Impact of Mobility Prediction on the Temporal Stability of MANET Clustering Algorithms

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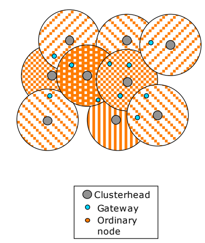
Abstract

- Scalability issues for routing in mobile ad hoc networks (MANETs) have been typically addressed using hybrid routing schemes operating in a hierarchical network architecture.
- Several clustering schemes have been proposed to dynamically identify and maintain hierarchy in MANETs.
- We study the impact of mobility prediction schemes on the temporal stability of the clusters obtained using a mobility-aware clustering framework.
- We investigate the performance of the prediction schemes with respect to Gauss-Markov, Random Waypoint, and Reference Point Group mobility models under varying network and mobility conditions.

A Predictive Clustering Framework

We propose a distributed location-aware clustering framework that dynamically identifies persistent clusters in the network consisting of nodes that exhibit temporal similarity in their mobility pattern. The resultant topology of the network is then defined in terms of a *Clusterhead* and *Ordinary* nodes

- Every cluster has an admission criteria associated with it
- A mobile node is allowed to join the cluster only if it satisfies the cluster admission criteria
- The clusterhead uses a mobility prediction scheme to check if a node satisfies the admission criteria



Mobility Prediction Schemes

Link Expiration Time (LET)

- Determines the duration of a wireless link between two mobile nodes by assuming that their speed and direction of movement remains constant.

	Node i	Node j
Velocity	v_i	v_j
Bearing	θ_i	θ_j

- The LET, D_t, is given by

$$D_t = \frac{-(ab+cd)+\sqrt{(a^2+c^2)r^2-(ad-bc)^2}}{a^2+c^2}$$

where,

$$a = v_i\cos\theta_i - v_j\cos\theta_j,\ b = x_i - x_j$$
$$c = v_i\sin\theta_i - v_j\sin\theta_j,\ d = y_i - y_j$$

First Order Linear Autoregressive Models

- The linear first order autoregressive (AR-1) model has been shown to effectively track the movement of a mobile node irrespective of the underlying mobility model.
- The state of the mobile node is defined by the column vector

$$s_n = [x_n, \dot{x}_n, y_n, \dot{y}_n, \ddot{x}_n, \ddot{y}_n]$$

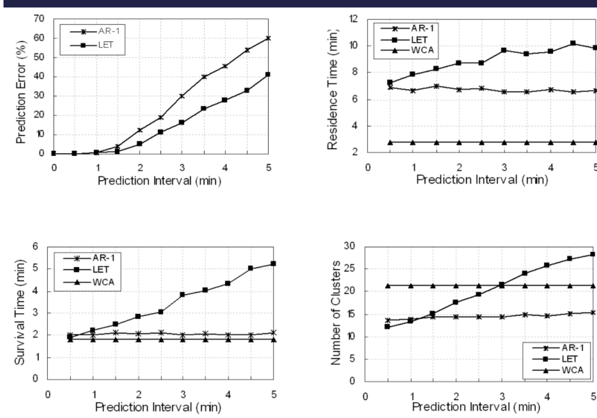
which captures the node's position, velocity and acceleration
- The AR-1 model for the mobility state s_n of a node is given by

$$s_{n+1} = As_n + w_n$$

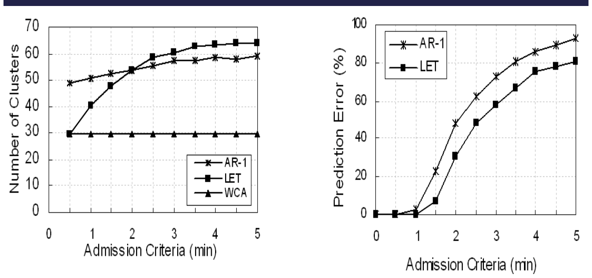
- The mobility state at time *n+m* in future is predicted using the equation

$$s_{n+m} = A^m s_n$$

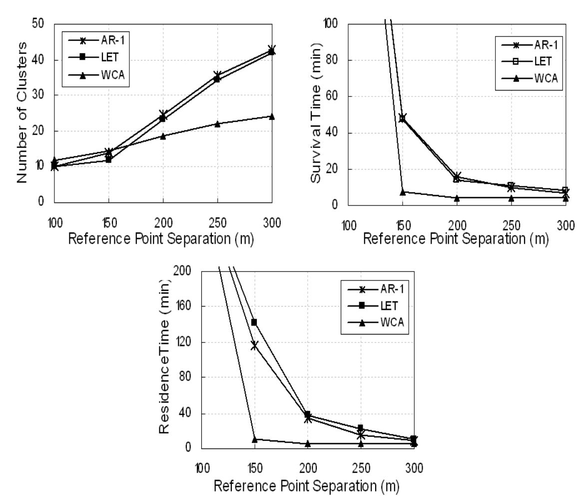
Results with Gauss Markov Mobility Model



Results with Random Mobility Model



Results with RPGM Mobility Model



Conclusions

- A predictive clustering scheme significantly improves the temporal stability of the clusters in the absence of total random motion
- A predictive clustering scheme is able to adapt to varying network conditions by dynamically adjusting the cluster size in order to guarantee temporal stability.
- An accurate mobility tracking algorithm need not always lead to an accurate mobility prediction scheme