Community Network in Competition with ISPs

Patrick Maillé
Institut Mines-Télécom / Télécom Bretagne
2, rue de la Châtaigneraie, 35576 Cesson Sévigné Cedex, France,
patrick.maille@telecom-bretagne.eu

Bruno Tuffin
Inria Rennes Bretagne Atlantique
Campus Universitaire de Beaulieu, 35042 Rennes Cedex, France
bruno.tuffin@inria.fr

October 5, 2016

Abstract

XXXXXXX

1 Introduction

XXXXX Intro community networks

XXXXXX Models: cf Marbach and Hubaux

XXXX Our contribution instead: investigate the impact mobility and user density on community networks, with the competitive presence of an ISP.

2 Model

Consider a continuum of users characterized by their type u. This type typically defines a home location. There is a density $f(u)$ in terms of parameter u running over space Ω.

We consider two ways for users to access the Internet: through a regular ISP, assumed to fully cover space, or through a community network. Let $D \subset \Omega$ be the set (domain) of users subscribing to the community network.

Each user u has an average number of communication requests $m(u)$. Define $g(v|u)$ as the density that a given request from $u$is happening when at v.It models the mobility behavior of user u. Then the number (density) of requests at u from the community network is

$$n(u) = \int_D g(u|v)m(v)f(v)dv.$$

A user u chooses to subscribe to the ISP or the community network depending on the subscription price and a notion of quality which we define as the proportion of (or probability that) requests will be fulfilled. If made through the ISP, this probability is 1. If made through the community network, it is

$$q_u = \int_D g(v|u) f(v) dv.$$

Let a be a parameter representing the sensitivity to quality. and p_I (respectively p_C) the subscription price to the ISP (respectively the community network).

The utilities of u for using the community network, the ISP, or none of them are respectively

$$\begin{aligned} U_C(u) &= a q_u - p_C - cn(u) \\ U_I(u) &= a - p_I \\ U_\emptyset(u) &= 0 \end{aligned}$$

where $cn(u)$ models the disturbance from requests of others u has to serve, c corresponding to a unit cost.

User u's choice is the one with the maximal utility.

3 Game definition

We thus end up with a multilevel game where:

1. The ISP and community network play on the subscription prices, in order to maximize revenues (expressed as the product of price and mass of users).
2. Given the allocated qualities, users choose their network.

The game is played by backward induction, meaning that even if ISPs play first, they will make their decision strategically, by anticipating what will be the subsequent decision of users.

4 First case study

We first consider the simplest situation where the mobility pattern is the same for all users:

$$g(v|u) = g(v).$$

In that case, q_u does not depend on u:

$$q_u = \int_D g(v) f(v) dv$$

and $n(u) = \in_D g(u) m(v) f(v) dv = g(u) \int_D m(v) f(v) dv$.

XXXX TBC

5 Second case study

We consider a domain made of two cities separated by the country side, and the same behavior of all users in an area. Formally, $\Omega = \Omega_{c_1} \cup \Omega_{c_2} \cup \Omega_s$ where Ω_{c_k} is for the population of City k and Ω_s for the population of the countryside.

For $k \in \{c_1, c_2, s\}$ and $u \in \Omega_k$, let $g_k(v|u)$ be the mobility behavior of u.

XXXXXX TBC