RNG EVALUATION REPORT

FOR

VIRTUE FUSION'S

RNG

SUBMITTED TO

VIRTUE FUSION

BY

SQS INDIA INFOSYSTEMS PVT LTD

ON

01ST APRIL 2014

Executive Summary

This document is our report for RNG evaluation activity carried out for Virtue Fusion's RNG as per Alderney Gambling Control Commission (AGCC) guidelines V 3.7.

Scope

The scope is to determine the compliance of RNG function and scaling mechanism used by Virtue Fusion against applicable AGCC guidelines.

Test Approach

SQS India has conducted RNG evaluation activity for Virtue Fusion as described below.

1. The RNG functionality is implemented with the help of RNG function 'nextInt(inclusiveLowerBound, exclusiveUpperBound)'.
2. The NIST statistical test suite was applied to 7,500,000 random numbers generated by nextInt(inclusiveLowerBound, exclusiveUpperBound) function provided by Virtue Fusion.

Test Results

1. Seeding:

   Virtue Fusion's RNG mechanism uses default seeding provided by the JDK

2. Scaling:

   2.1. The random numbers generated by default seeding provided by the JDK are scaled down in a proportional manner with help of below line of code:

   ```
   //subtract inclusiveLowerBound so that number is between 0 and (exclusiveUpperBound - inclusiveLowerBound)
   int res = random.nextInt(exclusiveUpperBound - inclusiveLowerBound);
   //add inclusiveLowerBound back on to move into range
   res += inclusiveLowerBound;
   return res;
   ```

   2.2. The scaling of RNG to produce drawn numbers is statistically acceptable.

   2.3. This is proved to be sufficiently random in our tests.

3. Confidence level:

   As the chosen significance level is 0.01 and the generated *P-value is* ≥ 0.01, the sequence of numbers is considered to be random with a confidence of 99%.

4. The numbers generated by the RNG have passed mandatory NIST tests for statistical randomness. The details of such tests are mentioned below under 'Conclusion' section.

Conclusions

SQS India has executed all the 15 tests which are part of NIST test suite for Virtue Fusion's RNG and found that 13 statistical tests are executed successfully out of 15. SQS India has observed that 2 tests are not applicable for this RNG evaluation activity based upon test result observed for these tests.

SQS India has confirmed that out of 13 executed tests, all the mandatory tests (listed below) generate the desired P value. However there are 2 tests which generate P value = 0.00 and hence failed.

SQS India has done analysis for the tests which are failed for the algorithm and have provided required details about their failure causes in the 'Consolidated Report on NIST Statistical Tests' prepared for Virtue Fusion's RNG.

According to the prioritisation of NIST tests, the numbers generated by the RNG should pass the below mentioned tests in order to ensure the randomness for algorithm used for any application.

1. Frequency test within a block,
2. Longest Runs of Ones in a block
3. Spectral
4. Non-Overlapping template matching,
5. Serial
6. Cumulative Sums.
7. Random Excursions

SQS India has confirmed that Virtue Fusion's RNG provides suitable random numbers for use.

Therefore SQS India recommends to Virtue Fusion that Virtue Fusion's RNG be approved against AGCC guidelines for release for production use.

For SQS India Infosystems Pvt Ltd

Gireendra Kasmalkar
Director and CEO

Date: 01st April 2014