APPENDIX

To calculate the probability of violating conditions a and b, we set the following parameters. h_c: proportion of honest nodes in the committee; ε: committee size; R: total number of reputation units in the node-set; B: the proportion of votes required to reach consensus.

In committee elections, the probability of a sub-node being selected is p = $\frac{\varepsilon}{R}$. The probability of a K-sub-node being selected obeys a binomial distribution and is represented by the following equation.

$$C_R^K P^K (1-P)^{R-K} = \frac{R!}{K!(R-K)!}(\frac{\varepsilon}{R})^K(1-\frac{\varepsilon}{R})^{R-K}$$

This is equivalent to

$$\frac{R...(R-K+1)}{R^K}\frac{\varepsilon^K}{K!}(1-\frac{\varepsilon}{R})^{R-K} \tag{1}$$

To achieve the goal of SCAROP, it is assumed that the system has a large number of reputation cells (i.e., R can be arbitrarily large), so that effectively,

$$\frac{R...(R-K+1)}{R^K} = 1, \frac{\varepsilon^K}{K!} = e^{-\varepsilon}$$

Thus equation 10 can be reduced to,

$$\frac{R...(R-K+1)}{R^K}\frac{\varepsilon^K}{K!}(1-\frac{\varepsilon}{R})^{R-K} = \frac{\varepsilon^K}{K!}e^{-\varepsilon} \tag{2}$$

Condition a: #good $> B \cdot \varepsilon$. This condition is violated when the number of honest committee members is lower than $B \cdot \varepsilon$. From equation 11, the probability of having exactly K honest committee member is $\frac{(h_c\varepsilon)^K}{K!}e^{-h_c\varepsilon}$. Thus the probability of violating condition a is given by the formula:

$$F(a) = \sum_{K=0}^{B\cdot\varepsilon}\frac{(h_c\varepsilon)^K}{K!}e^{-h_c\varepsilon} \tag{3}$$

Condition b: #1/2good + #bad $\leq B \cdot \varepsilon$, which can be converted to #good + #2bad $\leq 2B\cdot\varepsilon$. As above, the probability that malicious nodes is L among the committee members is:

$$\frac{((1-h_c)\varepsilon)^L}{L!}e^{(-(1-h_c))\varepsilon}$$

The probability of good nodes being K and bad nodes being L is:

$$\frac{(h_c\varepsilon)^K}{K!}e^{-h_c\varepsilon}\frac{((1-h_c)\varepsilon)^L}{L!}e^{(-(1-h_c))\varepsilon} =$$

$$\frac{(h_c\varepsilon)^K}{K!}\frac{((1-h_c)\varepsilon)^L}{L!}e^{-h_c}$$

Therefore, the probability that condition b will be violated is given by the formula.

$$\sum_{K+2L>2B\cdot\varepsilon}^{\infty}\frac{(h_c\varepsilon)^K}{K!}\frac{((1-h_c)\varepsilon)^L}{L!}e^{-h_c} =$$

$$F(b) = \sum_{K=0}^{\infty}\sum_{K=max\{B\cdot\varepsilon-2L,0\}}^{\infty}\frac{(h_c\varepsilon)^K}{K!}\frac{((1-h_c)\varepsilon)^L}{L!}e^{-h_c} \tag{4}$$