	6	0.85
2020-04-22 14:59:05	1	8	0	0	21	75.6	20.97	21.0	0	2	0.2
2020-04-22 14:59:05	1	9	0	0	0.0	0.0	0	0.0	0	0	0
2020-04-22 14:59:05	2	0	9.075	0	0.0	0.0	0	0.0	0	0	0
2020-04-22 14:59:05	2	2	0	0	0.0	0.0	0	0.0	0	0	0
2020-04-22 14:59:05	2	3	0	27.6	27.6	99.4	28.33	28.3	0	17	1.45
2020-04-22 14:59:05	2	5	0	0	0.0	0.0	0	0.0	0	0	0
2020-04-22 14:59:05	2	7	0	23.7	23.7	85.3	24.49	24.5	0	8	0.9
2020-04-22 14:59:05	2	8	0	24.5	24.5	88.2	24.38	24.4	0	9	2.1
2020-04-22 14:59:05	2	9	0	24.3	24.3	87.5	24.27	24.3	0	2	0.5
2020-04-22 14:59:05	3	0	10.725	0	0.0	0.0	0	0.0	10.505	0	0
2020-04-22 14:59:05	3	2	0	0	0.0	0.0	0	0.0	0	0	0
2020-04-22 14:59:05	3	3	0	0	30	108.0	30.6	30.6	0	17	1.4
2020-04-22 14:59:05	3	5	0	17.1	17.1	61.6	17.07	17.1	0	1	0.05
2020-04-22 14:59:05	3	7	0	30.5	30.5	109.8	29.86	29.9	0	7	0.65
2020-04-22 14:59:05	3	8	0	27.9	27.9	100.4	27.92	27.9	0	1	0.15
2020-04-22 14:59:05	3	9	0	0	24	86.4	24	24.0	0	1	0.3

**CARRIL
 CLASIFICACIÓN**

**VELOCIDAD
 PROMEDIO**

CANTIDAD

% OCUPACIÓN

4 ETDS TRAFFIC INFORMATION.

According to the information provided by Interexport, it is verified that the closest ETDs in the area, used as a reference for this test, only deliver information from the three lanes together, that is, the amount of vehicles, speed and occupation of the road, so there is no separate information for each lane, classification or statistics compared to those obtained by the radar.

The ETDs information available corresponds to the following items:

- **n_vei** : Vehicles count.
- **n_Vel_med** : Average speed.
- **n_etd_ide** : ETD number.

4.1 ETDs Reports.

The reports delivered by the client are of two types:

- A report with the consolidated data from the last 24 hours, showing the data obtained by time intervals every 5 minutes, indicating columns information for time stamp , name of the measurement point, number of vehicles, average speed and occupation percentage.
- The second type corresponds to the data obtained from the last 24 hours, indicating the measurements obtained every minute.

The available information in first mentioned report (consolidated report every 5 minutes), corresponds to information contained in the second report (every minute), filtering and adding the data of the necessary time intervals.

Below is an excerpt from both types of report:

logic_code	n_per_med	d_msg	n_err_rel	non_c	n_vei / N°vehiculos	n_occ	n_det.con / carril	n_vei.con	n_sen_cir	n_vel_med / velocidad	n_lun_med	n_gap	n_cla	d_ins	f_add
PM014110-D	60	2020-04-22 0:00:00	0		1	0	0	0	0	19	3	85	2	2020-04-22 0:04:02	0
PM014110-D	60	2020-04-22 0:01:00	0		2	0	0	0	0	63	31	122	2	2020-04-22 0:05:03	0
PM014110-D	60	2020-04-22 0:02:00	0		1	0	0	0	0	109	15	85	2	2020-04-22 0:06:01	0
PM014110-D	60	2020-04-22 0:03:00	0		1	0	0	0	0	93	65	85	2	2020-04-22 0:07:03	0
PM014110-D	60	2020-04-22 0:04:00	0		4	1	0	0	0	89	61	170	2	2020-04-22 0:08:02	0
PM014110-D	60	2020-04-22 0:05:00	0		3	1	0	0	0	103	43	85	2	2020-04-22 0:09:02	0
PM014110-D	60	2020-04-22 0:06:00	0		2	0	0	0	0	102	91	170	2	2020-04-22 0:10:02	0
PM014110-D	60	2020-04-22 0:07:00	0		3	0	0	0	0	85	76	170	2	2020-04-22 0:11:06	0

Fecha	Hora	Nombre	Código	Cantidad	Velocidad(km/h)	Ocupación (%)	Eje	Ubicación
22/04/2020	14:05	PM014110-D	ERU-002-D	90	99	3	G VELASQUEZ SUR	Expresa
22/04/2020	14:10	PM014110-D	ERU-002-D	70	94	4	G VELASQUEZ SUR	Expresa
22/04/2020	14:15	PM014110-D	ERU-002-D	34	103	3	G VELASQUEZ SUR	Expresa
22/04/2020	14:20	PM014110-D	ERU-002-D	39	95	4	G VELASQUEZ SUR	Expresa
22/04/2020	14:25	PM014110-D	ERU-002-D	43	89	4	G VELASQUEZ SUR	Expresa
22/04/2020	14:30	PM014110-D	ERU-002-D	33	99	4	G VELASQUEZ SUR	Expresa
22/04/2020	14:35	PM014110-D	ERU-002-D	45	103	3	G VELASQUEZ SUR	Expresa
22/04/2020	14:40	PM014110-D	ERU-002-D	92	96	3	G VELASQUEZ SUR	Expresa
22/04/2020	14:45	PM014110-D	ERU-002-D	54	93	3	G VELASQUEZ SUR	Expresa
22/04/2020	14:50	PM014110-D	ERU-002-D	34	92	4	G VELASQUEZ SUR	Expresa

5 DATA COMPARISON AND ANALYSIS.

For data's comparison and analysis between the ETDs and Radar, it is necessary to clarify some pre-evaluation considerations, in addition to explaining the methodology used for the comparison.

5.1 Previous considerations.

Although the tests were satisfactory and the data it is a good reference to compare the behavior between the technologies, it is necessary to specify that it must take into account the conditions in which the tests was carried out, where, although the collected data by each equipment was adequately, there are differences that affect in some way the comparison between the ETD data and smartmicro Radar:

- The time stamp was not synchronized, so it is unknown if the time stamp of each systems has any difference of one or more minutes.
- The obtained ETDs information it is limited compared to the available Radar information. The lack of detailed information for each lane and vehicle classification makes it necessary to adapt the radar data as indicated in the used methodology.
- In the data comparison between both equipments, important differences was observed in some time intervals. When reviewing reports, we found that data provided by ETD has some lost information. The detail of this problem will be explained later.
- The value of the occupancy obtained between the ETDs and the radar it is different, so it will be left out of the data analysis. We assume that the difference is due to the procedure of each brand to perform the calculation of this data, however, we consider that the little variation in the data recorded in the ETD report is a bad indicator, because it is obvious that there are different occupancy levels according to the use profile of the highway, with traffic markings during rush hours.

If an accurate radar evaluation is required, it is recommended to implement a test for a longer period time and with the availability of a camera installed in the radar position, to have a second data validation, which helps to compare the logged data, and with an ETD measurement point with more detailed classification information and statistics.

5.2 Methodology.

The used methodology to compare the data between the ETD and the radar information was as follows:

- A. The ETD's consolidated every 5 minutes report was used, because the radar reports were also made every 5 minutes.

B. The data were evaluated in a time interval of 2 hours, in the corresponding section between 15:00 and 17:00 as shown in the following table with ETD information:

Fecha	Hora	Nombre	Codigo	Cantidad	Velocidad(km/h)	Ocupación (%)	Eje	Ubicación
22/04/2020	15:00	PM014110-D	ERU-002-D	73	95	3	G VELASQUEZ SUR	Expresa
22/04/2020	15:05	PM014110-D	ERU-002-D	84	97	3	G VELASQUEZ SUR	Expresa
22/04/2020	15:10	PM014110-D	ERU-002-D	64	95	3	G VELASQUEZ SUR	Expresa
22/04/2020	15:15	PM014110-D	ERU-002-D	80	95	4	G VELASQUEZ SUR	Expresa
22/04/2020	15:20	PM014110-D	ERU-002-D	91	98	3	G VELASQUEZ SUR	Expresa
22/04/2020	15:25	PM014110-D	ERU-002-D	81	98	3	G VELASQUEZ SUR	Expresa
22/04/2020	15:30	PM014110-D	ERU-002-D	66	91	5	G VELASQUEZ SUR	Expresa
22/04/2020	15:35	PM014110-D	ERU-002-D	102	94	4	G VELASQUEZ SUR	Expresa
22/04/2020	15:40	PM014110-D	ERU-002-D	109	98	4	G VELASQUEZ SUR	Expresa
22/04/2020	15:45	PM014110-D	ERU-002-D	92	98	3	G VELASQUEZ SUR	Expresa
22/04/2020	15:50	PM014110-D	ERU-002-D	57	93	4	G VELASQUEZ SUR	Expresa
22/04/2020	15:55	PM014110-D	ERU-002-D	100	95	4	G VELASQUEZ SUR	Expresa
22/04/2020	16:00	PM014110-D	ERU-002-D	100	94	4	G VELASQUEZ SUR	Expresa
22/04/2020	16:05	PM014110-D	ERU-002-D	69	93	3	G VELASQUEZ SUR	Expresa
22/04/2020	16:10	PM014110-D	ERU-002-D	33	97	3	G VELASQUEZ SUR	Expresa
22/04/2020	16:15	PM014110-D	ERU-002-D	70	95	3	G VELASQUEZ SUR	Expresa
22/04/2020	16:20	PM014110-D	ERU-002-D	83	94	5	G VELASQUEZ SUR	Expresa
22/04/2020	16:25	PM014110-D	ERU-002-D	119	95	5	G VELASQUEZ SUR	Expresa
22/04/2020	16:30	PM014110-D	ERU-002-D	86	97	3	G VELASQUEZ SUR	Expresa
22/04/2020	16:35	PM014110-D	ERU-002-D	96	93	4	G VELASQUEZ SUR	Expresa
22/04/2020	16:40	PM014110-D	ERU-002-D	38	91	4	G VELASQUEZ SUR	Expresa
22/04/2020	16:45	PM014110-D	ERU-002-D	70	99	4	G VELASQUEZ SUR	Expresa
22/04/2020	16:50	PM014110-D	ERU-002-D	106	93	4	G VELASQUEZ SUR	Expresa
22/04/2020	16:55	PM014110-D	ERU-002-D	90	95	4	G VELASQUEZ SUR	Expresa
22/04/2020	17:00	PM014110-D	ERU-002-D	60	97	6	G VELASQUEZ SUR	Expresa

C. It was selected radar reports with the closest time range in the section from 15 to 17hrs. (They present a minute difference between reports).

D. In each Radar report, only count, average speed and occupancy data was selected as a comparative reference with ETD, summing all the quantities of vehicles and occupancy, and averaging the speeds as indicated in the following table:

Avg. Speed [km/h]	Gap [s]	Volume	Occupancy [%]	λ
0	24.64	0	0	
0	0	0	0	
97,5	0	4	0,45	
0	0	0	0	
85	0	6	0,85	
75,5	0	2	0,2	
0	0	0	0	
0	8.8	0	0	
0	0	0	0	
102	0	17	1,45	
0	0	0	0	
88,2	0	8	0,9	
87,8	0	9	2,1	
87,4	0	2	0,5	
0	10.505	0	0	
0	0	0	0	
110,2	0	17	1,4	
61,5	0	1	0,05	
107,5	0	7	0,65	
100,5	0	1	0,15	
86,4	0	1	0,3	
1089,5				
90,8		75	9	

E. Once the Radar data was filtered, a comparative table was made that considers the data obtained by the ETDs and the data obtained by the Radar in order to calculate the differences between both.

Fecha	Hora	Nombre	Codigo	Cantidad	Velocidad(km/h)	Ocupación (%)	Eje	Ubicación	SMART MICRO	TIME	AVG.SPEED	CANTIDAD	OCUPACIÓN (%)	DIF_CANT	DIF_VELOCIDAD
22/04/2020	15:00	PM014110-D	ERU-002-D	73	95	3	G VELASQUEZ SUR	Expresa		2020-04-22 14:59:05	90,8	75	9	2	-4,2
22/04/2020	15:05	PM014110-D	ERU-002-D	84	97	3	G VELASQUEZ SUR	Expresa		2020-04-22 15:04:06	89,4	97	12,4	13	-7,6
22/04/2020	15:10	PM014110-D	ERU-002-D	64	95	3	G VELASQUEZ SUR	Expresa		2020-04-22 15:09:06	92,9	95	11,8	31	-2,1
22/04/2020	15:15	PM014110-D	ERU-002-D	80	95	4	G VELASQUEZ SUR	Expresa		2020-04-22 15:14:06	91,6	84	11,65	4	-3,4
22/04/2020	15:20	PM014110-D	ERU-002-D	91	98	3	G VELASQUEZ SUR	Expresa		2020-04-22 15:19:06	88,2	99	12,25	8	-9,8
22/04/2020	15:25	PM014110-D	ERU-002-D	81	98	3	G VELASQUEZ SUR	Expresa		2020-04-22 15:24:07	92,1	72	24,55	-9	-5,9
22/04/2020	15:30	PM014110-D	ERU-002-D	66	91	5	G VELASQUEZ SUR	Expresa		2020-04-22 15:29:07	81,7	111	15,15	45	-9,3
22/04/2020	15:35	PM014110-D	ERU-002-D	102	94	4	G VELASQUEZ SUR	Expresa		2020-04-22 15:34:07	86,9	108	14,9	6	-7,1
22/04/2020	15:40	PM014110-D	ERU-002-D	109	98	4	G VELASQUEZ SUR	Expresa		2020-04-22 15:39:07	90,8	102	12,85	-7	-7,2
22/04/2020	15:45	PM014110-D	ERU-002-D	92	98	3	G VELASQUEZ SUR	Expresa		2020-04-22 15:44:07	92,1	101	12,15	9	-5,9
22/04/2020	15:50	PM014110-D	ERU-002-D	57	93	4	G VELASQUEZ SUR	Expresa		2020-04-22 15:49:08	89	96	12,7	39	-4,0
22/04/2020	15:55	PM014110-D	ERU-002-D	100	95	4	G VELASQUEZ SUR	Expresa		2020-04-22 15:54:08	91,9	102	12,95	2	-3,1
22/04/2020	16:00	PM014110-D	ERU-002-D	100	94	4	G VELASQUEZ SUR	Expresa		2020-04-22 15:59:08	90,2	102	13,15	2	-3,8
22/04/2020	16:05	PM014110-D	ERU-002-D	69	93	3	G VELASQUEZ SUR	Expresa		2020-04-22 16:04:08	87,8	102	12,45	33	-5,2
22/04/2020	16:10	PM014110-D	ERU-002-D	33	97	3	G VELASQUEZ SUR	Expresa		2020-04-22 16:09:09	91,1	81	10,2	48	-5,9
22/04/2020	16:15	PM014110-D	ERU-002-D	70	95	3	G VELASQUEZ SUR	Expresa		2020-04-22 16:14:09	95,5	81	9,75	11	0,5
22/04/2020	16:20	PM014110-D	ERU-002-D	83	94	5	G VELASQUEZ SUR	Expresa		2020-04-22 16:19:09	87,4	90	11,8	7	-6,6
22/04/2020	16:25	PM014110-D	ERU-002-D	119	95	5	G VELASQUEZ SUR	Expresa		2020-04-22 16:24:09	90,1	123	15,35	4	-4,9
22/04/2020	16:30	PM014110-D	ERU-002-D	86	97	3	G VELASQUEZ SUR	Expresa		2020-04-22 16:29:09	90,1	91	12,6	5	-6,9
22/04/2020	16:35	PM014110-D	ERU-002-D	96	93	4	G VELASQUEZ SUR	Expresa		2020-04-22 16:34:10	88,5	100	12,85	4	-4,5
22/04/2020	16:40	PM014110-D	ERU-002-D	38	91	4	G VELASQUEZ SUR	Expresa		2020-04-22 16:39:10	88	100	12,35	62	-3,0
22/04/2020	16:45	PM014110-D	ERU-002-D	70	99	4	G VELASQUEZ SUR	Expresa		2020-04-22 16:44:10	91,1	91	12,3	21	-7,9
22/04/2020	16:50	PM014110-D	ERU-002-D	106	93	4	G VELASQUEZ SUR	Expresa		2020-04-22 16:49:10	89,8	97	12,2	-9	-3,2
22/04/2020	16:55	PM014110-D	ERU-002-D	90	95	4	G VELASQUEZ SUR	Expresa		2020-04-22 16:54:11	87,8	111	14,9	21	-7,2
22/04/2020	17:00	PM014110-D	ERU-002-D	60	97	6	G VELASQUEZ SUR	Expresa		2020-04-22 16:59:11	93	115	14,85	55	-4,0

F. To calculate the difference between the measurements of both devices, a subtraction was made from the value obtained by the radar, minus the value obtained by the ETD.

5.3 Data comparison.

In accordance with the explained procedure on methodology section, the count, average speed and occupation data between 15 to 17hrs were analyzed, with time intervals every 5 minutes, where the values obtained from the ETD was as follows:

Fecha	Hora	Nombre	Codigo	Cantidad	Velocidad(km/h)	Ocupación (%)	Eje	Ubicación
22/04/2020	15:00	PM014110-D	ERU-002-D	73	95	3	G VELASQUEZ SUR	Expresa
22/04/2020	15:05	PM014110-D	ERU-002-D	84	97	3	G VELASQUEZ SUR	Expresa
22/04/2020	15:10	PM014110-D	ERU-002-D	64	95	3	G VELASQUEZ SUR	Expresa
22/04/2020	15:15	PM014110-D	ERU-002-D	80	95	4	G VELASQUEZ SUR	Expresa
22/04/2020	15:20	PM014110-D	ERU-002-D	91	98	3	G VELASQUEZ SUR	Expresa
22/04/2020	15:25	PM014110-D	ERU-002-D	81	98	3	G VELASQUEZ SUR	Expresa
22/04/2020	15:30	PM014110-D	ERU-002-D	66	91	5	G VELASQUEZ SUR	Expresa
22/04/2020	15:35	PM014110-D	ERU-002-D	102	94	4	G VELASQUEZ SUR	Expresa
22/04/2020	15:40	PM014110-D	ERU-002-D	109	98	4	G VELASQUEZ SUR	Expresa
22/04/2020	15:45	PM014110-D	ERU-002-D	92	98	3	G VELASQUEZ SUR	Expresa
22/04/2020	15:50	PM014110-D	ERU-002-D	57	93	4	G VELASQUEZ SUR	Expresa
22/04/2020	15:55	PM014110-D	ERU-002-D	100	95	4	G VELASQUEZ SUR	Expresa
22/04/2020	16:00	PM014110-D	ERU-002-D	100	94	4	G VELASQUEZ SUR	Expresa
22/04/2020	16:05	PM014110-D	ERU-002-D	69	93	3	G VELASQUEZ SUR	Expresa
22/04/2020	16:10	PM014110-D	ERU-002-D	33	97	3	G VELASQUEZ SUR	Expresa
22/04/2020	16:15	PM014110-D	ERU-002-D	70	95	3	G VELASQUEZ SUR	Expresa
22/04/2020	16:20	PM014110-D	ERU-002-D	83	94	5	G VELASQUEZ SUR	Expresa
22/04/2020	16:25	PM014110-D	ERU-002-D	119	95	5	G VELASQUEZ SUR	Expresa
22/04/2020	16:30	PM014110-D	ERU-002-D	86	97	3	G VELASQUEZ SUR	Expresa
22/04/2020	16:35	PM014110-D	ERU-002-D	96	93	4	G VELASQUEZ SUR	Expresa
22/04/2020	16:40	PM014110-D	ERU-002-D	38	91	4	G VELASQUEZ SUR	Expresa
22/04/2020	16:45	PM014110-D	ERU-002-D	70	99	4	G VELASQUEZ SUR	Expresa
22/04/2020	16:50	PM014110-D	ERU-002-D	106	93	4	G VELASQUEZ SUR	Expresa
22/04/2020	16:55	PM014110-D	ERU-002-D	90	95	4	G VELASQUEZ SUR	Expresa
22/04/2020	17:00	PM014110-D	ERU-002-D	60	97	6	G VELASQUEZ SUR	Expresa

After filtering the radar data, the average speed, count and occupancy data was attached to the comparative table, leaving the radar information as follows:

TIME	AVG.SPEED	CANTIDAD	OCUPACIÓN (%)
2020-04-22 14:59:05	90,8	75	9
2020-04-22 15:04:06	89,4	97	12,4
2020-04-22 15:09:06	92,9	95	11,8
2020-04-22 15:14:06	91,6	84	11,65
2020-04-22 15:19:06	88,2	99	12,25
2020-04-22 15:24:07	92,1	72	24,55
2020-04-22 15:29:07	81,7	111	15,15
2020-04-22 15:34:07	86,9	108	14,9
2020-04-22 15:39:07	90,8	102	12,85
2020-04-22 15:44:07	92,1	101	12,15
2020-04-22 15:49:08	89	96	12,7
2020-04-22 15:54:08	91,9	102	12,95
2020-04-22 15:59:08	90,2	102	13,15
2020-04-22 16:04:08	87,8	102	12,45
2020-04-22 16:09:09	91,1	81	10,2
2020-04-22 16:14:09	95,5	81	9,75
2020-04-22 16:19:09	87,4	90	11,8
2020-04-22 16:24:09	90,1	123	15,35
2020-04-22 16:29:09	90,1	91	12,6
2020-04-22 16:34:10	88,5	100	12,85
2020-04-22 16:39:10	88	100	12,35
2020-04-22 16:44:10	91,1	91	12,3
2020-04-22 16:49:10	89,8	97	12,2
2020-04-22 16:54:11	87,8	111	14,9
2020-04-22 16:59:11	93	115	14,85

Below is the complete table with the recorded data comparison:

Fecha	Hora	Nombre	Codigo	Cantidad	Velocidad(km/h)	Ocupación (%)	Eje	Ubicación	SMART Micro	TIME	AVG.SPEED	CANTIDAD	OCCUPACIÓN (%)	DIF_CANT	DIF_VELOCIDAD
22/04/2020	15:00	PM014110-D	ERU-002-D	73	95		3 G VELASQUEZ SUR	Expresa		2020-04-22 14:59:05	90,8	75	9	2	-4,2
22/04/2020	15:05	PM014110-D	ERU-002-D	84	97		3 G VELASQUEZ SUR	Expresa		2020-04-22 15:04:06	89,4	97	12,4	13	-7,6
22/04/2020	15:10	PM014110-D	ERU-002-D	64	95		3 G VELASQUEZ SUR	Expresa		2020-04-22 15:09:06	92,9	95	11,8	31	-2,1
22/04/2020	15:15	PM014110-D	ERU-002-D	80	95		4 G VELASQUEZ SUR	Expresa		2020-04-22 15:14:06	91,6	84	11,65	4	-3,4
22/04/2020	15:20	PM014110-D	ERU-002-D	91	98		3 G VELASQUEZ SUR	Expresa		2020-04-22 15:19:06	88,2	99	12,25	8	-9,8
22/04/2020	15:25	PM014110-D	ERU-002-D	81	98		3 G VELASQUEZ SUR	Expresa		2020-04-22 15:24:07	92,1	72	24,55	-9	-5,9
22/04/2020	15:30	PM014110-D	ERU-002-D	66	91		5 G VELASQUEZ SUR	Expresa		2020-04-22 15:29:07	81,7	111	15,15	45	-9,3
22/04/2020	15:35	PM014110-D	ERU-002-D	102	94		4 G VELASQUEZ SUR	Expresa		2020-04-22 15:34:07	86,9	108	14,9	6	-7,1
22/04/2020	15:40	PM014110-D	ERU-002-D	109	98		4 G VELASQUEZ SUR	Expresa		2020-04-22 15:39:07	90,8	102	12,85	-7	-7,2
22/04/2020	15:45	PM014110-D	ERU-002-D	92	98		3 G VELASQUEZ SUR	Expresa		2020-04-22 15:44:07	92,1	101	12,15	9	-5,9
22/04/2020	15:50	PM014110-D	ERU-002-D	57	93		4 G VELASQUEZ SUR	Expresa		2020-04-22 15:49:08	89	96	12,7	39	-4,0
22/04/2020	15:55	PM014110-D	ERU-002-D	100	95		4 G VELASQUEZ SUR	Expresa		2020-04-22 15:54:08	91,9	102	12,95	2	-3,1
22/04/2020	16:00	PM014110-D	ERU-002-D	100	94		4 G VELASQUEZ SUR	Expresa		2020-04-22 15:59:08	90,2	102	13,15	2	-3,8
22/04/2020	16:05	PM014110-D	ERU-002-D	69	93		3 G VELASQUEZ SUR	Expresa		2020-04-22 16:04:08	87,8	102	12,45	33	-5,2
22/04/2020	16:10	PM014110-D	ERU-002-D	33	97		3 G VELASQUEZ SUR	Expresa		2020-04-22 16:09:09	91,1	81	10,2	48	-5,9
22/04/2020	16:15	PM014110-D	ERU-002-D	70	95		3 G VELASQUEZ SUR	Expresa		2020-04-22 16:14:09	95,5	81	9,75	11	0,5
22/04/2020	16:20	PM014110-D	ERU-002-D	83	94		5 G VELASQUEZ SUR	Expresa		2020-04-22 16:19:09	87,4	90	11,8	7	-6,6
22/04/2020	16:25	PM014110-D	ERU-002-D	119	95		5 G VELASQUEZ SUR	Expresa		2020-04-22 16:24:09	90,1	123	15,35	4	-4,9
22/04/2020	16:30	PM014110-D	ERU-002-D	86	97		3 G VELASQUEZ SUR	Expresa		2020-04-22 16:29:09	90,1	91	12,6	5	-6,9
22/04/2020	16:35	PM014110-D	ERU-002-D	96	93		4 G VELASQUEZ SUR	Expresa		2020-04-22 16:34:10	88,5	100	12,85	4	-4,5
22/04/2020	16:40	PM014110-D	ERU-002-D	38	91		4 G VELASQUEZ SUR	Expresa		2020-04-22 16:39:10	88	100	12,35	62	-3,0
22/04/2020	16:45	PM014110-D	ERU-002-D	70	99		4 G VELASQUEZ SUR	Expresa		2020-04-22 16:44:10	91,1	91	12,3	21	-7,9
22/04/2020	16:50	PM014110-D	ERU-002-D	106	93		4 G VELASQUEZ SUR	Expresa		2020-04-22 16:49:10	89,8	97	14,9	-9	-3,2
22/04/2020	16:55	PM014110-D	ERU-002-D	90	95		4 G VELASQUEZ SUR	Expresa		2020-04-22 16:54:11	87,8	111	14,9	21	-7,2
22/04/2020	17:00	PM014110-D	ERU-002-D	60	97		6 G VELASQUEZ SUR	Expresa		2020-04-22 16:59:11	93	115	14,85	55	-4,0

5.4 Results.

In accordance with the data presented in the previous table, and with the methodology explained above, the difference between the values registered by each team was calculated, remaining as follows:

Difference between vehicles amount.

$$\text{IDF_CANT} = (\text{Radar count}) - (\text{ETD count})$$

Difference between average speed.

$$\text{DIF_VELOCIDAD} = (\text{Radar speed}) - (\text{ETD speed})$$

Fecha	Hora	DIF_CANT	DIF_VELOCIDAD
22/04/2020	15:00	2	-4,2
22/04/2020	15:05	13	-7,6
22/04/2020	15:10	31	-2,1
22/04/2020	15:15	4	-3,4
22/04/2020	15:20	8	-9,8
22/04/2020	15:25	-9	-5,9
22/04/2020	15:30	45	-9,3
22/04/2020	15:35	6	-7,1
22/04/2020	15:40	-7	-7,2
22/04/2020	15:45	9	-5,9
22/04/2020	15:50	39	-4,0
22/04/2020	15:55	2	-3,1
22/04/2020	16:00	2	-3,8
22/04/2020	16:05	33	-5,2
22/04/2020	16:10	48	-5,9
22/04/2020	16:15	11	0,5
22/04/2020	16:20	7	-6,6
22/04/2020	16:25	4	-4,9
22/04/2020	16:30	5	-6,9
22/04/2020	16:35	4	-4,5
22/04/2020	16:40	62	-3,0
22/04/2020	16:45	21	-7,9
22/04/2020	16:50	-9	-3,2
22/04/2020	16:55	21	-7,2
22/04/2020	17:00	55	-4,0

In addition, the differences obtained were averaged to obtain a general reference of the behavior of the radar compared to the ETD, obtaining the following:

- Average speed difference : -5.28
- Average difference in quantities : 16.28

The data indicates that there is little difference in speed calculations, where radar technology records differences ranging from 0.5 km / h to 7.9 km / h less than the information recorded by the ETD. In addition, the average calculated during the two-hour section indicates a difference of 5.2 km / h between both technologies, so we consider the radar performance was really satisfactory.

In the case of the difference in the vehicles amount registered, the average is 16.28 vehicles in difference. This result is considered as high, but the reason for the difference is in the ETD count failure, as shown in the next point.

5.5 ETDs Data loss.

After identifying that in some sections of time there is a considerable difference between the number of vehicles registered between the ETD and Radar, ranging from 30 to 60 vehicles, we proceeded to analyze the detailed record every one minute of data from the ETD report, where it was discovered that in some time sections some data records were lost, ranging from the loss of one minute to three minutes in some cases as shown in the following images:

consolidado cantidad	Minutos faltantes
73 14:56 a 15:00	
84 15:01 a 15:05	
64 15:07 a 15:10	falta minuto 06
80 15:11 a 15:15	falta minuto 13
91 15:16 a 15:20	
81 15:21 a 15:25	
66 15:26 a 15:29	falta minuto 30

consolidado cantidad	Minutos faltantes
86 16:26 a 16:30	
96 16:31 a 16:35	
38 16:38 a 16:39	faltan minutos 36,37 y 40
70 16:42 a 16:45	falta mnuto 41
106 16:46 a 16:50	
90 16:51 a 16:54	falta minuto 55
60 16:57 a 17:00	faltan minutos 56, 58 y 59

5.6 Differences in Occupancy calculation.

According to the data obtained in the occupation, this is the difference between both:

		ETD	RADAR
Fecha	Hora	Ocupación (%)	OCUPACIÓN (%)
22/04/2020	15:00	3	9
22/04/2020	15:05	3	12,4
22/04/2020	15:10	3	11,8
22/04/2020	15:15	4	11,65
22/04/2020	15:20	3	12,25
22/04/2020	15:25	3	24,55
22/04/2020	15:30	5	15,15
22/04/2020	15:35	4	14,9
22/04/2020	15:40	4	12,85
22/04/2020	15:45	3	12,15
22/04/2020	15:50	4	12,7
22/04/2020	15:55	4	12,95
22/04/2020	16:00	4	13,15
22/04/2020	16:05	3	12,45
22/04/2020	16:10	3	10,2
22/04/2020	16:15	3	9,75
22/04/2020	16:20	5	11,8
22/04/2020	16:25	5	15,35
22/04/2020	16:30	3	12,6
22/04/2020	16:35	4	12,85
22/04/2020	16:40	4	12,35
22/04/2020	16:45	4	12,3
22/04/2020	16:50	4	12,2
22/04/2020	16:55	4	14,9
22/04/2020	17:00	6	14,85

smartmicro Radar occupancy:

	CARRIL	CLASE	CANTIDAD	%OCUPACIÓN	
Time	L	Class	Volume	Occupancy [%]	
2020-04-22 14:59:05	1	0	0	0	CARRIL 1
2020-04-22 14:59:05	1	2	0	0	
2020-04-22 14:59:05	1	3	4	0,45	
2020-04-22 14:59:05	1	5	0	0	
2020-04-22 14:59:05	1	7	6	0,85	
2020-04-22 14:59:05	1	8	2	0,2	
2020-04-22 14:59:05	1	9	0	0	
2020-04-22 14:59:05	2	0	0	0	CARRIL 2
2020-04-22 14:59:05	2	2	0	0	
2020-04-22 14:59:05	2	3	17	1,45	
2020-04-22 14:59:05	2	5	0	0	
2020-04-22 14:59:05	2	7	8	0,9	
2020-04-22 14:59:05	2	8	9	2,1	
2020-04-22 14:59:05	2	9	2	0,5	
2020-04-22 14:59:05	3	0	0	0	CARRIL 3
2020-04-22 14:59:05	3	2	0	0	
2020-04-22 14:59:05	3	3	17	1,4	
2020-04-22 14:59:05	3	5	1	0,05	
2020-04-22 14:59:05	3	7	7	0,65	
2020-04-22 14:59:05	3	8	1	0,15	
2020-04-22 14:59:05	3	9	1	0,3	
				9	
					TOTAL 3 CARRILES

The occupancy recorded for each lane and type of vehicles provide more accurate and reasonable information.

Little variation in ETD occupancy data:

Fecha	Hora	Nombre	Codigo	Cantidad	Velocidad(km/h)	Ocupación (%)
22/04/2020	16:30	PM014110-D	ERU-002-D	86	97	3
22/04/2020	16:35	PM014110-D	ERU-002-D	96	93	4
22/04/2020	16:40	PM014110-D	ERU-002-D	38	91	4
22/04/2020	16:45	PM014110-D	ERU-002-D	70	99	4
22/04/2020	16:50	PM014110-D	ERU-002-D	106	93	4
22/04/2020	16:55	PM014110-D	ERU-002-D	90	95	4
22/04/2020	17:00	PM014110-D	ERU-002-D	60	97	6
22/04/2020	17:05	PM014110-D	ERU-002-D	85	98	3
22/04/2020	17:10	PM014110-D	ERU-002-D	111	101	4
22/04/2020	17:15	PM014110-D	ERU-002-D	45	98	4
22/04/2020	17:20	PM014110-D	ERU-002-D	45	99	4
22/04/2020	17:25	PM014110-D	ERU-002-D	61	101	3
22/04/2020	17:30	PM014110-D	ERU-002-D	111	100	5
22/04/2020	17:35	PM014110-D	ERU-002-D	105	96	4
22/04/2020	17:40	PM014110-D	ERU-002-D	114	98	4
22/04/2020	17:45	PM014110-D	ERU-002-D	111	96	4
22/04/2020	17:50	PM014110-D	ERU-002-D	109	100	4
22/04/2020	17:55	PM014110-D	ERU-002-D	90	102	3
22/04/2020	18:00	PM014110-D	ERU-002-D	73	102	3
22/04/2020	18:05	PM014110-D	ERU-002-D	17	97	3
22/04/2020	18:10	PM014110-D	ERU-002-D	81	99	3
22/04/2020	18:15	PM014110-D	ERU-002-D	97	101	3
22/04/2020	18:20	PM014110-D	ERU-002-D	92	92	4
22/04/2020	18:25	PM014110-D	ERU-002-D	80	99	3
22/04/2020	18:30	PM014110-D	ERU-002-D	52	94	3
22/04/2020	18:35	PM014110-D	ERU-002-D	83	95	3
22/04/2020	18:40	PM014110-D	ERU-002-D	97	98	3
22/04/2020	18:45	PM014110-D	ERU-002-D	93	96	3
22/04/2020	18:50	PM014110-D	ERU-002-D	86	99	3
22/04/2020	18:55	PM014110-D	ERU-002-D	69	102	2
22/04/2020	19:00	PM014110-D	ERU-002-D	83	97	3
22/04/2020	19:05	PM014110-D	ERU-002-D	86	98	3
22/04/2020	19:10	PM014110-D	ERU-002-D	23	98	2
22/04/2020	19:15	PM014110-D	ERU-002-D	61	97	3

Little or no variation is observed in the occupancy registered by the ETD, even if the peak hour section is revised between 6:00 p.m. and 7:00 p.m., the range remains between 2% and 4%.

6 CONCLUSIONS.

After reviewing the data and comparisons between the resulting information, we have the following comments:

Loss ETD data affects the performed comparison test. This does not allow for a precision comparison basis. The general measurement is verified, however, when validating the error percentages close to 1 or 2%, the ETD data are not reliable. This, rather than a problem for comparison, is a problem for the end customer, since the ETD device is performing poorly.

Despite the above, the radar test is considered as successful, given that, considering all the limitations of a temporary installation and the little data collection time, the measurements are seen to be true to reality, and even more accurate than the existing equipment today (ETDs).

A longer test would be desirable, against a more accurate basis of comparison, eg, readings from a collection portal. However, the obtained results with the test carried out are sufficient to show a comparison against the equipment that is currently being used.

We recommend the implementation of radars for traffic management in Autopista Central highway, we believe that the device is more reliable and also, as it is not invasive or requires modifications of the road, the advantages of maintenance and installation costs are relevant.