technicolor

Wi-Fi Doctor Related Research Topics

1 Context

Wi-Fi Doctor is a cloud based solution that is designed to detect, diagnose and cure Wi-Fi “illnesses” that occur in the Wi-Fi home networks of end users. The solution consists of a lightweight agent in the local gateway/AccessPoint that sends monitoring data to the cloud, where the data is collected, analysed, stored, and where several views can be presented to the different users of the service, e.g. an ISPs help desk operator. The solution can also apply automated configuration updates to the gateway/AccessPoint to pro-actively optimise the overall QoE experienced by the end users while minimising the cost of re-active interventions, e.g. help desk calls.

Since Wi-Fi is a fast moving technology with a vast penetration, we must continue to evaluate, study and improve our current solution. Whereas part of this is operational work tackled by the development team, there are several longer term areas of research where we seek cooperation with external partners. These areas are described in the following list.

1 Jun 2017v1.0

2 Wi-Fi Adjacent Channel Interference Characterisation

Category

Job Student? Internship? Masters Thesis if extended

Domain

Networking, practical test work + interpretation. Data analysis if extended.

Description

Very little to no good literature exists about how Wi-Fi traffic on a certain channel is interfering with Wi-Fi traffic on an adjacent overlapping traffic. Most experimental data in literature relates to DSSS (11b!) and not to OFDM (11g, n, ac), and most models that are used for frequency planning of different Wi-Fi APs are derived from that (and are thus useless). One article exists that proves experimentally that OFDM behaves very different from DSSS, but fails to provide a decent characterisation.

The idea is to measure in a controlled environment (shielded boxes connected through programmable attenuators) how Wi-Fi traffic on adjacent channels is interfering, while varying the coupling between the interferer and the interfered link, as well as the coupling of the interfered link.

This will serve as an input to frequency planning algorithms.

The extension mentioned above is to verify the model obtained in controllable envrionment with real life data.

3 QoE predictors for on-line gaming

Category

Masters thesis or part of PhD

Domain

QoE, machine learning + experimental networking

Description

Similar to the work of Diego (Diego Neves da Hora et al., Predicting the effect of home Wi-Fi quality on Web QoE, https://hal.inria.fr/hal-01339522/document), where Web surfing QoE is predicted from Wi-Fi metrics; the goal here is to have on-line gaming QoE predicted. A test bed is available to do experiments under controlled Wi-Fi conditions. The rest (including methodology to obtain QoE) needs to be worked out. Not easy.

4 Application recognition using Wi-Fi data patterns

Category

Masters thesis (or skilled internship?)

Domain

Machine learning + experimental work

Description

The idea is to “recognise” which application is using a specific Wi-Fi link by looking at the data pattern (time series of 10s samples of datarate TX and RX over a Wi-Fi link). E.g. http video streaming can be recognised by the first buffering sequence followed by a sustained lower bitrate.

The first step is to obtained “labelled data”, where a set of users note down which application is used in a realistic Wi-Fi home network while the Wi-Fi traffic is being collected (we have the infrastructure to do so). This data is then used as a training set for machine learning.

5 Influence of Interference on Wi-Fi Channel Bandwidth

Category

Internship or job student

Domain

Wi-Fi experimental

Description

Whereas we have a clear picture how Wi-Fi and non-Wi-Fi (Near and Far End) interference is behaving for Wi-Fi links using 20MHz Channel Bandwidth, this behaviour is unclear when 40 and or 80MHz channel bandwidth is used – as is commonly done in the 5GHz band.

Machine learning is not really of use here, as this would require labelled dataset where the groundtruth is known. The idea is to build the different (Wi-Fi and non-Wi-Fi) interference scenarios in a controlled way in an otherwise interference-free environment. This as a first step to understand the behaviour and later use this to recognise specific interference scenarios from observed data – and take appropriate action to solve the issue.

6 Wi-Fi Environment Analysis

Category

Internship or Masters Thesis, PhD when extended

Domain

Data Analysis

Description

From a Field Trial (MDU1) we have a few months of data of a lot of neighbouring networks: ~200APs seeing on average ~80 other networks (of which 15% under our control), where a scanlist is available at least once per day, and the observed “channel interference” is continuously monitored. This data allows to analyse how fast the “Wi-Fi environment” is changing, and how this relates to the observed channel interference. This is an important input for us to determine how frequently we shall update the config of “our” controlled gateways in a pro-active scenario.

Extension: In this MDU we have a majority of “foreign networks”, which we don’t control, but still a relevant number of gateways are under our control. Some of these are in close proximity of each other, and could disturb each other when on the same channel. This could “break” our normal optimisation processes (which consider a completely uncontrolled environment, and where each gateway is handled seperately), whereas the typical frequency planning approach for a completely controlled environment is also not applicable. The idea here is to use the MDU1 dataset to study solutions for these mixed scenarios, taking scalability into account. This to cover the situation of an ISP that provides a significant (tens of %) portion of the Wi-Fi networks in a larger area (country..).

7 Wi-Fi Usage Independent Metrics

Category

Skilled Job Student, Internship

Domain

Data Analysis

Description

In one of our large scale field trial (involving ~6k gateways), we have prototyped our earliest pro-active solution. In that trial, we have executed several configuration changes, preceeded by a reference week, and followed by an evaluation week. The config changes are basically a change of the list of channels that ACS (Auto Channel Selection) is allowed to choose from. These config changes were based on an early version of our channel recommendation logic, and calculated based on the monitoring info from the reference week.

The idea of this topic is to use the data available from this trial to evaluate several usage independent Wi-Fi metrics for their ability to predict the QoE experienced by the end user. For the latter, we want to use our well-established “Wi-Fi Experience Index” metric which is obviously usage dependent. For channel recommendation logic, however, usage independent metrics are preferred as they allow for a better founded decision requiring less statistics.

8 Detecting Gateway replacement

Category

Internship

Domain

Data analysis

Description

Detecting the replacement of a gateway by a new one. Or the re-use of a returned gateway in a new location. Should be detectable through checking connected stations. Would be valuable to get an idea of gateway reliability. For this to be feasible, we'd really need more than a small trial population.

9 Predicting a gateways environment, based on neighboring gateways' data

Category

Internship, Masters thesis?

Domain

Data Analytics

Description

Since not a gateway not always has statistics about all channels (because ACS did not select them, or because the ACS allowed channel list blocked out some channels), we can get in situations where we are not that happy about the current channel selection, but have no idea about the alternative. If we can use the data of neighboring gateways (defined based on - older - scanlists or defined MDU's or so) to predict what the environment looks like for the gateway, we can make better decisions on whether we risk the currently ignored channels or not.

Even a ballpark estimate can be of help. And if we cannot predict performance at all, we should still be able to give an estimate of how much (or little) the environment has changed on the channel.

END OF DOCUMENT