Two Radio Event Signatures

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In the spring of 2007 José, CT1BOH, a world-class contester and a member of the CQWW contest committee, contacted Sylvan, VE5ZX, a contester and complex systems scientist. He had read an article[1] Sylvan had written on amateur radio contesting. He wanted to know if Sylvan would be interested in working with him on a research problem.

José wanted to know if the CQWW cw logs could be used to find unique signatures for world class stations using two radios in the SOAB unassisted, SOAB assisted (SOAB A) and multi-operator one transmitter (MS) entry classes. Both SOAB classes and MS can use two radios. The single operator class can only have one signal on the air at a time (SO2R) while the MS stations can have two signals on the air, provided the second signal is used to work new multipliers. If unique signatures can be found then they might be useful for verifying the entry class of a log. This seemed like an exciting research project that would improve our understanding of radio sports and perhaps provide adjudicators with insights for techniques to aid decision making activities. So began an exchange of emails, telephone calls, spreadsheets, graphs and tables in search of two radio event signatures. The research reported[2] in this article was completed in December of 2007.

CQWW Open Log Policy

Many technologies such as packet and SO2R are changing the face of radio sports. Some competitors see these changes as positive while others don't. However, most contestants agree that non compliance with the class rules dilutes the validity of the competition in that class.

The CQWW committee recently endorsed an open log policy and they made the 2006 cw & ssb contest logs publicly available. The committee is inviting the contest community and the broader research communities to deepen their understanding of the art and practice of radio sports through the use of the CQWW contest logs. This initiative may encourage competitors to use these data for a variety of research projects. For example, the logs might be used to prepare a dynamic world map of the contest activity overlaid with actual propagation measures. Or competitors might study each others logs in the hope of acquiring insights to improve performance. Some people may wish to write articles comparing the strategies of different stations. And an open log policy will increase peer scrutiny of the committee decisions as well as encourage the development of analytical techniques to help enforce the rules.

The two radio hypothesis

José had a hunch that the top SOAB, SOAB A and MS cw contenders might differ in the way they use their two radio setups. He thought the use of packet by SOAB A and more than one operator as well as packet in the MS classes would change the profile of their two radio activity.

In 2006 a world class SOAB or MS high power cw operator(s) using a two radio setup logged 6,000 – 9,000 QSOs. An average logging rate of 2-3 QSOs per min (Q/min) is needed to log this many contacts in a 48 hour time period. During peak run periods the QSO rate can go over 5 Q/min.

The only way a SOAB operator can work new multipliers and stations that don't call him while he is running is through S&P activity frequently done on the second radio. Intuitively, it seems

[1] A novel perspective of amateur radio contesting
[2] An Excel workbook with the detailed calculations and two zipped intermediate data files are available from the radio sport research section of the Radio Sport Canada web site.

that at higher Q rates an SOAB operator is less likely to have time to use the second radio thereby decreasing the likelihood of the log containing second radio activity during high Q rate minutes. In comparison, SOAB A and MS operators, use packet to automatically fill the band maps of their logging programs. They spend much less time searching and more time pouncing thereby increasing the likelihood of logging activity on the second radio at high run rates.

If these notions are correct then logs that contain information about which radio a QSO is made on might contain signatures that help identify the entry class of the logs. Unfortunately, CQWW logs don't contain the information needed to figure out which QSOs were made on which radio. As a result we constructed a log analyzer that used software techniques to detect two radio events in CQWW cw logs.

Two radio events

A two radio event logic was determined after many hours of manually studying two radio activities from CQWW logs. We defined a two radio event (2RE) as a *specific contiguous sequence of log entries*. In this article we focus solely on log sequences consisting of 3 and 4 consecutive QSOs. Figure 1 is a schematic of the possible band change sequences that might be encountered by a log analyzer looking for 2REs in these sequences.

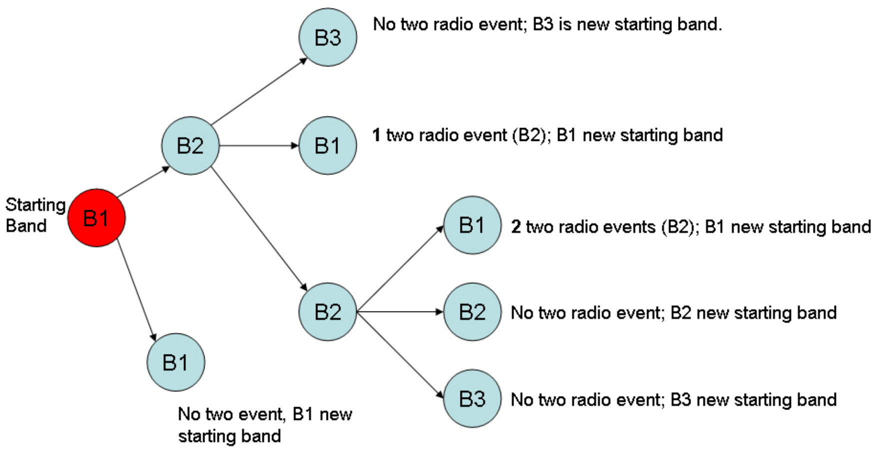


Figure 1 –Two Radio Event Logic

Consider which sequences a world class two radio station might use. An SO2R operator will be running one radio and using the other radio to QSY for a QSO or for S&P activity during slower intervals. The multi-op single transmitter operator will likely be assisted by another operator using the second radio to search for new multipliers.

For a top contender a 2RE will take place over a relatively short period of time. A single operator's attention is drawn away from the run radio to the second radio and then after making 1 or 2 QSOs it will return to the run radio. We consider the band sequences B1→B2→B1 and B1→B2→B2→B1 to qualify as 1 and 2 two radio events, respectively, if they take place during short enough time periods. The sequence B1→B2→B3→B1 could also be a 2RE but this sequence occurs infrequently and we did not count it as a 2RE. The maximum time interval during which a two radio sequence must have occurred to qualify as a 2RE was set to 3 minutes.

A Perl log analyzer was written to process the logs and build 2RE profiles for stations that submitted 2006 CQWW cw logs. In addition, a profile was made for each station of the number of QSOs that were made on each band during each minute of the contest. These profiles were used to determine the QSO rate (Q/min) at which the 2REs took place. José's 2RE profile at CT3NT is given as an example in appendix A.

In order to ensure stations truly used SO2R and did not just make many QSYs on just one radio, logs from SOAB and SOAB A with 50 or more 2REs and MS with more than 200 2REs were selected for this analysis. As a result 96 logs in the three classes of interest were collected for further analysis. The 96 logs were composed of 66 DX logs of which 54 logs were submitted by European stations and 30 North American logs. Only 6 logs were in the low power category. The selected logs with summary information are given in Appendix B. Despite all of the discussions about the use of SO2R in contests we found that less than 2% of SOAB and SOAB A entries were serious SO2R users.

Two radio signatures

The logs and 2RE profiles for the selected stations were used to develop common signatures for the three entry classes. The first step was to analyze each log and count how many two radio events occurred during the minutes when the operator(s) was making 1, 2, 3 … 8 QSOs per minute (Q/min). Table 1 summarizes the total number of QSOs and the number of 2REs at each run rate for all competitors in the three categories.

Table 1 – Number of two radio events at various QSO rates

				Rate (Q/min)							
Category	**Logs**	**QSOs**	**2RE**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
All	**96**	**357,621**	**26,116**	**4,796**	**8,569**	**6,918**	**3,919**	**1,460**	**370**	**77**	**7**
SOAB	**34**	**110,370**	**5,982**	**1,993**	**2,627**	**1,058**	**271**	**31**	**2**	**0**	**0**
EU	12	30,908	2,127	753	959	338	72	5	0	0	0
DX	4	25,430	326	93	107	81	35	9	1	0	0
NA	18	54,032	3,529	1,147	1,561	639	164	17	1	0	0
SOAB A	**9**	**29,189**	**2,595**	**412**	**831**	**711**	**426**	**165**	**37**	**8**	**5**
EU	5	14,335	1,608	267	594	412	234	81	17	3	0
DX	1	7,023	442	27	56	133	128	68	20	5	5
NA	3	7,831	545	118	181	166	64	16	0	0	0
MS	**53**	**218,062**	**17,539**	**2,391**	**5,111**	**5,149**	**3,222**	**1,264**	**331**	**69**	**2**
EU	37	155,835	13,009	1,747	3,783	3,987	2,362	870	210	50	0
DX	7	38,271	2,176	203	439	545	547	311	114	15	2
NA	9	23,956	2,354	441	889	617	313	83	7	4	0

Figure 2 gives the distribution of the probabilities for each entry class that QSOs made at a rate of n Q/min was a 2RE [3]. We call the 2RE probability distribution for a station or class its *two radio event signature*. The probabilities were computed by dividing the number of 2REs at each run rate by the total number of QSOs logged. For example, Table 2 gives the number of 2REs and the probability distribution for 2REs at various run rates for CT3NT. Also, it gives the average probability distributions[4] for each class calculated using 94 logs[5] which are plotted in Figure 2.

Table 2 – CT3NT and entry class probability distribution of 2REs

			Rate (Q/min)							
	QSOs	**2RE**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
CT3NT	6754	115	22	39	34	16	4	0	0	0
			0.003	0.006	0.005	0.002	0.001	0.000	0.000	0.000
SOAB			0.022	0.027	0.009	0.002	0.000	0.000	0.000	0.000
SOAB A			0.019	0.033	0.019	0.007	0.002	0.000	0.000	0.000
MS			0.013	0.026	0.024	0.014	0.005	0.001	0.000	0.000

[3] The graphs were plotted in Excel using the smooth line function not a statistical technique.
[4] For each log in a class the probability distribution was calculated and then the average probability was determined at each run rate using all the logs in the class.
[5] Although 96 logs were selected the C4M and UW8M logs were not used in the calculation of the average probabilities. The reasons for this are explained in the article.

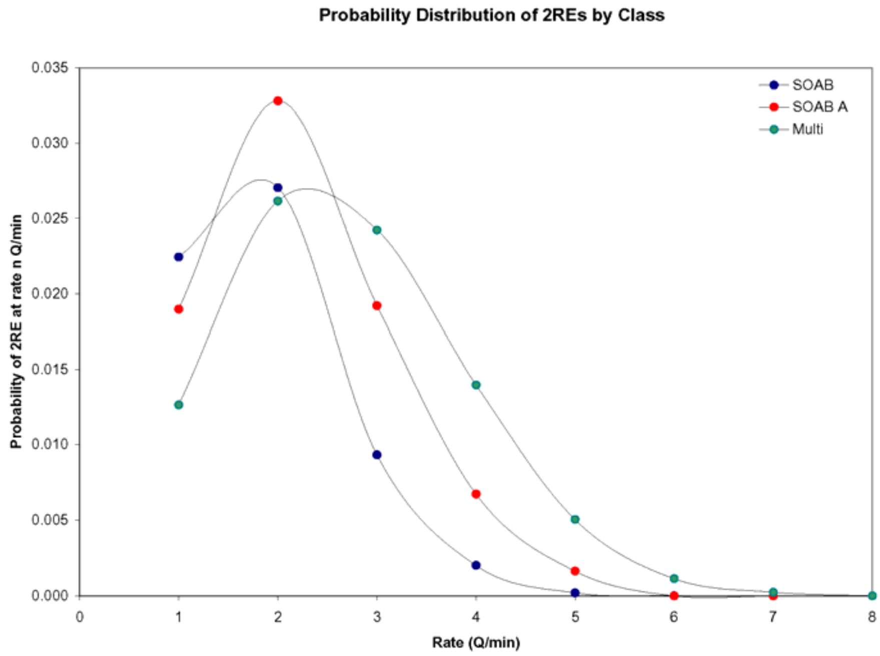


Figure 2 –Two Radio Event Signatures

There are two general differences in the average 2RE signatures among the classes.

1. The run rate with the maximum probability of a 2RE occurring, called *the peak run rate,* may increase for the SOAB A signature when compared to the SOAB signature.
2. The right hand side of the probability distribution, frequently called *the right hand tail*, broadens with the assistance of packet and another operator.

The differences among the average 2RE signatures for the three classes lend support to our hypothesis that assistance from packet and another operator will increase the likelihood of logging a 2RE at higher run rates. Let's test the hypothesis using three subclasses distinguished by geography (EU, DX and NA) for each main class.

World-class two radio event signatures

Subclass signature analysis was restricted to the six top European (EU), North American (NA) or DX high power logs in each subclass. Since we are exploring the effect of run rate on 2REs the logs were ranked using the total number of logged QSOs and not by the final scores. The findings can be related to scores later if required.

Figure 3 gives the 2RE signatures for high power entries in nine subclasses: EU SOAB, EU SOAB A, EU MS, NA SOAB, NA SOAB A, NA MS, DX SOAB, DX SOAB A and DX MS. The number in brackets after the calls in graphs are the number of 2REs detected in the log. Some single operator subclasses did not have six entries with 50 or more 2REs. In these cases the available logs were used to calculate the subclass averages.

The average 2RE signatures for each subclass are shown with red lines. The only log with 50 or more 2REs in the DX SOAB A class was entered by C4M who, according to the published results, was disqualified. It was used as a possible representative example of the DX SOAB A subclass. Also, the distribution for CT6A, a low power entry in the EU SOAB A subclass with 240 2REs, is provided for illustration purposes. It was not used to calculate the average for the high power entries in the EU SOAB A subclass.

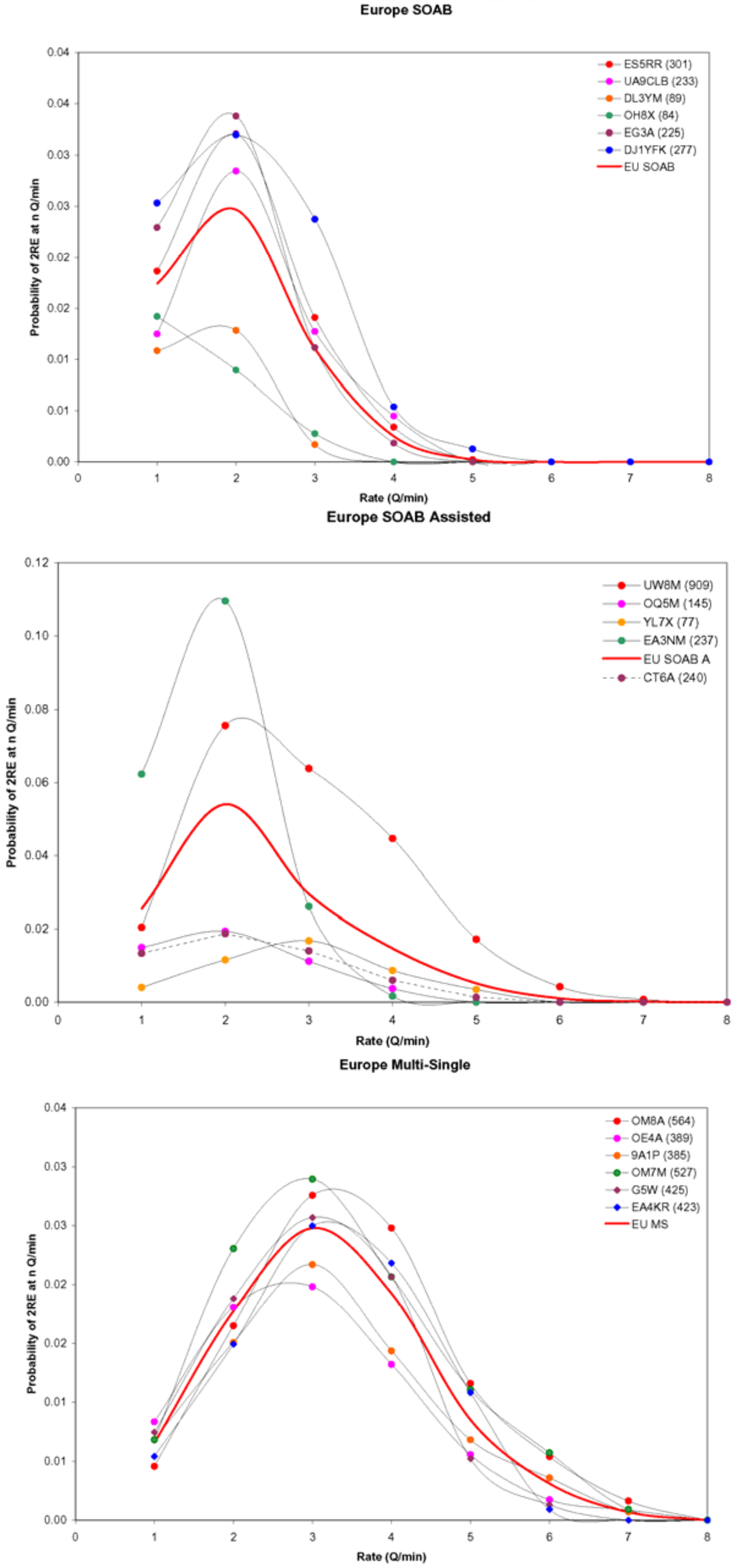
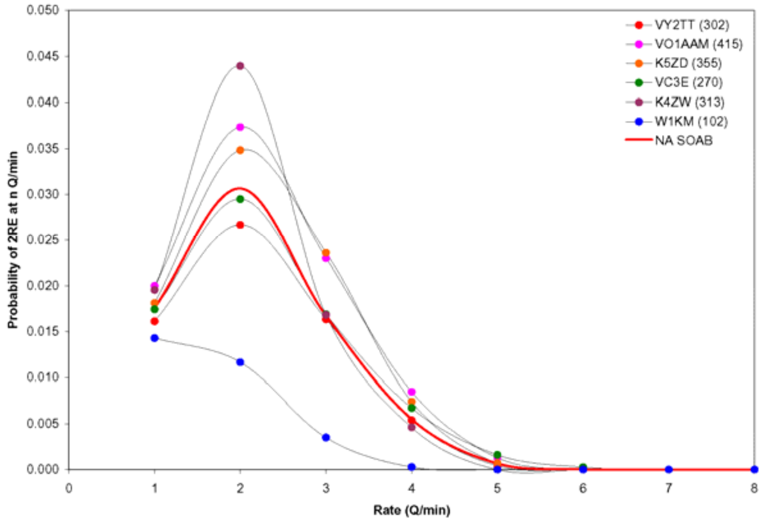
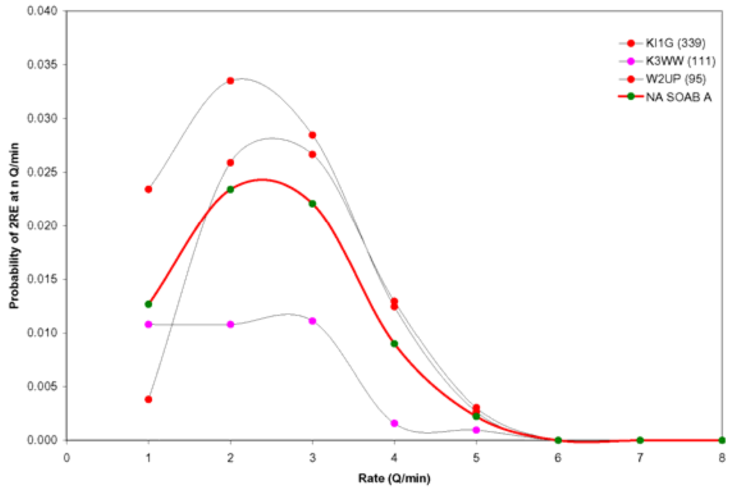


Figure 3a – European Two Radio Event Signatures

North America SOAB



North America SOAB Assisted



North America Multi-Single

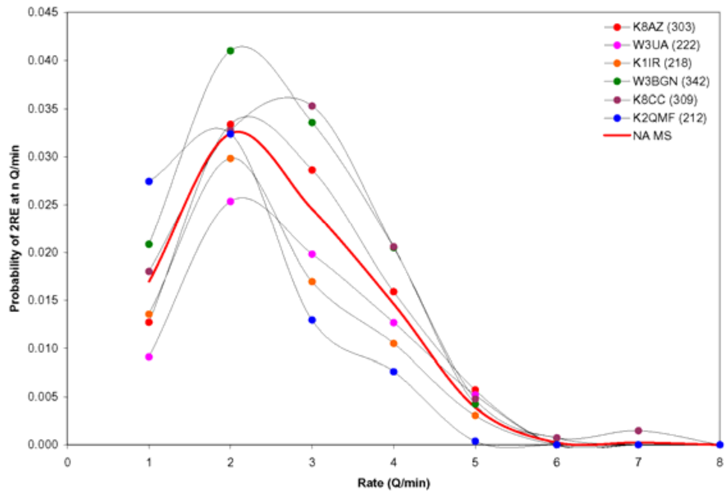
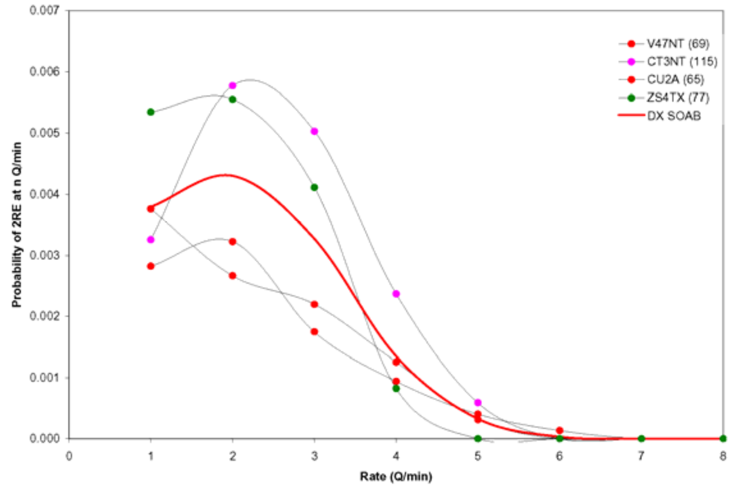
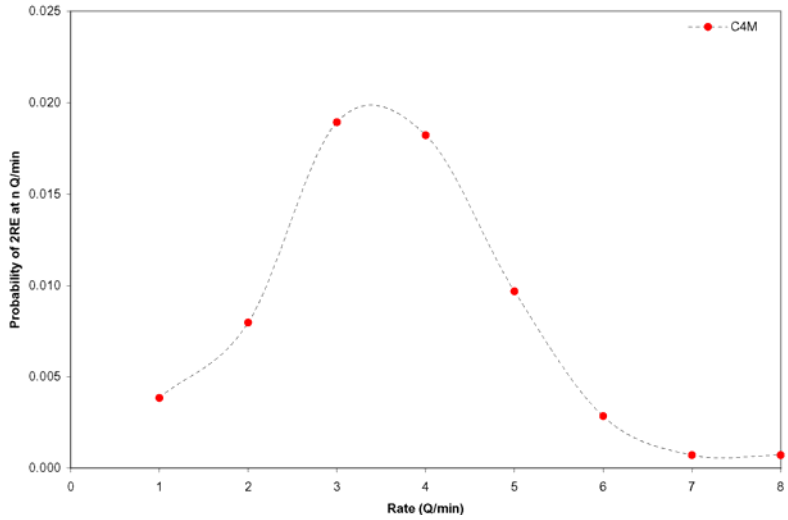


Figure 3b – North American Two Radio Event Signatures

DX SOAB



DX SOAB Assisted



DX Multi-Single

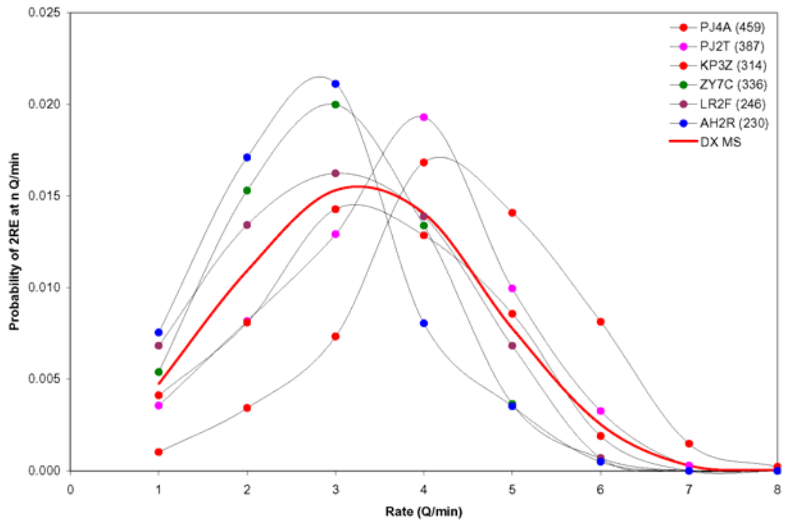


Figure 3c – DX Two Radio Event Signatures

On closer examination the UW8M log appears to belong to a different class than EU SOAB A. The log contained 60% more 2REs for 40% fewer QSOs than OM8A who won the MS class. And the UW8M signature has uncharacteristically broad right hand tail compared to the other SOAB A entries. For these reasons the average EU SOAB A signature was recalculated without using the UW8M log. The revised individual and average EU SOAB A signatures are presented in Figure 4.

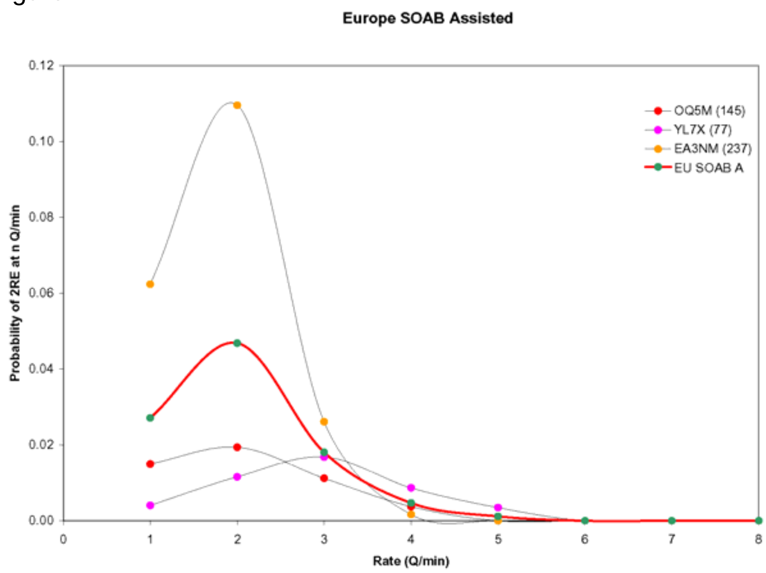


Figure 4 – Revised EU SOAB A Average Signature

The average 2RE signatures for each subclass were collected together and plotted on one graph in Figure 5. The European average signatures are given by red lines, the DX signatures by black lines and the North American signatures by blue lines. Overall profiles for each geographical area are given in Appendix C.

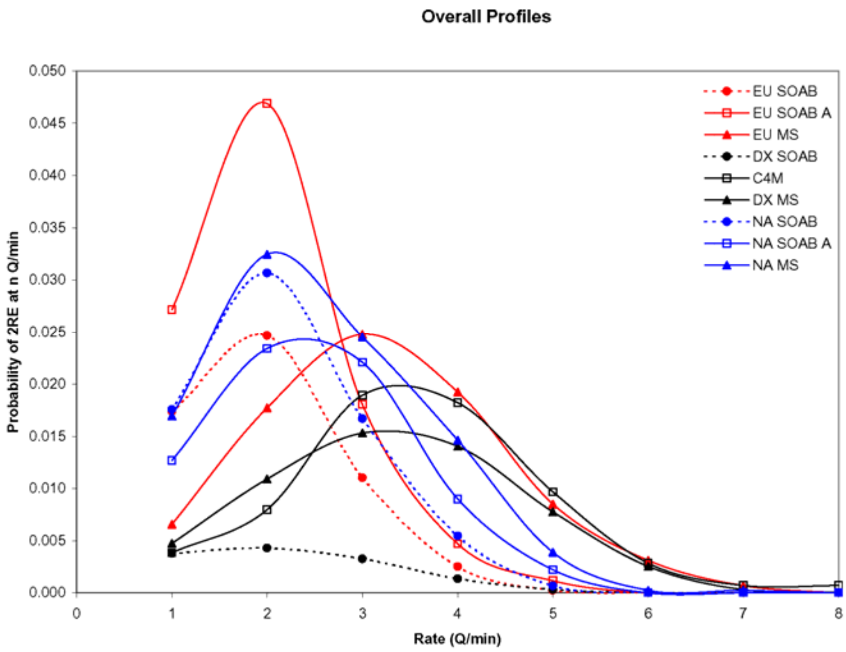


Figure 5 –Average Two Radio Event Signatures

Generally speaking the families of curves for the nine subclasses follow the same trend as the family of curves for the three overall classes shown in Figure 2. EU and NA SOAB A have broader right hand tails than EU and NA SOAB. EU and NA MS have broader right tails than EU and NA SOAB and SOAB A.

A notable difference is the signature of DX SOAB A represented by C4M's log. It does not appear to be the signature that would be expected for a DX SOAB A given the trends for EU and NA entries. The 2RE signature would be expected to peak earlier at a lower Q rate and fall quicker than the DX MS. However, more logs with 50 or more 2REs would be needed to confirm that the average 2RE signature for the DX SOAB A subclass follows the same trend as the others.

Another notable difference is the height of the NA SOAB A peak run rate is lower than the peak for NA SOAB. In contrast, in Figure 2 the peak run rate for SOAB A was higher than SOAB and in Figure 5 the EU SOAB A peak run rate is higher than the peak for EU SOAB. And as discussed above we don't have enough logs to establish a relationship between the peaks of the DX SOAB A and DX SOAB subclasses. However, one might expect the height of SOAB A peak run rate to always be higher than the SOAB peak operators because of the assistance of packet. Why is this not the case for NA SOAB A stations?

NA stations, notably USA stations, unlike European stations cannot work each other. USA stations S&P a lot more than European stations because there are many hours where running is almost impossible due to night time propagation conditions. Typically, the S&P rate is expected to be lower than the run rate. The result is the run versus S&P activity profiles for NA stations are much different than the profiles for European stations. For example, K5ZD had 4193 QSOs and 989 QSOs (24%) that were done in S&P mode. On the other hand ES5RR had 4400 QSOs and 428 (10%) that were done in S&P mode. The differences in operating practices imposed by the contest rules can produce significant differences in the average 2RE signature of the subclasses.

What have we learned?

Information gathered from CQWW contests logs for world class high power cw stations can be used to produce 2RE signatures. The profiles of these signatures are uniquely distinguished by the likelihood of 2REs occurring at high QSO rates. The more assistance a station receives the more likely it will log 2REs during high Q rate minutes. This information may be useful to contest adjudicators for checking the entry classes of logs.

Although this article shows how contest logs can be used to supplement the UBN information adjudicators use to make decisions it has shortcomings. We analyzed high power cw stations. There were too few lower power entries to study. And it has not been tested on SSB logs. Also, the findings for 3 of 9 subclasses were based on an analysis of less than six logs. More importantly, the average signatures for each subclass were derived using at most six logs. However, as average 2RE signatures are collected from future logs we will gain an understanding of how stable these signatures are and how useful they are to adjudicators. We don't advocate the use of this technique to prove a log has been entered in the wrong class but we think the technique might be useful to alert adjudicators about logs that may need further inspection.

The CQWW committee took a bold step forward when it adopted the open log policy. It makes the adjudication process more transparent to the participants. Hopefully other sponsors will follow suit and encourage the contest community to research and develop new ways to probe the art and practice of radio sports. The R&D derived from these studies will lead to increased participant confidence in the quality of the adjudication in the radio sport events they enter.

Acknowledgements

The authors would like to thank Bob Cox (K3EST), Doug Grant (K1DG), Randy Thompson, (K5ZD), Tõnno Vahk (ES5TV) and Doug Zwiebel (KR2Q) for comments on an earlier draft.

Please email comments and questions to ve5zx.ct1boh@gmail.com

Appendix A - CT3NT two radio events.

Date	UTC	Min.	Band	Station
25/11/2006	0011	11	14.0	6V7D
25/11/2006	0017	17	14.0	TZ5A
25/11/2006	0027	27	14.0	CE4CT
25/11/2006	0130	90	14.0	XU7MWA
25/11/2006	0152	112	14.0	TU2CI
25/11/2006	0213	133	3.5	P3F
25/11/2006	0224	144	3.5	MD4K
25/11/2006	0317	197	3.5	6Y3R
25/11/2006	0325	205	3.5	ZS4TX
25/11/2006	0330	210	3.5	V51AS
25/11/2006	0334	214	3.5	ZF1A
25/11/2006	0338	218	3.5	EA6IB
25/11/2006	0353	233	7.0	V47NT
25/11/2006	0356	236	7.0	EA6IB
25/11/2006	0416	256	7.0	HK1AR
25/11/2006	0422	262	7.0	6W1RW
25/11/2006	0523	323	7.0	ZF1A
25/11/2006	0542	342	7.0	6Y1V
25/11/2006	0546	346	7.0	TO5X
25/11/2006	0553	353	7.0	9K2HN
25/11/2006	0557	357	7.0	V31XX
25/11/2006	0558	358	7.0	OH0X
25/11/2006	0656	416	3.5	CT9L
25/11/2006	0732	452	21.0	OH0Z
25/11/2006	0740	460	21.0	8Q7DV
25/11/2006	0746	466	21.0	XU7MWA
25/11/2006	0820	500	28.0	UP5G
25/11/2006	0856	536	21.0	ZS4TX
25/11/2006	0859	539	21.0	4U1ITU
25/11/2006	0910	550	21.0	UA9QA
25/11/2006	0923	563	21.0	9V1YC
25/11/2006	0925	565	28.0	CT9L
25/11/2006	0951	591	14.0	8Q7DV
25/11/2006	0958	598	14.0	MD/DJ9RR
25/11/2006	1008	608	28.0	TZ5A
25/11/2006	1013	613	28.0	ZS6C
25/11/2006	1016	616	28.0	VK9AA
25/11/2006	1018	618	28.0	EA8EW
25/11/2006	1020	620	28.0	RT6A
25/11/2006	1027	627	28.0	J43J
25/11/2006	1041	641	28.0	5A7A
25/11/2006	1048	648	28.0	S52W
25/11/2006	1104	664	21.0	5H3EE
25/11/2006	1113	673	21.0	ZP0R
25/11/2006	1130	690	21.0	A45XR
25/11/2006	1133	693	21.0	CT6A
25/11/2006	1137	697	21.0	PZ5ZY
25/11/2006	1139	699	21.0	8P5A
25/11/2006	1143	703	21.0	9Y4AA
25/11/2006	1201	721	21.0	CT9L
25/11/2006	1206	726	21.0	J79EP

Date	UTC	Min.	Band	Station
25/11/2006	1210	730	21.0	TZ5A
25/11/2006	1212	732	21.0	CE4CT
25/11/2006	1215	735	21.0	ZY7C
25/11/2006	1256	776	14.0	V47NT
25/11/2006	1300	780	14.0	CN2WW
25/11/2006	1319	799	14.0	A45XR
25/11/2006	1332	812	14.0	YE1ZAT
25/11/2006	1335	815	14.0	LY2CX
25/11/2006	1351	831	14.0	3A2MW
25/11/2006	1413	853	28.0	PS2T
25/11/2006	1417	857	28.0	LU1HF
25/11/2006	1431	871	28.0	TU2CI
25/11/2006	1436	876	14.0	OY1CT
25/11/2006	1510	910	28.0	6W1RW
25/11/2006	1512	912	28.0	8P5A
25/11/2006	1514	914	28.0	CE4CT
25/11/2006	1518	918	28.0	EA8EW
25/11/2006	1519	919	28.0	CX7BY
25/11/2006	1520	920	28.0	PZ5ZY
25/11/2006	1525	925	28.0	HC8N
25/11/2006	1539	939	14.0	T94WF
25/11/2006	1544	944	14.0	CS7A
25/11/2006	1552	952	14.0	5Z1A
25/11/2006	1559	959	14.0	W3LPL
25/11/2006	1703	1023	21.0	PJ4A
25/11/2006	1722	1042	21.0	XE1NTT/2
25/11/2006	1729	1049	21.0	HI3A
25/11/2006	1730	1050	21.0	HC8N
25/11/2006	1733	1053	21.0	VP2VVV
25/11/2006	1857	1137	14.0	P40W
25/11/2006	1859	1139	14.0	EA8EW
25/11/2006	1904	1144	14.0	KH6ZM
25/11/2006	1951	1191	21.0	V47NT
25/11/2006	1956	1196	21.0	TI3TLS
25/11/2006	2032	1232	3.5	4O3B
25/11/2006	2036	1236	3.5	BA4RF
25/11/2006	2118	1278	14.0	VP2VVV
25/11/2006	2134	1294	14.0	HC8N
25/11/2006	2143	1303	3.5	IH9P
25/11/2006	2224	1344	7.0	GD8T
25/11/2006	2243	1363	14.0	5A7A
25/11/2006	2244	1364	14.0	9Y4AA
25/11/2006	2321	1401	3.5	A45XR
25/11/2006	2328	1408	14.0	PZ5ZY
26/11/2006	0155	1555	14.0	CX7BY
26/11/2006	0157	1557	14.0	9N7JO
26/11/2006	0223	1583	1.8	YW4D
26/11/2006	0340	1660	1.8	6W1RW
26/11/2006	0413	1693	7.0	VP5W
26/11/2006	0415	1695	7.0	9Y4AA
26/11/2006	0446	1726	14.0	ZL6QH
26/11/2006	0448	1728	7.0	HC8N
26/11/2006	0654	1854	14.0	IT9ORA

Date	UTC	Min.	Band	Station
26/11/2006	0734	1894	1.8	MD6V
26/11/2006	0930	2010	21.0	EX2A
26/11/2006	0933	2013	21.0	6W1RW
26/11/2006	0936	2016	21.0	9M2TO
26/11/2006	1001	2041	28.0	VK9AA
26/11/2006	1120	2120	21.0	LX7I
26/11/2006	1135	2135	21.0	5A7A
26/11/2006	1442	2322	21.0	P40T
26/11/2006	1657	2457	21.0	J79EP
26/11/2006	1701	2461	21.0	VP5W
26/11/2006	1841	2561	7.0	ZS3NN

Note:

1. The 2RE profiles for all 96 logs can be downloaded in a zip file from http://www.radiosport.ca/rsrp/documents/2RE%20profile.zip

2. The Q rate profiles for all 96 logs can be downloaded in a zip file from http://www.radiosport.ca/rsrp/documents/Qrate%20profile.zip

Appendix B –SOAB and SOAB A logs with 50 or more 2REs and MS log with more than 200 2REs listed in descending order by section (sec) and number of two radio events

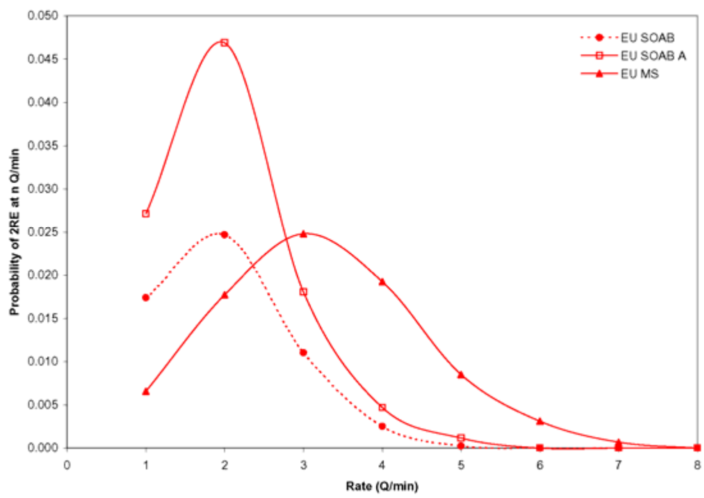
Log	Sec	Operator	Assisted	Power	QSOs	2RE
PJ4A	DX	MULTI-OP	ASSISTED	HIGH	8734	459
C4M	DX	SINGLE-OP	ASSISTED	HIGH	7023	442
PJ2T	DX	MULTI-OP	ASSISTED	HIGH	6734	387
ZY7C	DX	MULTI-OP	ASSISTED	HIGH	5753	336
KP3Z	DX	MULTI-OP	ASSISTED	HIGH	6305	314
LR2F	DX	MULTI-OP	ASSISTED	HIGH	4250	246
AH2R	DX	MULTI-OP	ASSISTED	HIGH	3976	230
JA7YAA	DX	MULTI-OP	ASSISTED	HIGH	2519	204
CT3NT	DX	SINGLE-OP		HIGH	6754	115
ZS4TX	DX	SINGLE-OP		HIGH	4860	77
V47NT	DX	SINGLE-OP		HIGH	7440	69
CU2A	DX	SINGLE-OP		HIGH	6376	65
UW8M	EU	SINGLE-OP	ASSISTED	HIGH	4004	909
OM8A	EU	MULTI-OP	ASSISTED	HIGH	6127	564
OM7M	EU	MULTI-OP	ASSISTED	HIGH	5422	527
OK5W	EU	MULTI-OP	ASSISTED	HIGH	4701	468
OL7R	EU	MULTI-OP	ASSISTED	HIGH	4717	467
IR4M	EU	MULTI-OP	ASSISTED	HIGH	5087	460
TM2Y	EU	MULTI-OP	ASSISTED	HIGH	4739	431
OL3A	EU	MULTI-OP	ASSISTED	HIGH	4312	429
G6PZ	EU	MULTI-OP	ASSISTED	HIGH	5023	426
G5W	EU	MULTI-OP	ASSISTED	HIGH	5370	425
EA4KR	EU	MULTI-OP	ASSISTED	HIGH	5361	423
HG1S	EU	MULTI-OP	ASSISTED	HIGH	5216	408
YT0A	EU	MULTI-OP	ASSISTED	HIGH	4426	403
OE4A	EU	MULTI-OP	ASSISTED	HIGH	5754	389
9A1P	EU	MULTI-OP	ASSISTED	HIGH	5574	385
DF3CB	EU	MULTI-OP	ASSISTED	HIGH	3886	373
OH1F	EU	MULTI-OP	ASSISTED	HIGH	3687	373
RL3A	EU	MULTI-OP	ASSISTED	HIGH	4498	372
LX7I	EU	MULTI-OP	ASSISTED	HIGH	5223	370
LN8W	EU	MULTI-OP	ASSISTED	HIGH	4304	369
OH5Z	EU	MULTI-OP	ASSISTED	HIGH	3453	335
OH4A	EU	MULTI-OP	ASSISTED	HIGH	3920	332
RK2FWA	EU	MULTI-OP	ASSISTED	HIGH	5302	322
OL3Z	EU	MULTI-OP	ASSISTED	HIGH	3645	308
TM4Q	EU	MULTI-OP	ASSISTED	HIGH	4288	307
SQ6Z	EU	MULTI-OP	ASSISTED	HIGH	3136	302
ES5RR	EU	SINGLE-OP		HIGH	4400	301
SO9Q	EU	MULTI-OP	ASSISTED	HIGH	3164	300
DP9A	EU	MULTI-OP	ASSISTED	HIGH	3382	287
PI4D	EU	MULTI-OP	ASSISTED	HIGH	3120	284
DJ1YFK	EU	SINGLE-OP		HIGH	3158	277
RT6A	EU	MULTI-OP	ASSISTED	HIGH	4338	276
DL1EFD	EU	SINGLE-OP		LOW	1782	265
RO4M	EU	MULTI-OP	ASSISTED	HIGH	2625	262
RZ9OZO	EU	MULTI-OP	ASSISTED	HIGH	3724	259
OL1C	EU	MULTI-OP	ASSISTED	HIGH	3293	251
LN3Z	EU	MULTI-OP	ASSISTED	HIGH	3847	244

RSC Radio Sport Canada

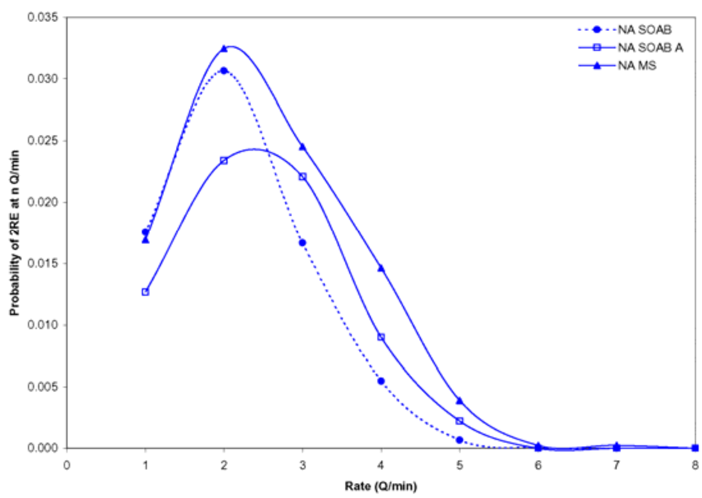
Log	Sec	Operator	Assisted	Power	QSOs	2RE
OT6L	EU	MULTI-OP	ASSISTED	HIGH	3470	242
CT6A	EU	SINGLE-OP	ASSISTED	LOW	4481	240
EA3NM	EU	SINGLE-OP	ASSISTED	HIGH	1186	237
DR4A	EU	MULTI-OP	ASSISTED	HIGH	3028	233
UA9CLB	EU	SINGLE-OP		HIGH	4006	233
EG3A	EU	SINGLE-OP		HIGH	3228	225
SN2K	EU	MULTI-OP	ASSISTED	HIGH	2477	202
RZ4CWW	EU	MULTI-OP	ASSISTED	HIGH	2196	201
UA4FER	EU	SINGLE-OP		LOW	2055	193
RV6LFE	EU	SINGLE-OP		LOW	1614	182
OQ5M	EU	SINGLE-OP	ASSISTED	HIGH	2939	145
LY6M	EU	SINGLE-OP		LOW	1091	144
DL3YM	EU	SINGLE-OP		HIGH	3506	89
OH8X	EU	SINGLE-OP		HIGH	3241	84
SE5E	EU	SINGLE-OP		HIGH	1190	80
YL7X	EU	SINGLE-OP	ASSISTED	HIGH	1725	77
ES2DJ	EU	SINGLE-OP		HIGH	1637	54
VO1AAM	NA	SINGLE-OP		HIGH	4607	415
K5ZD	NA	SINGLE-OP		HIGH	4193	355
W3BGN	NA	MULTI-OP	ASSISTED	HIGH	2829	342
KI1G	NA	SINGLE-OP	ASSISTED	HIGH	3371	339
K4ZW	NA	SINGLE-OP		HIGH	3686	313
K8CC	NA	MULTI-OP	ASSISTED	HIGH	2719	309
K8AZ	NA	MULTI-OP	ASSISTED	HIGH	3144	303
VY2TT	NA	SINGLE-OP		HIGH	4652	302
VC3E	NA	SINGLE-OP		HIGH	3730	270
N0NI	NA	MULTI-OP	ASSISTED	HIGH	2277	269
K0RF	NA	MULTI-OP	ASSISTED	HIGH	2480	267
WX0B	NA	SINGLE-OP		HIGH	2100	256
W3UA	NA	MULTI-OP	ASSISTED	HIGH	3077	222
K1IR	NA	MULTI-OP	ASSISTED	HIGH	2949	218
K5TR	NA	SINGLE-OP		HIGH	2426	214
K2QMF	NA	MULTI-OP	ASSISTED	HIGH	2624	212
W8AV	NA	MULTI-OP	ASSISTED	HIGH	1857	212
W9RE	NA	SINGLE-OP		HIGH	2867	212
NN1N	NA	SINGLE-OP		HIGH	2858	205
VE3EY	NA	SINGLE-OP		HIGH	3280	190
K0SR	NA	SINGLE-OP		HIGH	1363	155
N2YO	NA	SINGLE-OP		HIGH	2751	120
K3WW	NA	SINGLE-OP	ASSISTED	HIGH	3148	111
K3CR	NA	SINGLE-OP		HIGH	3195	108
N2IC	NA	SINGLE-OP		HIGH	2444	106
W1KM	NA	SINGLE-OP		HIGH	3429	102
W2UP	NA	SINGLE-OP	ASSISTED	HIGH	1312	95
K5YA	NA	SINGLE-OP		HIGH	2314	89
K1ZZ	NA	SINGLE-OP		HIGH	2556	61
VE3KF	NA	SINGLE-OP		LOW	1581	56

Appendix C – Overall profiles for each geographical area

Overall EU Profiles



Overall NA Profiles



Overall DX Profiles