

Cybersecurity Championship Cup – Collegiate Algorithm and Rules

Introduction: The algorithm and method to determine the winner of the Cybersecurity Championship Cup – Collegiate (C4) should stress the goals and objectives of the purpose of the cup. What factors do we stress in the determination of the winning team? For example, is participation more important (with emphasis placed on participating in as many competitions as possible) or is it more important for a college to do well in a few competitions? This document will suggest a general objective for the Cybersecurity Championship Cup program and a method to arrive at a winning team as objectively as possible.

General Rules, Objectives and Assumptions: The rules proposed in this document will attempt to achieve a balance between participation and performance. The school winning the C4 should not simply be a school that enters as many teams as possible in competitions but does not do well in any of them. At the same time, a school that only enters one large competition but wins it should also not automatically win the C4. We have tried to strike a balance between the two. In addition, an objective of the program is to stress team as opposed to individual performance. The cybersecurity field requires individuals that can work together in the event of a cyber incident. C4 thus weighs team competitions slightly higher than individual competitions. There are some general rules that will apply to schools wishing to participate.

1. Schools are encouraged to participate in multiple competitions per year with a variety of security disciplines tested.
2. Teams from a given school do not have to be composed of the same team members for each competition.
3. A team member should participate for only one school during a specific C4 year.

Entering Competitions Into the Program: The best description of an event will come from the developers of the competition itself, they are the ones who put it together, best know the goals and objectives, and best understand what the competition involves. Because of this, the preference is to have the individual competitions communicate with the C4 program to establish the correct multipliers and base score for the competition. The C4 program will contact competitions it is aware of and will attempt to obtain information from the competition organizers to establish the appropriate values. If a response is not received, or if the C4 program is unaware of a specific competition, a school that has participated in a competition can request that it be included in the C4 program. When this happens, the C4 program will attempt to communicate with the competition organizers. Until a response is received, the C4 program will attempt to determine the multipliers but will include a 0.5 overall multiplier penalty. This means the value of that competition will be less than what it could be. The school participating in that competition can also submit information on the competition, but again a penalty multiplier will be assigned (0.7) that will be less than what could be assigned if the competition organizers provided validated information. The purpose of this is to encourage the organizers to submit the information and ensure an accurate accounting of the competition event(s).

One requirement for competitions to participate in the C4 is that competition organizers can determine which teams consist solely of individuals from a single college or university. Since the Cybersecurity Championship Cup – Collegiate is a college-level competition, it is important that for purposes of this championship, teams considered consist solely of college students. Competitions that have mixed teams can still be included in the championship calculation but it will be subject to certain restrictions, specifically:

- Base score will be a percentage based on the percentage of college students from a specific school on the team. Since it is extremely hard to determine the contributions of specific individuals in the competition to any degree, the base score is not strictly the percentage of college students on the team but is based on this number. This addresses the issue of having a “ringer” participate with a team providing an inordinate amount of assistance. Thus, the equation to calculate the base score will be as follows:

$$\text{Base score} = \text{initial base score} * 0.90 * \frac{\text{number of college students on the team}}{\text{total number of team members}}$$

Counting Competitions for a School: The rules in this section address the issue of quantity over quality. Schools will be limited in the number of competitions that will count for them in any one school year. This will encourage better performance and will also not penalize smaller schools competing against schools with a large student body who could field many more teams. Schools will be limited to 12 competitions that will count for determination of the winning C4 team. In the event a school has participated in more than 12 competitions during a given competition season, the highest scoring 12 competitions will be used to determine the team’s overall score. The competition season will be considered to take place from 1 June of a year through 31 May of the following year. The reason for this is to take into account graduation for most schools which generally occur before June. This will allow team members a full last year to be part of their schools competition program.

The Base Score: The base score is based on the size of the competition in terms of the number of schools fielding a team. The base score is determined by first establishing the range score and then adding a possible modifier. The base or range score is established as follows:

<= 5 schools: The base score is 3.5 + (number of schools)

6-10 schools: the range score is 10

11-25 schools: the range score is 20

26-50 schools: the range score is 30

51-100 schools: the range score is 40

101-250 schools: the range score is 50

251-1000 schools: the range score is 60

>1000 schools: the base score is 70

To the range score is added a modifier based on where in the range the actual number of teams falls. What we want to do is to provide a gradual increase in the base score so that there are no abrupt changes. For example we don’t want a competition with 49 teams to have a base score of 30 and a competition with 52 teams to have a score of 40, the difference between the number of teams in these

two competitions is so small it does not justify a 10 point difference in the base score. Consequently, we modify the range score by adding a value equal to the following:

$$10 \times \frac{\text{the number of teams above the low value in the range}}{\text{(the number of teams in the range)}}$$

Thus, a competition with 160 teams would receive a range score of 50 points to which $(10 \times 60/150) = 4$ is added for a base score of 54.

Competitions With More Than Just Collegiate Teams: In cases where a competition has more than just collegiate teams participating, the score can be calculated in one of two ways with the higher value being used for the calculation of the championship cup score. If the number of collegiate teams in the competition is known then the school can use this number along with its finishing place among the collegiate schools only. Alternatively, the total number of schools ABOVE THE HIGH SCHOOL LEVEL can be used along with the school's finishing place among these teams. This will reward collegiate teams that place highly in competitions that include teams with security professionals participating. If the competition cannot determine the number of teams above a high school level and it is known that high school (or below) teams are participating, the best guess as to the number of high school teams participating will be made and this number subtracted from the figure for the number of teams participating.

The Multipliers: As is seen in the algorithm discussed later in this paper, there are a number of multipliers that are applied to the base score in order to obtain the total points for the competition. These multipliers are used to adjust the base score in order to reflect things such as the difficulty of the competition. A competition that has 10 local teams competing at a beginner level should not result in the same number of points as an international competition of 10 teams at an expert level. The modifiers used are as follows:

Team Size: the multiplier is assigned based on the number of individuals on a team. This rewards competitions that encourage team work. For non-team competitions in which a school has more than one person participate, the 1* multiplier of 0.6 will be used. The multipliers are as follows:

<u>Team size</u>	<u>Multiplier</u>
1	0.5
1*	0.6
2 – 5	0.75
6 – 7	1.0

Geographic scope/scale: this multiplier is used to encourage competitions that include teams from a larger geographic area. The multiplier is determined as follows:

- Local : 0.8 - The competition consists of teams from a small geographic area such as a single institution, city, county or state.
- Regional: 1.0 – The competition consists of teams from three or more states.

National: 1.3 – The competition has a national scope.

International: 1.5 – The competition has an international scope.

Finishing Place: this multiplier is used to reward teams that do well in a competition. The multiplier is determined as follows:

<u>Place</u>	<u>Multiplier</u>
1	2.0
2	1.7
3	1.5
4	1.3
5	1.2
6 – 10	1.1
11 – 25	1.0
26 – 50	0.9
51 – 100	0.8
100 – 250	0.7
250+	0.6

Tiered competitions: If a competition involves different tiers (state, regional, national), the school only may count one of the competitions in the calculation of their C4 score. In order to reward their performance, the highest level they participated in will be used for calculations and the multiplier used to reward their attaining a higher level of the competition. This acknowledges the fact they had to compete multiple times. See also the rules on Tournaments. The multiplier is determined as follows:

1 Level (tier) only:	1.0	1 Round:	1	6 Rounds	1.5
2 tiers:	1.2	2 Rounds:	1.1	7 Rounds	1.6
3 tiers:	1.5	3 Rounds:	1.2	8 Rounds	1.7
4 tiers:	1.6	4 Rounds:	1.3	9 Rounds	1.8
5+ tiers:	1.7	5 Rounds:	1.4	10 Rounds	1.9

Format: this multiplier is used to differentiate between head-to-head competitions and competitions in which the teams compete at their own time and choosing and are not competing at the same time as other competitors. This multiplier is used to recognize the added stress that accompanies competitions in which the other teams are also present. The multiplier is determined as follows:

Head to Head competition: 1.2

Indirect competition: 1.0

Nature: this multiplier is used to reward those competitions that require the competitors to actually accomplish a hands-on task as opposed to simply answering questions on a test. The multiplier is determined as follows:

Hands-on competition: 1.5

Academic/quiz: 1.0

Breadth: this multiplier is used to recognize that various competitions test more skills than others. We want to recognize those competitions for which the competitors need a greater breadth of knowledge or have a larger number of skills. The specific list of skills will be covered in a separate document, but the equation to be used is as follows:

$$1 + \frac{\text{the number of skills in the competition}-1}{\text{the total number of possible skills in the list}-1}$$

Depth: this multiplier is used to reward those competitions in which the level of understanding required is greater (deeper). The determination is subjective and how this will be calculated will be covered in a separate document. The multiplier will be determined as follows:

Master: 1.5

Expert: 1.3

Journeyman: 1.0

Beginner/Entry: 0.7

Individual Versus Team Competitions and Multiple Teams: The C4 program recognizes that team competitions are not the only type of cybersecurity competition. There exist competitions in which individuals participate without being part of a team. In order for such competitions to be considered as part of the C4 program, each will be treated as a team event with all individuals at a university who participate being part of the team but with the team size 1* multiplier of 0.6 being used if more than one individual from the school participates. The place of the highest individual performer will be used as the place calculated for the team/school. The number of schools that had an individual participate in the competition will be used in the calculation of the base score. In order to reward schools that have more than one individual participate in an individually-based competition, a bonus will be added to the multiplier. Competitions that allow for small teams also receive a smaller multiplier than competitions that allow for the fielding of larger teams. No difference in the multiplier will be made for schools that do not fill a team. For example, if a competition allows for teams of 6 individuals but a school fields a team with only 4 individuals, the multiplier used will be that for a team size of 6. For competitions that allow multiple teams from the same school, only the top team's performance will be used in the determination of the schools C4 score.

Mixed Teams:

The Algorithm and Calculating a Schools Score: Once a competition has been evaluated for its appropriate multipliers, then the algorithm used and the process to determine the schools C4 score is fairly straightforward. The scores for all of the competitions the school participated in shall be individually calculated as follows:

$$\text{Score} = \text{Base Score} \times \text{TM} \times \text{SM} \times \text{PM} \times \text{LM} \times \text{FM} \times \text{NM} \times \text{BM} \times \text{DM}$$

Where:

- TM is the Team Multiplier
- SM is the Scope/Scale Multiplier
- PM is the Place Multiplier
- LM is the Level (tier) Multiplier
- FM is the Format Multiplier
- NM is the Nature Multiplier
- BM is the Breadth Multiplier
- DM is the Depth Multiplier

League and Tournament Play: Two other issues need to be considered and addressed. The first is the participation of a school in a competition league in which there are a number of competitions against a few other schools (or even just a single other school). While participation in a league is certainly encouraged, we believe no additional multiplier should be applied to these contests but instead they should each be treated as small, individual competitions. Where leagues will assist a school in excelling in the championship cup competition is when at the end of a season an elimination tournament is held (something akin to the NCAA basketball tournament). Even though competitions in a tournament may be individually based (i.e. head-to-head with only one other competitor at a time) for purposes of scoring the tournament, it will be counted as a single competition consisting of the total number of teams that entered the tournament. The number of tiers used for calculation of the C4 score will depend on the number of rounds that the team participated in and is calculated as follows:

$$\text{Tier Multiplier} = 1 + (\text{number of rounds} - 1) * 0.1$$

Thus, for a league tournament consisting of 64 teams competing in 2-team head-to-head elimination contests, the two teams who make it to the final competition will have participated in 6 rounds and for them the Tier Multiplier will be 1.5. For those that were eliminated in the 3rd round, the Tier Multiplier will be 1.2. This method will recognize the fact that they had to compete multiple times in order to get to the level that they did and will reward them accordingly.

Settling of Ties: In the event that two or more schools are tied after calculating their overall scores, a tiebreaker will be used to determine the final standings. The tiebreaker is based on the performance of the school's teams. The winner will be determined by making the following comparisons until one school comes out on top:

- 1) The number of first place finishes in competitions for
 - a. International competitions
 - b. National competitions
 - c. Regional competitions
 - d. Local competitions
- 2) The number of second place finishes in competitions for
 - a. International competitions
 - b. National competitions

- c. Regional competitions
 - d. Local competitions
- 3) Similar comparisons will be made for 3rd through 10th place finishes.
- 4) The number of competitions each school participated in that were:
 - a. International
 - b. National
 - c. Regional
 - d. Local
- 5) The total number of students that participated in a competition at the school

If after going through all of these comparisons teams are still tied, then they will be considered tied and no further tiebreaker will be considered.