test1

APPENDIX A

The intermediate parameters in (**??**), (**??**), (**??**), (**??**) and (**??**) are given by:

$$\theta_1 = \arccos(\frac{d^2+r^2-r_i^2}{2dr}), \theta_2 = \arccos(\frac{r^2+r_i^2-d^2}{2rR_I}),$$

$$\theta_3 = \arccos(\frac{d}{2r_i}), \theta_4 = \arccos(\frac{r^2+{r_i}^2-r_{cs}^2}{2rr_i}),$$

$$\theta_5 = \arccos(\frac{2{r_i}^2-d^2}{2{r_i}^2}), \theta_6 = \arccos(\frac{r}{2r_i}),$$

$$\varphi_1 = \arccos(\frac{\delta_2^2+d^2-r_i^2}{2\delta_2 d}), \varphi_2 = \arccos(\frac{\delta_2^2+\delta_3^2-d^2}{2\delta_2\delta_3}),$$

$$\varphi_3 = \arccos(\frac{\delta_3^2+d^2-r_i^2}{2\delta_3 d}),$$

$$\delta_1 = \sqrt{r_{cs}^2-\frac{d^2}{4}}-\sqrt{{r_i}^2-\frac{d^2}{4}},$$

$$\delta_2 = \sqrt{r^2+r_i^2+2rr_i\cos(\theta-\theta_3)},$$

$$\delta_3 = \sqrt{r^2+r_i^2-2rr_i\cos(\theta+\theta_3)}.$$

APPENDIX B

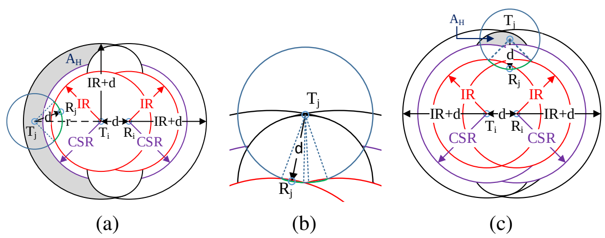

Fig. 1: (a) Geometry of V_{HN1}, (b) the small overlap HN region, and (c) geometry of V_{HN2}.

The calculation of V_{HN} can be divided into two situations, which are corresponding to the expressions (**??**) and (**??**), respectively.

Situation 1: In Fig. 1 (a), T_j is randomly distributed in the left-hand side HN region. If T_j is a hidden node, R_j will be located within the interference range of T_i. According to the symmetry principle, we can easily find that the right-hand side HN region is the same as the left-hand side HN region. But there is a small overlap HN region as shown in Fig. 1 (b).

The small overlap HN region requires special consideration, because R_j could not only fall in the interference region of T_i, but also the interference region of R_i. Since the location that R_j is within the bicircle interference region is discontinuous, we only consider R_j is located within the interference region of T_i in the left-hand side and similarly assume R_j is located within the interference region of R_i in the right-hand side.

Situation 2: In Fig. 1 (c), T_j is randomly located in the upper side HN region. If T_j is a hidden node, R_j is interfered by both T_i and R_i, and the location where R_j may be within the bicircle interference region is continuous. According to symmetry, the lower side HN region is similar to the upper side HN region.

APPENDIX C

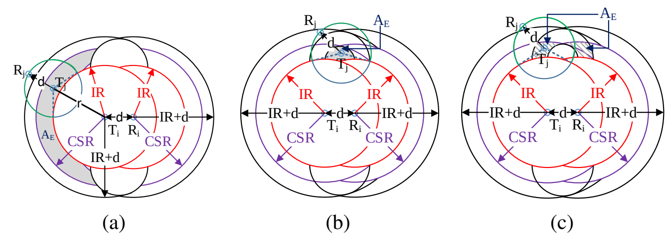

Fig. 2: (a) Geometry of V_{EN1}, (b) geometry of V_{EN2}, and (c) geometry V_{EN3}.

The calculation of V_{EN} can be divided into three situations, which are corresponding to the expressions (**??**), (**??**) and (**??**), respectively.

Situation 1: In Fig. 2 (a), T_j is located in the left-hand side EN region where T_j may be an exposed node if R_j is outside the bicircle interference region. Symmetrically, the right-hand side EN region the same as the left-hand side EN region.

Situation 2: In Fig. 2 (b), T_j is inside the circle with the upper intersection of the two interference circles as the center and δ_3 as the radius. Symmetrically, there is a region at the bottom that is the same as V_{EN2}.

Situation 3: In Fig. 2 (c), There is a discontinuous symmetric region that the EN problem may exist. In this case, we can only calculate the half part because the other half can be obtained by symmetry. Besides, the corresponding lower region is similar to V_{EN3}.