RootMetrics®
By IHS Markit

Understanding RootScores and RootScore Rankings

What is a RootScore?

RootScores offer a simple way to translate thousands or millions of complex data points into clear and easy-to-understand marks of performance. RootScores are designed to reflect a consumer's experience of network performance; the higher the score, the better the performance. For instance, the Overall RootScore reflects a consumer's everyday experience across data, call, and text usage. A good Overall RootScore means a good overall consumer experience and good overall network performance.

Using an educational analogy, think of RootScores like you would a final grade in a semester-long course: scores approaching the upper limit (100) indicate extraordinary performance, like receiving an "A" grade at the end of the semester. Scores approaching the lower limit (0) represent network performance that would be clearly unacceptable to everyday consumer usage, similar to receiving a poor grade at the end of the semester.

Just as a final grade in a semester-long course is a function of performance across multiple exams, no single test determines RootScore results for any performance category; RootScores are calculated from multiple tests that are weighted according to the impact to a consumer's experience.

RootScore® Awards

RootScore® Awards are available in the following performance categories: Overall, Network Reliability, Network Accessibility, Network Speed, Data, Call, and Text. The top-performing network within each performance category earns the corresponding RootScore Award.

If two or more networks share the highest rank in the same category by recording statistically indistinguishable results, each network earns a RootScore Award in that category.

RootMetrics scoring

The RootMetrics testing methodology, scoring system, and ranking algorithms offer insights on network performance from a consumer's point of view. RootScores are calculated by applying scoring algorithms to data, call, and text test results. Scoring is weighted to ensure that the categories and results most relevant to consumers carry the most significance. Scoring is based on the following broad measures of performance:

Overall RootScore

Comprised of weighted results from the data, call, and text categories:

- Data 55%
- Call 40%
- Text 5%

Network Reliability RootScore

- Lite data reliability
- Lite data secure reliability
- Downlink/uplink throughput reliability
- Mobile-to-mobile blocked and dropped call reliability
- Intra- and inter-operator text send and receipt reliability

Network Accessibility RootScore

- Lite data speed
- Lite data secure speed
- Downlink/uplink access speed
- Mobile-to-mobile call setup time
- Intra- and inter-operator text send speed

Network Speed RootScore

- Downlink/uplink throughput speed

Data RootScore

- Lite data reliability and speed
- Lite data secure reliability and speed
- Downlink/uplink throughput reliability and speed

Call RootScore

- Mobile-to-mobile blocked and dropped calls

Text RootScore

- Intra- and inter-operator send and receipt reliability
- Intra- and inter-operator send and receipt speed

Standardized index

Each RootScore is a standardized index. This means the value of the index is not adjusted based on the performance of the networks in a given area. Essentially, using an educational analogy, networks are not graded "on a curve."

Network rankings are determined through statistical comparison of RootScores; RootMetrics utilizes a bootstrap t-test at an achieved significance level of 0.1. RootScores have variability associated with them. We use a standard competition-ranking algorithm to assign each network a final rank.

Understanding RootScore rankings

There are two key components for understanding the RootMetrics ranking process: 1) the importance of variability and confidence intervals, and 2) the competition-ranking algorithm.

Variability and confidence intervals

After compiling thousands of test results in a market, we estimate each network's RootScore. Based on statistical principles, RootScores have uncertainty associated with them. Confidence intervals represent this uncertainty and reflect the distribution of possible RootScore values based on our sampling of network performance. More specifically, confidence intervals reflect the underlying statistical uncertainty associated with any estimate based on random sampling.

The number of samples available impacts confidence intervals; the greater the number of samples within a test location, the more precise the estimate and the smaller the confidence interval.

Comparing networks and bootstrap t-tests

Network rankings are determined through statistical comparison of RootScores; RootMetrics utilizes a bootstrap t-test at an achieved significance level of 0.1. Specifically, the t-test provides probabilistic evidence that two networks' scores are not equivalent to each other.

Through this process, networks with divergent scores are at times determined to be statistically indistinguishable and therefore receive the same rank, and networks with very close scores can receive different final rankings depending on the level of precision of the scoring.

For example, a Data RootScore might distinguish a clear ranking separation between 94.5 and 95.0, while a Call RootScore could result in a tie between scores of 93.0 and 95.0, based on observed differences in the uncertainty of the final RootScore.

Example RootScore rankings – wins, ties, close ties

Pages 4 and 5 of this document contain diagrams that illustrate various RootScore Ranking scenarios and the competition ranking process.

Of note, there is an inherent association between t-tests and confidence intervals, as they are based on similar statistical principles. In general, it is typically true that when two confidence intervals do not overlap, the t-test would indicate a significant difference between networks. Likewise, it is typically true that when two confidence intervals overlap by a considerable amount, the t-test would not indicate a significant difference between the two networks.

It is important to understand, however, that it is entirely reasonable to find a scenario in which the confidence intervals overlap, but the networks are determined to be statistically different from each other. In these instances, it is because the result of the t-test is *always* the determining factor when assessing differences, regardless of what the confidence intervals appear to show.

Identifying a clear winner

When the statistical test indicates a significant difference between networks, often the confidence intervals for those networks will not overlap (**Diagram 1**).

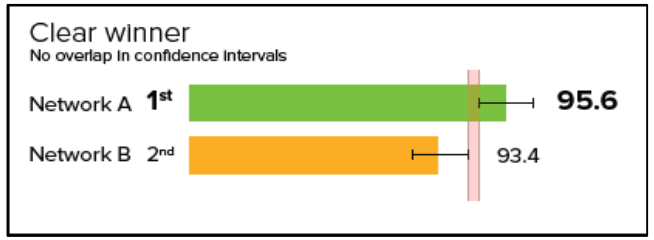
Identifying a clear tie

When the statistical test does not indicate a significant difference between carriers, the confidence intervals will typically have a large degree of overlap despite how divergent the scores appear at first glance (**Diagram 2**).

Identifying a close tie

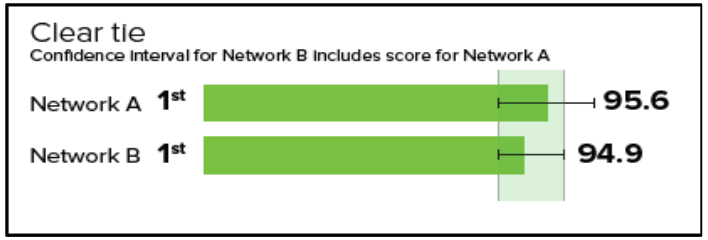
There can be occasions in which the statistical test indicates that either the networks are significantly different or the networks are not significantly different, but the overlap in the confidence intervals appears mixed. In these instances, *regardless of how the confidence intervals appear*, the decision about whether the networks have different ranks relies exclusively on the results of the statistical test. In this case, the amount of overlap and asymmetry both play into whether we can determine if the scores are statistically indistinguishable or if a winner can be declared (**Diagram 3**).

Diagram 1 – Clear winner



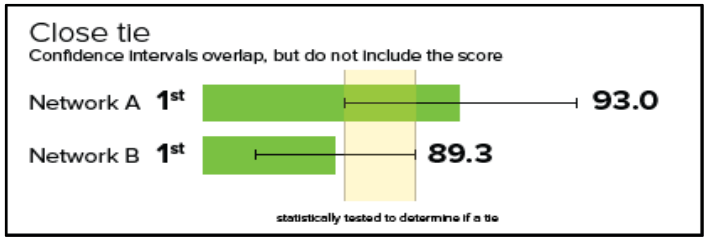
There is a difference of 2.2 points in these scores, the statistical test indicates that the networks are different from each other, and there is no overlap in the confidence intervals (as delineated by the red line). Because of the result of the statistical test, one clear winner (Network A) can be declared, and the confidence intervals are visually consistent with this outcome.

Diagram 2 – Clear tie



There is a difference of 0.7 points, the statistical test indicates that the networks are not different from each other, and the confidence interval for Network B clearly includes the score for Network A. Because of the result of the statistical test, this would be referred to as a tie, and the confidence intervals are consistent with this outcome.

Diagram 3 – Close outcomes



With a difference of 3.7 points between scores, the amount of overlap (yellow box) in the confidence intervals (error bars) is statistically tested. If the test indicates that there is no significant difference, a tie would be declared between Networks A and B. If the test indicates that there is a significant difference, then Network A would be declared the winner. The results are based *only* on the statistical test, regardless of the appearance of similarity or difference based on the confidence intervals.

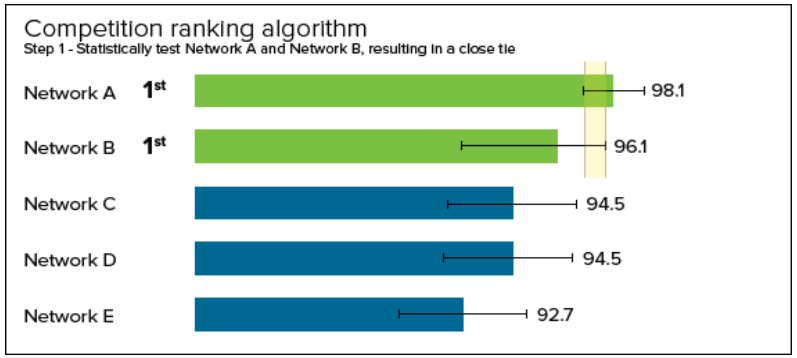
Competition ranking algorithm

When scores and confidence intervals overlap from multiple networks, and statistical testing indicates significant differences between networks, the competition-ranking algorithm can reveal differences in rank.

Example: Competition ranking steps illustrated in Diagrams 4a – 4d

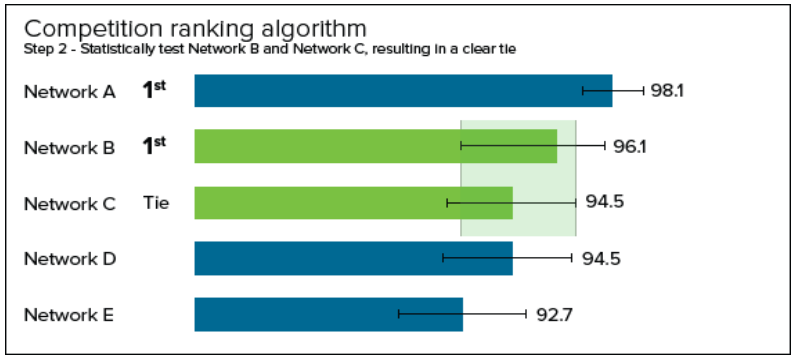
Since there is no significant difference, as determined using statistical tests, between Network A and Network B (**Diagram 4a**), and there is likewise no significant difference between Network B and Network C (**Diagram 4b**), but there is a statistically significant difference between Network A and Network C (**Diagram 4c**), then the algorithm ranks Network A and Network B tied for 1st, and Networks C, D, and E tied for 3rd (**Diagram 4d**).

Diagram 4a - Competition Ranking Algorithm (Step 1)



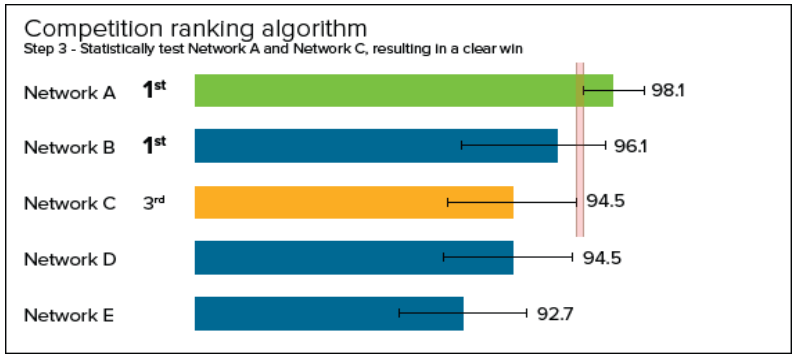
Step 1: Statistical tests are performed on the scores and confidence intervals for Network A and Network B; results show that there is no significant difference between the two, resulting in a tie between Networks A and B.

Diagram 4b – Competition Ranking Algorithm (Step 2)



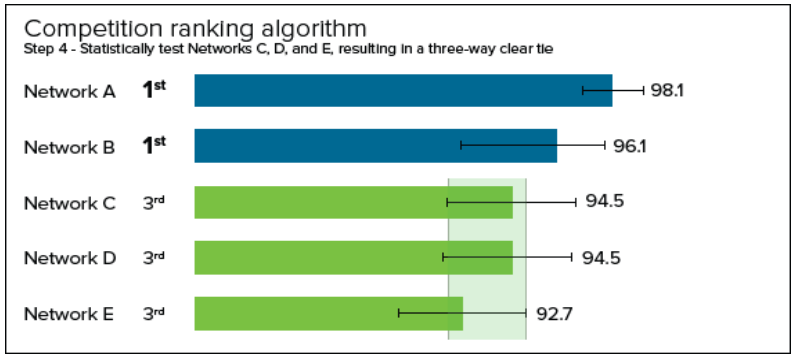
Step 2: Statistical tests are performed on the scores and confidence intervals for Network B and Network C; results show that there is no significant difference between the two, resulting in a tie between Networks B and C. However, because step 3 (**Diagram 4c**) determined a significant difference between Networks A and C, Network C ultimately placed 3rd.

Diagram 4c – Competition Ranking Algorithm (Step 3)



Step 3: Testing is performed on the scores and confidence intervals for Network A and Network C; results show that there is a significant difference between the two, resulting in a clear win for Network A, while Network C placed 3rd.

Diagram 4d - Competition Ranking Algorithm (Final rankings)



Step 4 - Final rankings: Because there is a significant difference between Network A and Network C (**Diagram 4c),** the algorithm ranks Network A and Network B tied for 1st, while Network C. Network D, and Network E are in a three-way tie for 3rd (**Diagram 4d**).