DARPA Spectrum Challenge
Notes for Final Tournament
Revised March 17, 2014

This document contains general information in preparation for the Spectrum Challenge Final Event. Please read it carefully. Based on our observations and your feedback from the Preliminary Challenge, we are making several significant modifications to the general rules originally posted on the Challenge website. Thus, information contained here supersedes that which has been provided previously via the Challenge website, via direct emails or via FAQ postings.

Radio Geometry / ORBIT Grid Configuration

As with the Preliminary tournaments, the Final Challenge tournaments will take place on the ORBIT grid; however, *the configuration of the radio pairs for the Competitive tournament has changed* from what was previously supplied in the document "DSC Radio Design Guidelines and Requirements".

The new radio node geometry for the Competitive-mode tournament is shown in Figure 1. The geometry depicted consists of two separate "diagonal" arenas. Only one diagonal (arena) – the solid circles or dashed circles – will be used at a time, but radios will be configured on both arenas to shorten down time between games during the actual Final Challenge event. Other than physical location in the grid, the geometry of the two arenas is identical.

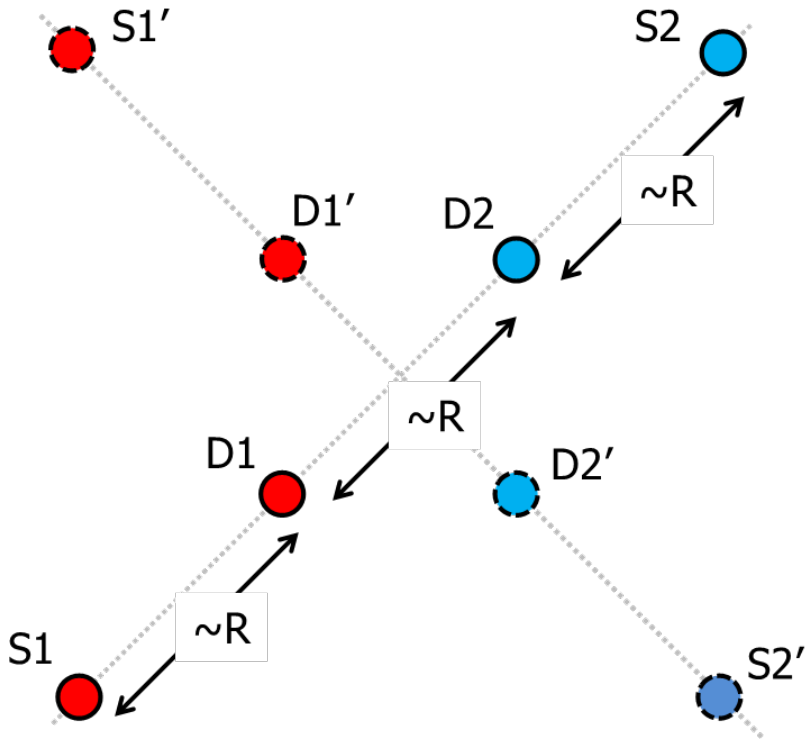

Figure 1. Radio node geometry for the Competitive mode tournament. The node spacing (R) will be provided. The geometry for the "dashed" set of nodes is identical to the "solid" set.

The blue circles represent Source and Destination nodes of one team and the red circles represent the Source and Destination nodes of the other team. The distance S1-D1, S2-D2, and D1-D2 is roughly R but due to the fixed spacing of the ORBIT grid nodes, the Rs will not be exactly the same. The node spacing will become apparent once the specific nodes are identified on the grid.

The arrangement offers some interesting characteristics and teams are encouraged to implement strategies that exploit the node geometry. In particular, note that a team's forward channel (S→D) has a high SINR if the opposing team is only transmitting from its source node, but drops to near zero if the opposing team transmits from its destination node. Also note that the reverse channel (D→S) always has a positive SINR, providing a relatively robust signal path for feedback.

Teams should be aware that the distance between their source and destination nodes is sufficiently short to require control of the transmit power and/or receiver gain/attenuation to avoid saturating the receiver's front-end.

As in the Preliminary tournament, a match will consist of two games such that a team plays one game using the S1/D1 pair and one game using the S2/D2 pair. Each team's score is the sum of its successful packet transfers from both games.

The geometric configuration for the Cooperative tournament will remain unchanged from the Preliminary tournament; however, nodes will be configured on two arenas using 3 nodes at each corner of the grid so as to minimize down time between matches.

For both the Competitive and Cooperative tournaments, all matches within a particular group of teams (groups are described below) are played on the same arena. This will allow for consistent score comparisons within a group, but not between groups playing on different arenas. Although we will attempt to use nodes with equivalent performance characteristics in both arenas, they will not be identical.

Tournament Structures

Both the Competitive and Cooperative tournament structures will change for the final event.

Competitive Tournament

The format of the Competitive tournament will change from the previous win/lose ladder configuration to one based on total packets transferred over multiple matches. The tournament process, depicted in Figure 2, is as follows.

- Preliminary Rounds - The 18 teams are divided into 6 groups of 3 (Groups A-F). Seeding basis is to be determined.
    - Within each group, matches are played between all combinations of pairs, providing 2 matches per team. A team's total score is the sum of the 2 match scores – i.e., the total number of packets successfully delivered. As in the Preliminary tournament, a match consists of two games; one on the S1/D1 nodes and one on the S2/D2 node (see Fig. 1).
    - The teams with the highest cumulative scores across the matches played within each group advance to the semifinals.

    - The team with the 2nd-highest scores in Groups A, B, C, designated A2, B2 and C2 in Figure 2, will play all combinations of pairs (2 matches per team) and the team with the highest cumulative score will advance to the semifinals as team ABC2. Similarly, the teams with the 2nd-highest scores in Groups D, E, F (D2, E2, F2) will play all combinations of pairs and the team with the highest cumulative score will advance as team DEF2. .
- Semifinal Rounds - The 2 groups of 4 teams (Groups G and H) play all combinations of pairs. Each team accumulates a score from its 6 matches. The teams with the highest score within each group advance to the final round.
- The Final Round consists of 1 match to determine the overall winner.

Competitive Tournament Notes:

- Scores are accumulated only within each Group and do not carry forward between preliminary, semifinal and final rounds.
- Scoring stops if one team completes the file transfer before the time limit.
- A team's score is the total packets delivered, accumulated for all matches played within a grouping (3 matches in the preliminary round, 6 matches in the semifinal round)
- If the two highest scoring teams within a group are tied, the winner of their head-to-head match will advance. If the head-to-head match was also a tie, or if there is a 3-way tie, then each team will play 1 game against a House radio to determine the winner. The House radio will be a time and frequency varying interferer that has not previously been seen by contestants.
- If a radio fails to register with the scoring server, it will be eliminated from the Competitive Tournament. All other teams within the Group will be given the maximum score for matches played or to be played against the failed team.
- If a radio crashes or otherwise behaves unexpectedly after registering with the scoring server, the match is played out to completion.

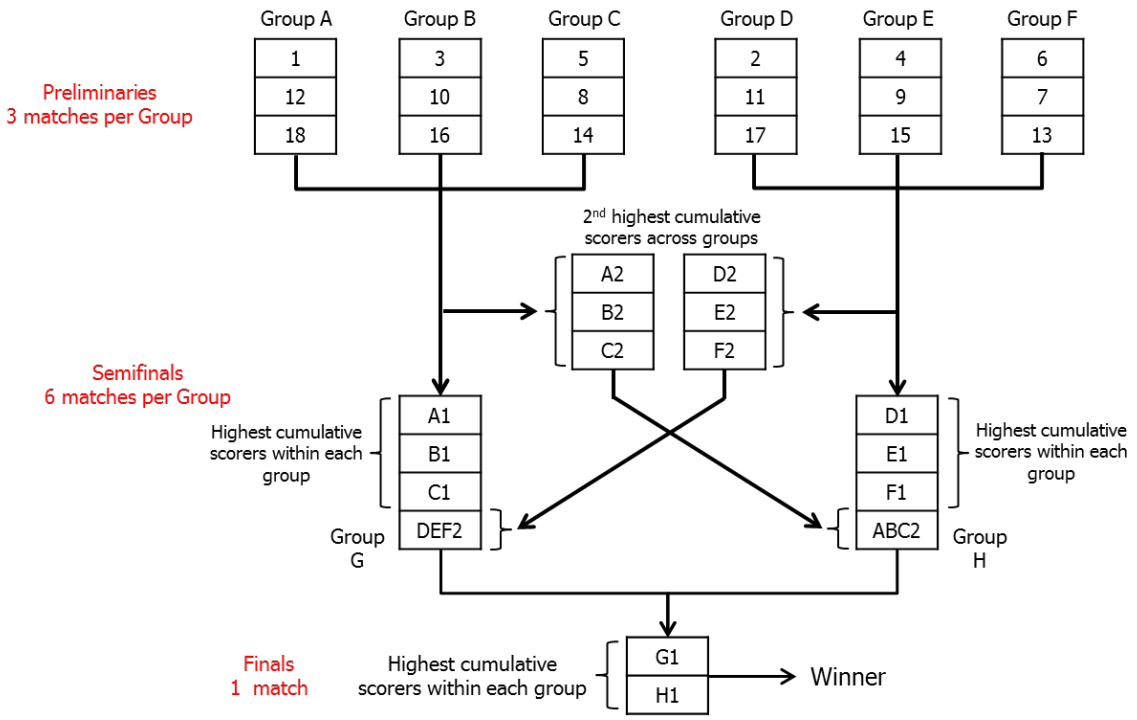

Figure 2. Competitive tournament structure

Cooperative Tournament

The format of the Cooperative tournament will change to one that provides more combinations of players within groups of teams and ensures that teams play equally on all nodes. The tournament process, depicted in Figure 3, is as follows.

- Preliminary Rounds - The 18 teams are divided into 5 groups of 4 (Groups A-E). One spot in Groups C and D is filled with the top two teams from Group A. Seeding basis is to be determined.
    - Within each group, matches are played between all combinations of 3 teams, providing 3 matches per team. A team's match score is their total packets delivered plus the higher of the two other teams' delivered packets. A team's total score within a group is the sum of its 3 match scores.
    - The 2 teams with the highest scores from Groups B and C advance to the semifinal round as Group F. The 2 teams with the highest scores from Groups D and E advance as Group G.
- Semifinal Rounds - The 2 groups of 4 teams (Groups F and G) play all combinations of 3 teams and each team accumulates a score from its 3 matches. The first and second highest scoring teams from each group advance to the finals.
- In the Final Round, the 4 remaining teams play in all combinations of 3 and accumulate a score from their 3 matches. The winner is the team with the highest cumulative score.

Cooperative Tournament Notes:

- Scores are accumulated only within each Group and do not carry forward between preliminary, semifinal and final rounds.

- Time to complete the transfer is not a factor in scoring.
- Scoring continues until all teams complete the file transfer or until the time limit is reached.
- Tie scores are resolved by examining the cumulative time for all matches played by the tied teams within a group. The team with the lowest cumulative time advances. If the cumulative times are identical, then the individual team that delivered the highest number of packets across all matches played advances.
- If a radio fails to register with the scoring server, it will be eliminated from the Cooperative Tournament and replaced with a House radio. All matches previously played with the failed radio (whether it failed previously or not), will be replayed with the House radio.
- If a radio crashes or otherwise behaves unexpectedly after registering with the scoring server, the match is played out to completion.

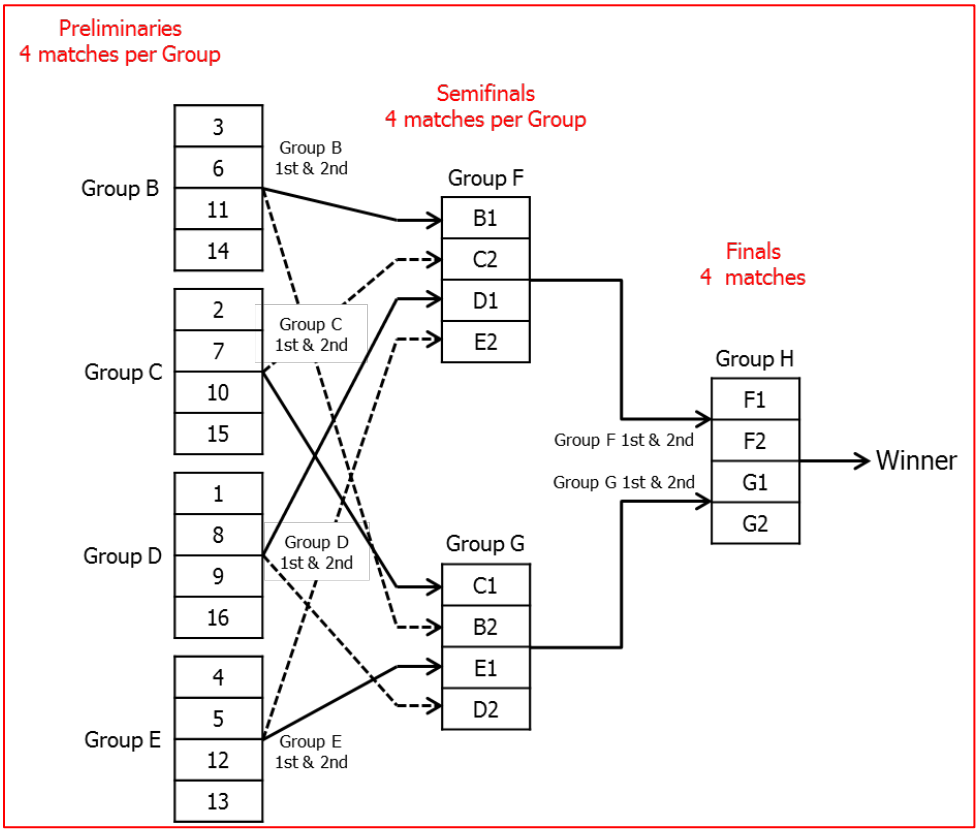

Figure 3. Cooperative tournament structure

Use of ORBIT

Up until a few weeks prior to the Final Challenge event, teams must use the ORBIT scheduler to reserve time on the grid. Additional information will be provided regarding the specific node numbers to use for your development and testing. Previous instructions on how to access the ORBIT grid and how to prepare and test your radio designs are still valid.

A revised framework will be released that will contain procedures for loading the appropriate nodes on the grid, use of WINLAB-supplied bots, interference injection, code validation and other resources. In addition to the scoring server, we plan to release a match visualization tool very similar to the one used during the Preliminary Tournament. More details will follow.

Design Validation

A validation process similar to that used for the Preliminary Challenge event will be released by the ORBIT team. For the Final Challenge, the validation process will be more robust in an attempt to reduce the incidence of code crashes and other unexpected radio behaviors during the tournaments. Unlike in the Preliminary Challenge*, there will be no re-starts in the Final Challenge matches*. If a radio fails to load or execute to completion there will be no re-loading or re-playing of the match. Teams are highly encouraged to thoroughly test their designs under a variety of conditions to ensure operational and functional stability.

Scrimmages

Two scrimmage events will be held prior to the Final Challenge. These will be opportunities for teams to run their radio designs against other teams in both Competitive and Cooperative modes. Since the ORBIT team will only be providing 1 or 2 House bots to use as practice opponents, the scrimmages will provide teams with opportunities to see how their designs perform against several other unknown radios. This will also provide an opportunity to make sure your design executes as expected and doesn't hang or crash when operating with unknown interferers. Scrimmages will not be full tournaments but will be played on the same nodes to be used for the Final Challenge. See the schedule below for the planned scrimmage dates. Code must be delivered by the indicated deadline for each scrimmage. For the first scrimmage, code validation will not be required. For the second scrimmage, code is to be validated using a process similar to that used in the Preliminary Challenge (validation details will be released at a later date). The matches will then be run by the ORBIT Spectrum Challenge Team and the results released within one week. Teams will receive results in the form of video screen captures of each match that they played. The names of the opponent teams will be anonymous.

The specific format for the scrimmages and procedures for submitting code will be released at a later date.

Key Dates

The following schedule shows tentative dates for key events leading up to the Final Challenge event. Additional details will be added to the schedule as they are identified.

Event	Date
Release of Test Framework	11/15/2013
Release Team Visualization Tools	12/13/2013
Release New Bots	12/20/2013
Release Scrimmage Structure and Plan	12/20/2013

Hold Pre-Scrimmage Townhall Teleconference	1/7/2014
Submit Code for Scrimmage 1	1/15/2014
Scrimmage 1	(ORBIT internal)
Release Scrimmage 1 Results	1/20/2014
Hold Pre-Scrimmage Townhall Teleconference	2/4/2014
Submit Code for Scrimmage 2 (Validated)	2/12/2014
Scrimmage 2	(ORBIT internal)
Release Scrimmage 2 Results	2/17/2014
Assigned Contestant Time Slots	2/27 - 3/12/2014
Code Delivery for Final Tournaments	3/12/2014
Final DSC Challenge Event	3/19 – 3/20/2014

Additional Information

All questions regarding Challenge rules and procedures must be submitted via email to spectrumchallenge@darpa.mil. Procedure updates and answers to questions that are deemed to be of interest to all teams will be posted on a FAQ page at http://dtsn.darpa.mil/spectrumchallenge/FAQ.aspx.

Questions that deal specifically with technical issues regarding the ORBIT testbed should be submitted via email to challenge@orbit-lab.org. Answers to ORBIT-related questions that are deemed to be of interest to all teams will be posted on a Q&A page at http://www.orbit-lab.org/wiki/DSC/QandA .