Université Pierre et Marie Curie
Module: Smart Mobility Systems

General project assignment

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Students, either individually or in pairs, must carefully read this text, design and implement the specified protocol, and produce the relative documentation.

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Scenario

Over the past few years, we have witnessed the widespread diffusion of smartphones, tablets, and other mobile devices with diverse networking and multimedia capabilities. Major operators in the US and Europe are experiencing severe problems in coping with the mobile data traffic generated by their users. The main reason is that the trend of traffic demand is exponentially increasing, while physical layer improvements are limited.
To boost network capacity further, mobile network operators must adopt alternative solutions to alleviate the burden on their infrastructure. An approach that has been receiving increasing attention from both the research community and operators themselves is *traffic offloading*, which can be achieved by a variety of accessory means.
One of these methods consists in letting users cooperate with the wireless infrastructure and with each other by leveraging short-range opportunistic communications between neighboring terminals, in order to facilitate content dissemination while reducing the load on the network infrastructure of the cellular and Wi-Fi operators.

Assignment

Design and implement a distributed network protocol aimed at exchanging files among an arbitrary number of mobile nodes. The nodes can use TCP or UDP or a combination of both as the transport protocol, as well as a custom IP-based or Ethernet-based protocol specifically designed for this scenario.

CONTENTS. Files of any type and size. At the beginning of the simulation, the files are randomly distributed among the nodes. No single node possesses all the files. Nodes have

information only about the file they possess only, and they are unaware of the popularity of a file.

NODES. Act as the users in the scenario. Each node moves around the map according to a mobility pattern hidden from the student. All nodes start moving at the beginning of the simulation and they remain in the map until the simulation ends.
Each node is equipped with a WiFi network interface in ad-hoc mode, whose settings are given to the student. When the simulation begins, nodes can start exchanging information via the WiFi network interface (e.g. files or chunks of files, or "accessory" data such as node position, files already downloaded, and so on).
The peer-to-peer protocol used between nodes can be anything, even non IP-based. Being nodes mobile in the described scenario, it must be foreseen that link among two nodes is limited in time and may experience packet losses.
Nodes can be assumed to have enough storage space to store all the files existing in the simulation scenario.

Code provided to the students

Students will be given a C++ header file, named "`sms-helpers.h`", that provides the following free functions in the global namespace:

- *getNumberOfMobileNodes*: returns the number of mobile nodes running in the simulation
- *getSimulationDuration*: returns the duration of the simulation in seconds
- *installMobility*: installs the mobility component on all the nodes in a NodeContainer
- *installWifi*: installs a WiFiNetDevice on each node in a NodeContainer, and takes care of configuring the WiFi parameters for the simulation
- *getInitialFileList*: returns the list of files that are available in a mobile node at the beginning of the simulation

(See the provided code for more information)

These functions must be used to setup the simulation scenario. The students must keep in mind that while the signature of the provided functions will not change, their IMPLEMENTATION MAY CHANGE when the projects are evaluated; file distribution, file size, number of nodes, node mobility, and so on... will be different.

Evaluation

Each group of students must produce the complete source code and extensive documentation on the overall system architecture and behavior, and on the application-layer protocol(s) implemented.

The project will be evaluated through a test run of the submitted code.
The performance of the protocol(s) will be empirically evaluated according to the following criteria:

1. Maximize the number of fully downloaded files over all the nodes;
2. Minimize the overall energy consumption of the nodes, which in this case translates into minimizing the data exchange over WiFi.

This last point regards a fundamental aspect of designing protocols for mobile devices: the battery capacity is limited, therefore one must avoid wasting energy (sending data over WiFi) when this is not needed. For instance, nodes should not broadcast everything they possess all the time, even when nobody is around or nobody needs that files.

In simulations a node may have a global view of the system (position of other nodes, files, etc...). This is an artifact of simulations which does not occur in real life. Therefore students are forbidden to exploit this artifact. A node has information about itself only. All other information, if needed, must be gathered from the other nodes and exchanged over WiFi (and thus will be accounted for the energy consumption evaluation).