Analysis of Access and Connectivity Probabilities in Vehicular Relay Networks

Seh Chun Ng, et al., "Analysis of Access and Connectivity Probabilities in Vehicular Relay Networks", IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, VOL. 29, NO. 1, JANUARY 2011.

Summary of contributions

- **In this paper, an analytical model with a generic radio channel model is proposed.**

- **access probability and connectivity probability are derived.**

- **Access probability: the probability that an arbitrary vehicle can access its nearby BSs within two hops.**
- **connectivity probability, i.e. the probability all vehicles can access at least one BS within two hops.**

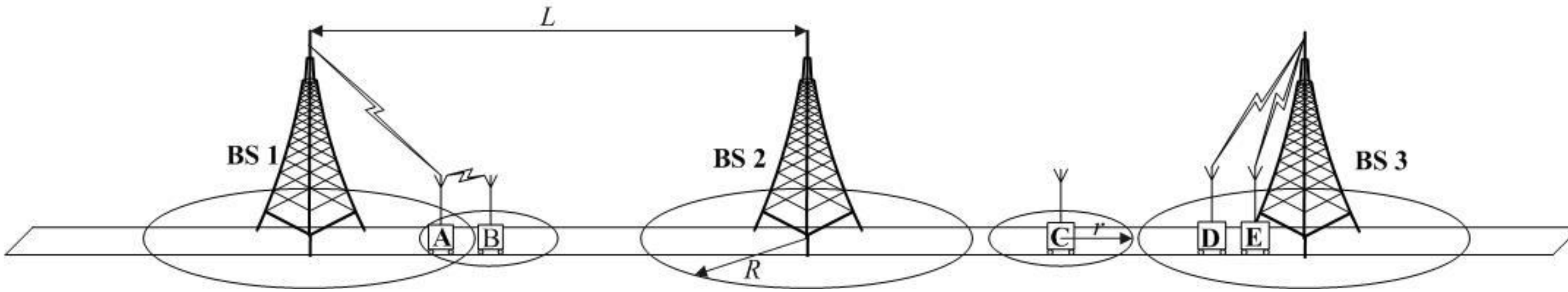
- **Both one-hop (direct access) and two-hop (via a relay) communications between a vehicle and the infrastructure are considered.**

- **Reveal the trade-offs between key system parameters, such as inter-BS distance, vehicle density, transmission ranges of a RSU and a vehicle, and their collective impact on access probability and connectivity probability.**

- **Two different communication channel models are specifically analyzed:**

1. **Unit disc model**
2. **Log-normal shadowing model**

System Model



An Infrastructure-based Vehicular Relay Network.

- BSs are uniformly deployed along a long road.
- Vehicles are distributed on the road randomly according to a Poisson distribution.
- investigate a sub-network bounded by two adjacent base stations with inter0distacnce "*L*" *meters.*

Performance Analysis

probability that the vehicle is directly connected to either BS1 or BS2.

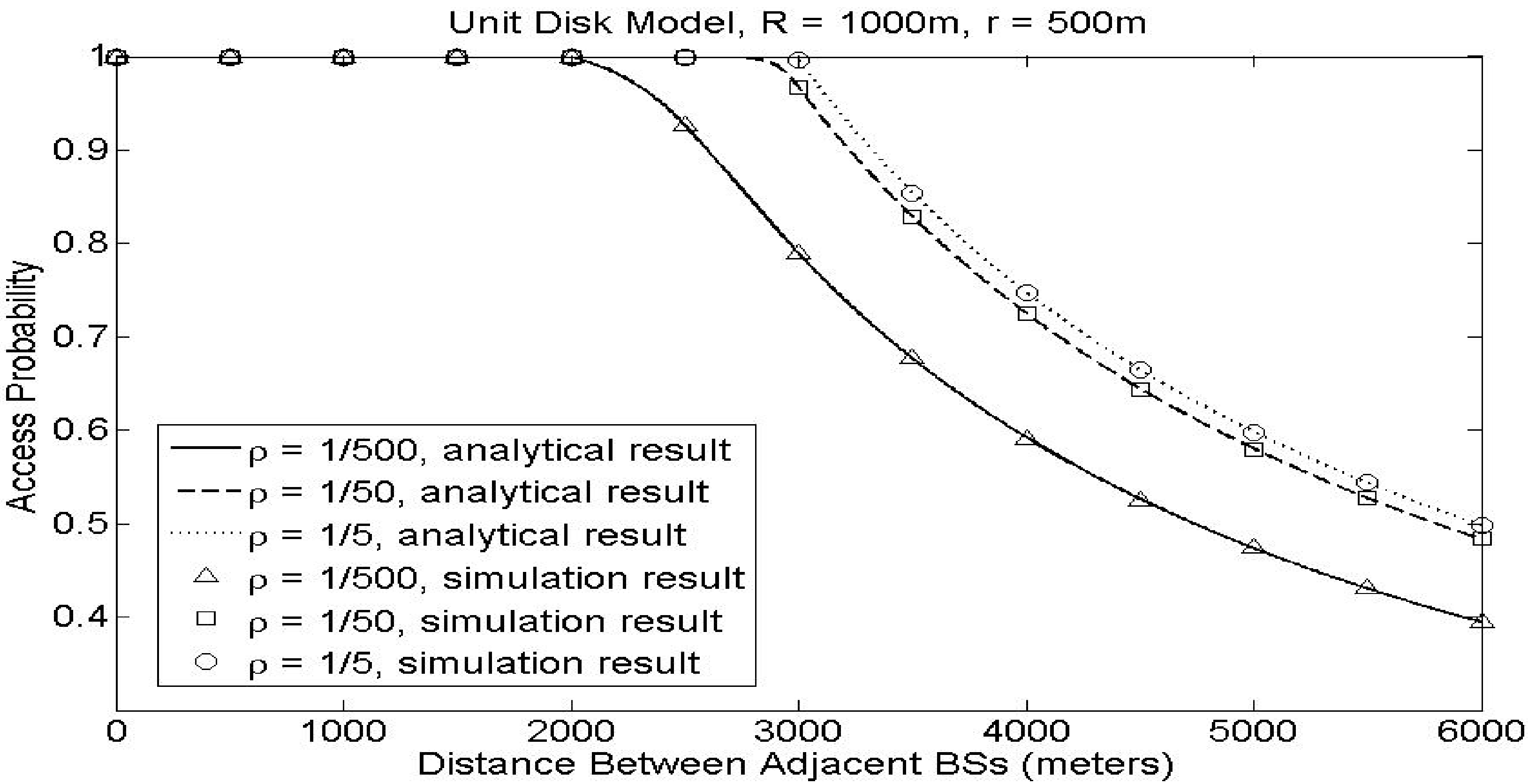
$$p_1(x) = 1 - (1 - g_b^{\mathcal{C}}(x))(1 - g_b^{\mathcal{C}}(L - x)).$$

Let p2(x) be the probability that a vehicle located at x (distance to BS1) is directly Connected to at least one vehicle in this subnet between BS1 and BS2.

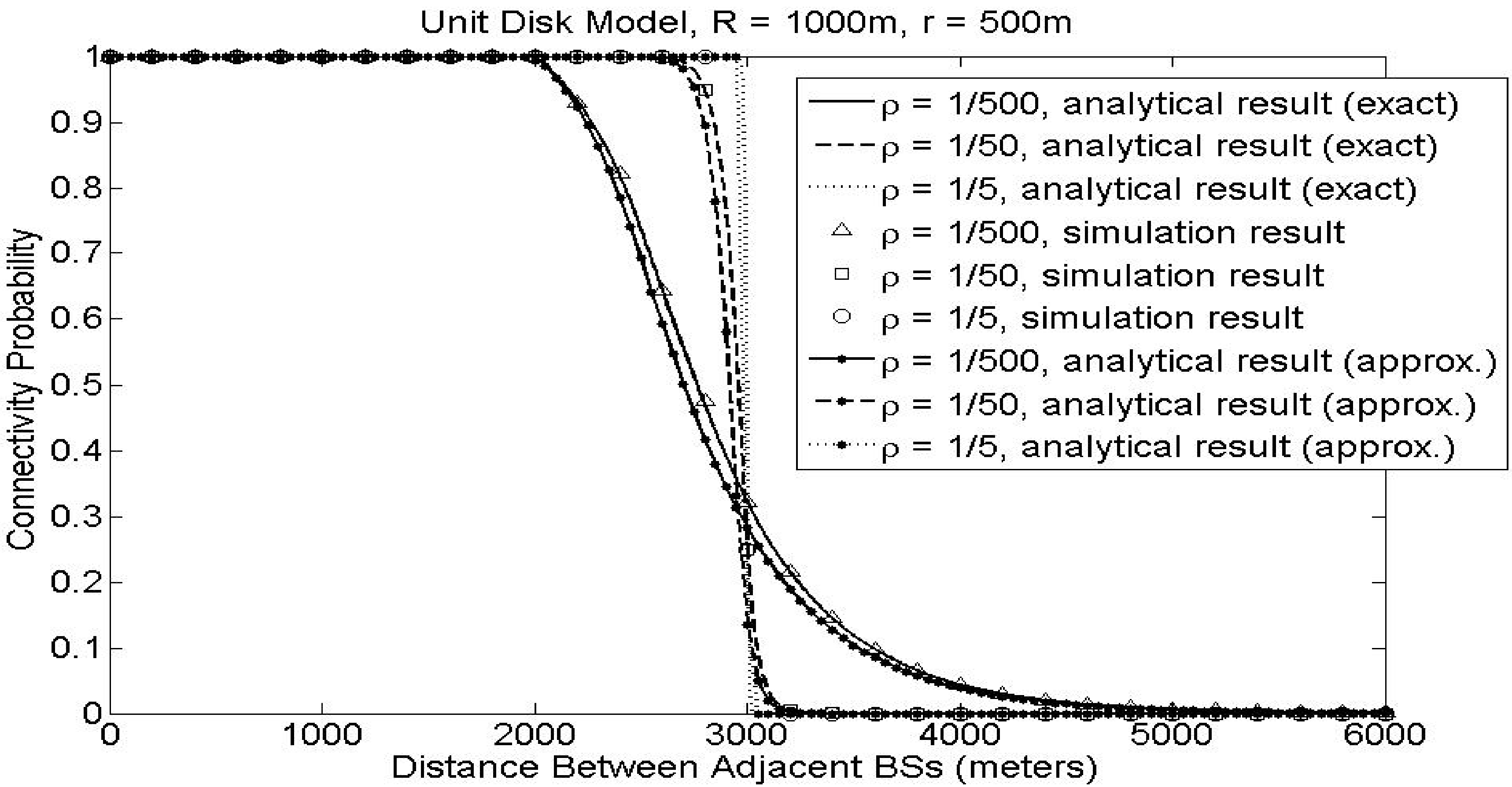
$$p_2(x) = 1 - e^{-\int_0^L g_v^{\mathcal{C}}(||x-y||)\rho p_1(y)dy}$$

Denote by pa(x) the access probability of vehicle at x, i.e. the probability that the vehicle at x is connected to either BS1 or BS2 in at most two hops.

$$p_a(x) = 1 - (1 - p_1(x))(1 - p_2(x))$$



Access probability with L changing under the unit disk model, R = 1000m, r = 500m, ρ = 1/5, 1/50, 1/500 vehicles/m respectively.



Connectivity probability with L changing under the unit disk model, R = 1000m, r = 500m, ρ = 1/5, 1/50, 1/500 vehicles/m respectively.