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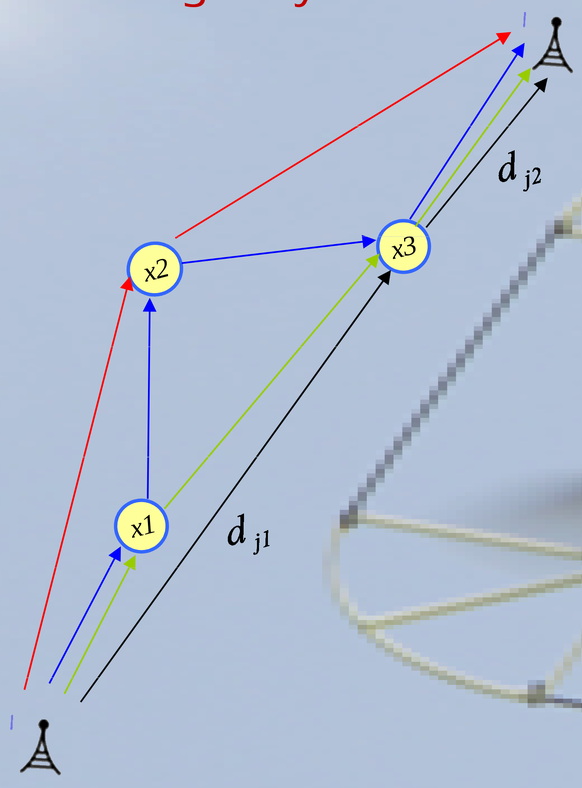
Self-organized Positioning of Mobile Relays

Helicopter Drones

Wireless communication is an important means for coordination rescue and saving operations. Helicopter drones could easily be used as mobile relay stations, to provide a wireless link over long distances. Choosing a self-organizing approach for positioning of the drones shows the following advantages:

- no knowledge about the landscape is needed
- drones can be dynamically removed and added
- dynamically appearing/disappearing obstacles are automatically considered

Routes along relay drones



Self-organization based on Flows

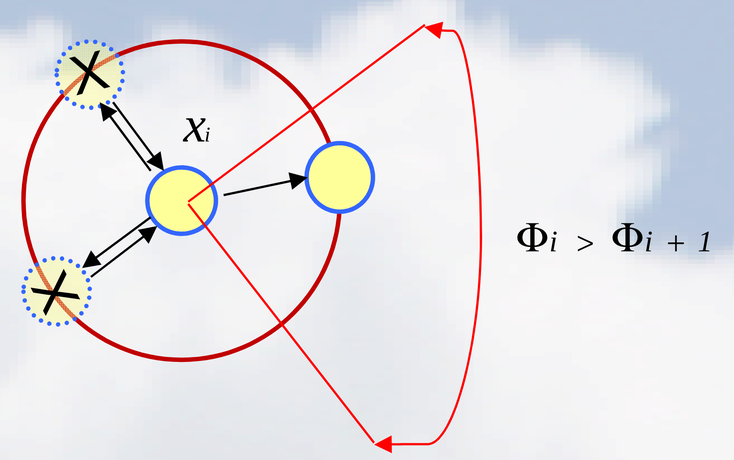
The ground stations are connected by multi-hop communication over drone-relays. For each possible route a "flow" value ϕ is calculated. Each drone participates in in several routes and inherits the maximum flow from each route.

Phi value or "Flow" for a Route *j*

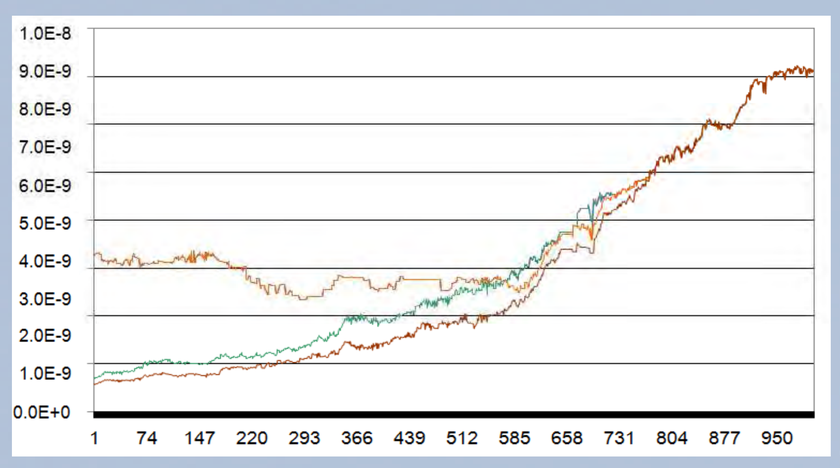
$$\Phi r_j = \frac{1}{\left(\sum_{k=1}^{n_j} d_{jk}^{\ \alpha}\right) + h_j * c}$$

Movements Controlled by Evolution Strategy

Each drone decides autonomously on its movements in terms of direction and distance. After a move, a (1+1) evolution strategy (ES), which uses the ϕ value as fitness function, is applied to the actual and previous position. Finally the ES ensures, that the relay drone moves to a direction with increasing phi value. The distance for a move is adopted over time, according to the change rate of the phi value of the drone.



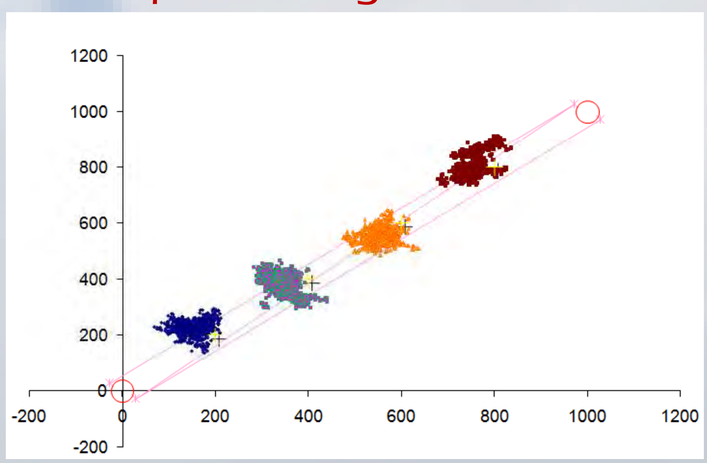
Phi value – trend for four drones



Simulation & Results

The simulation implements Rayleigh block fading based on the physical properties of a standard WLAN router model. Simulations have been conducted from one to four drones. The "flow" as depicted by the phi value increases consistently because the evolution strategy selects positions with a better phi value. The systems shows stability if initially a route can be established.

drone positioning after ~1500 steps



All drones reach a region where the position of a drone is near the theoretical optimum. As there are always routes with a suboptimal ϕ value, the position of the drones will be influenced by this kind of "noise". The relay drones therefore do not get pinned to a specific position, but closely oscillate around a theoretical ideal position.

Visit our project MESON (Modeling and Engineering of Self-Organizing Networks) at http://www.demesos.tk