Analytics applied to the mobile data access network.

Content.

1. Abstract.

Mobile data services are growing up spectacularly all over the world. Users have at hand more and more sophisticated devices every day, demanding progressively higher amount of data, higher speed and lower access time. Operators are forced to invest heavily to attend this demand. Achieving profitability on these investments is vital for Operator´s survival and development. For that achievement, two issues are of utmost importance: demand predictability and network performance planning. The first is roughly under operator´s control as mobile data demand is mostly driven by applications and devices capabilities. The later is – or should be – entirely under operator´s control.

This paper refers to radio access network optimization and planning, meaning a two-dimensional feature composed by network performance in terms of data capacity (the amount of data that each individual network cell allows to transport) and quality for the user (a combination of speed and delay which drivers customer experience). The rationale behind Telconomics approach to solve this issue relies on the fact that mobile data technologies are far from being deterministic in its performance. More specifically, Telconomics states this is not possible to plan in advance the radio access network performance offered to its users but it is to determine it by empirical statistical processes which, in turn, allows for elaboration of what if scenarios, so network performance can be continuously improved to match real demand and eventually to anticipate to expected or desired demand.

That´s what we call real time intelligence applied to the mobile data access network. It is the basis for achieving one of the most important targets for Operators all over the world: **"Obtain as much return as possible from investment in the network and focus it on real quality to the customer."**

2. Analytics applied to network performance.

2.1. The issue of mobile data access network performance.

Performance of a mobile data network in terms of its data communications capacity is affected by a number of factors that might or might not be under operator´s control. Among others:

- End user devices installed base. There are many types of devices, grouped in categories (up to 32), that show different and complex interaction with the network.
- Traffic demand. It changes in the long term following evolution of devices installed base. It changes in the medium and short term following services and applications availability. And it shows a variable impact on the network as the network severely degrades in quality form a given level of served traffic.
- Radio ambient. Each radio cell is deployed in a specific location and the customers use it in variable positions within the radio coverage. All these changing conditions make that the radio equipment can have different capacity depending on where it is deployed and where are the customers that use it.
- Signaling load. There are increasingly more applications generating heavy signaling traffic even for very little effective data traffic, causing pernicious effect on the network and reducing the capacity for data traffic.
- Many other bottle-neck type of factors, like radio licensees, RNC´s dimensioning, transport network dimensioning, etc.

Operators use a number of values regarding data capacity served by a given technology in a given scenario that can be used as a reference. It is usual to run specific tests that show off some results that allow to benchmark network performance, but normally under given idealized conditions, far from behave as an actual network.

Telconomics has developed a tool that allows the Operator to know the performance of a mobile data network in terms of its data communications capacity at cell level for the entire network. Running the tool requires a certain level of interaction with Operator´s OSS so a number of radio parameters are continuously collected, then mathematically processed and finally presented as a "map" of the empirical statistic performance of the mobile data network. Running the tool in "supervision" mode, allows for continuous updating of the map (as it will change with network upgrades, devices park evolution, etc.) which allows for real time detection of abnormal performances, follow up of the effects of done actions, etc. Additionally, the tool allows for projections on capacity performance based on given scenarios. At the end of the day, it will allow the Operator to align investment to real and desired network capacity. The same methodology and processes can be applied to all technologies coexisting in a real network, say from remnant 2G to newest LTE deployments at any frequency, and even for wifi spots regardless they are integrated or not in the mobile network. Therefore, it is of utmost importance for refarming analysis and planning.

This tool is called Telconomics DYMEF and is available and market proven.

2.2. The issue of mobile data end user quality.

If the real capacity offered by a mobile network is an unpredictable feature due to a number of technicalities as mentioned above, quality is an even harder issue, to start with, there is not a clear definition of it. Most operators identify quality with maximum speed of data download in their commercial offer but this is far from being perfect. A given download speed might be excellent for a given service while unacceptable for other; even the same speed may goes to a different user experience depending on the device used.

Operators usually count on probes collocated in a number of base stations and teams running "drive tests". Neither of these is really useful to determine data quality, at least form a user related perspective; static probes are fixed equipment good to detect network failures or anomalous performance and drive test are mobile engineering tools good at determine coverage, but neither of them behaves like a market device in user real operation. Therefore, Operators find difficult to understand the network behavior in terms of quality and more important, to drive actions into the network and the commercial areas based on quality.
It is no surprise that many operators are investing heavily in analyzing CRM information trying to find what users understand by quality and its relationship to network.

Telconomics has developed a tool that allows the Operator to know the performance of a mobile data network in terms of its data communications quality, as experimented by real market user devices, at specific spots/areas/paths of interest. Running the tool does not require any level of interaction with any other Operator´s tools or resources. It is done by means of a client-server architecture commanding a client specific application running on standard market devices that collect basic network parameters as well as quality specific parameters; those parameters are defined depending on the service or services to be measured, i.e., file transfer, web browsing, video and audio steaming, instant messaging, etc. The combination of those technical measured parameters define the real quality the device is

objectively being offered, much more closer to user experience than any other type of quality measuring so far. Those parameters are collected, then mathematically processed and finally presented as a "result" of the empirical statistic performance of the mobile data network. Running the tool for different families of devices (for example top features smartphones and medium features smartphones) will throw additional vision of how the different families experiment the same network in terms of quality. Running periodical iterations of the tool will show the effect in quality of actions done in the network. At the end of the day, it will allow the Operator to understand what its customers are getting from its network status and eventually align investment to real and desired network quality.

This tool is called Telconomics SONEF and is available and market proven.

2.3. Combining network and user perspectives.

As stated before, both network performance in terms of data capacity and end user quality are not deterministic functions, but probability distributions that can be empirically determined and monitored. All the same, there is not a deterministic relationship between these two sides of network behavior. It should not be a surprise, as we are talking of sharing resources technologies, where the management of those resources from the infrastructure point of view may show differences from one technology and vendor to another and the use of them is also depending on technical differences between the devices.

But for Operators it is clear from experience that as the network increases in load, the quality delivered to its users is affected. So another issue arises which is to determine how the quality of the data services experienced by the users is affected when the network is getting loaded or, from another point of view, what are the network limits before getting into un unacceptable level of quality. Clearly, the only way to establish relationships between network status and served quality is again to work statistically on measuring quality at different network status. Network performance in terms of capacity has to be established at cell level because each cell has its own universe of parameters affecting it; relationship between network performance and quality has to be done extensively within the network also or at least for a statistically representative sample of the network. It will take some time, but the prize is highly rewarding: once the relationship between network status and quality is determined, Operator may infer the quality offered to its customers just monitoring the network performance, doing some quality measures here and there to fine tune the relationship and getting it updated as the network, installed base of end user devices and demand evolve. In other words, drive tests and other means of quality testing related expenses can be saved at the same time as real time information on when a given cell would start getting quality problems is available. At the end of the day, it will allow the Operator to align investment to real and desired network performance.

Fortunately, once the tough work is done, a number of benefits can be obtained. The information collected, as well as the results obtained, can be stored for additional processing and further uses. For example, information stored will allow "post mortem" analysis of determined events; continuous mathematical analysis of data may drive to the identification of performance "patterns" which in turn could be used for fault detection, alarm generation and even preventive maintenance, real time sorting of results will drive to specific actions on the network, etc. Thus, integrating DYMEF and SONEF in a wider tool involving data repository and additional mathematical engines will allow Operator for real time management of the mobile data access network.

This tool is called Telconomics INTEF and is available and market proven.

3. One step forward.

On top of INTEF direct outputs and learning capabilities and its mathematical processes to determine network feature it will also allows for what if scenarios and projections analysis. It means INTEF is very much a live solution continuously adapting to Operator´s business and network evolution, resulting in a potent tool for investment and strategy deployment.

3.1. Projections.

INTEF provide a statistical characterization of the relationship between network status and end user objective quality of services that can be as detailed as needed in terms of technologies, devices types and services profiles. From this basis, its mathematical engine may be used for what if scenarios analysis, therefore to study what will be the impact on quality for a given park of customers following a given network evolution or, on the other way round, what should be the network evolution to match a given expected customer demand without eroding quality, or any other feasible combination of inputs.

3.2. Customer experience.

Customer experience is normally tracked by Operators through its CRM departments collecting information, both customer generated when the customer calls to the CRM with question or complain, and through surveys addressed to a given portion of the market. In any case, customer experience is quite on the subjective side though it may have an influence form objective quality as stated by INTEF. The mathematical engines of INTEF allows for correlation between objective quality and customer experience, therefore identifying to which extent network status affects quality of experience as declared by customers.

3.3. Integration.

INTEF has been conceived and developed to be core of a very specific propose: understanding network performance and its relationship to quality of services. The heart of it is expertise analytics but it is aimed to be as flexible as possible in real operations. Therefore, it is open to integration to and from other sources of information or platforms that the operator may have in use, among the most usual big data and visualization engines.

4. Conclusion.

Telconomics has developed a number of tools and processes aimed to take the most out of the Operator´s network. INTEF is an integrated set of tools combining extensive knowledge of mobile access technologies, mathematical engines and data management techniques, providing an empirical and statistical knowledge of network performance which, in turn, allows the Operator manage its network following its real performance and its strategic alignments.

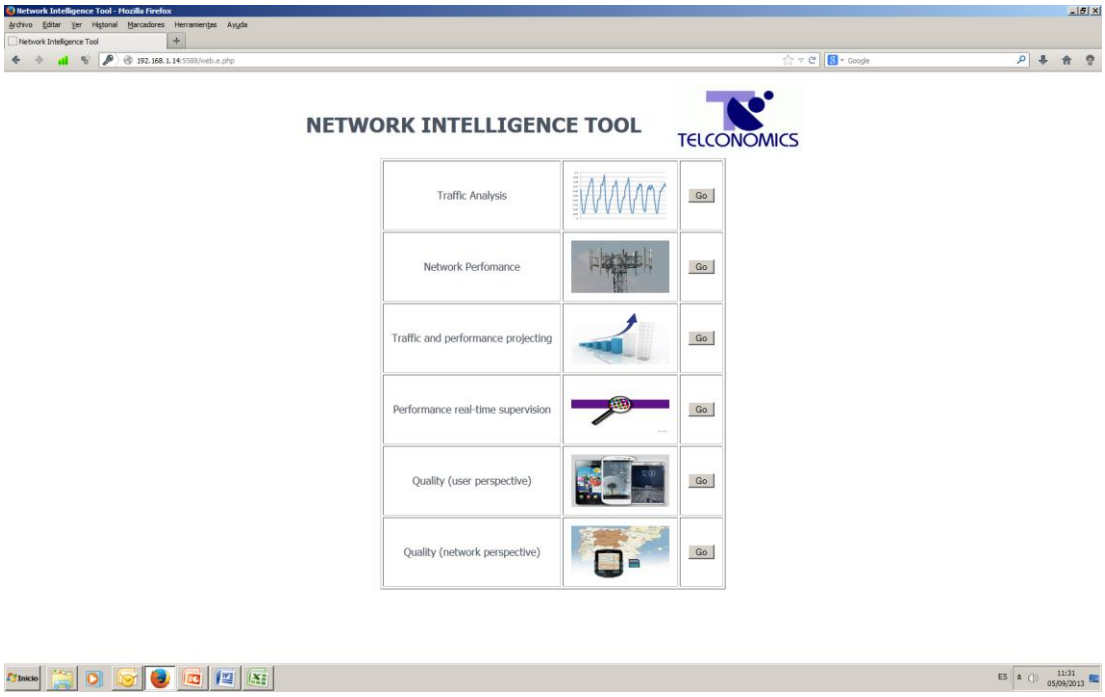
Thus, INTEF will eventually become an instrument to **“Obtain as much return as possible from investment in the network and focus it on real quality to the customer.”**

More info at www.teleconomics.com

5. Annex: Examples of a typical implementation of Telconomics tools.

The following screenshots show the user interface in a typical implementation of Telconomics tools. This interface can be easily customized to operator´s preferences.

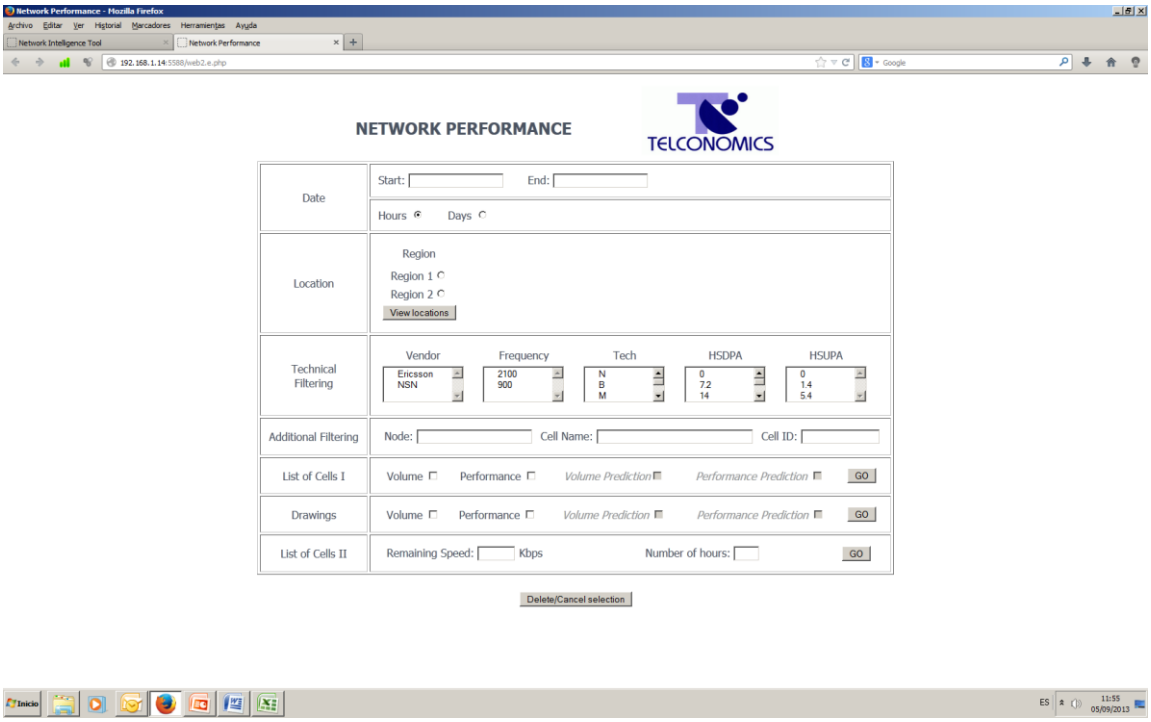
Screenshot 1: Once an operator has rightfully accessed to the tool from a connected workstation, he/she will be shown a menu screen allowing to choosing between the implemented applications.



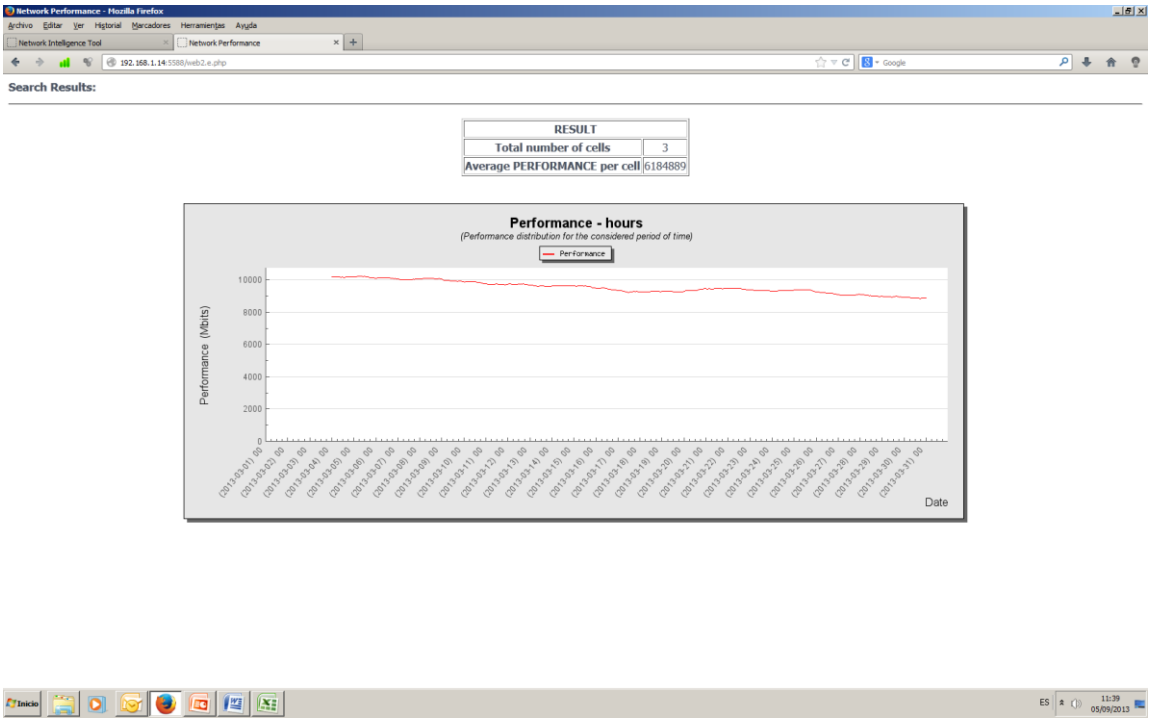
Each of the listed possibilities will bring the operator to the respective application, which in turn will show a menu of settings to run specific queries.

Let see what can be obtained with a couple of examples.

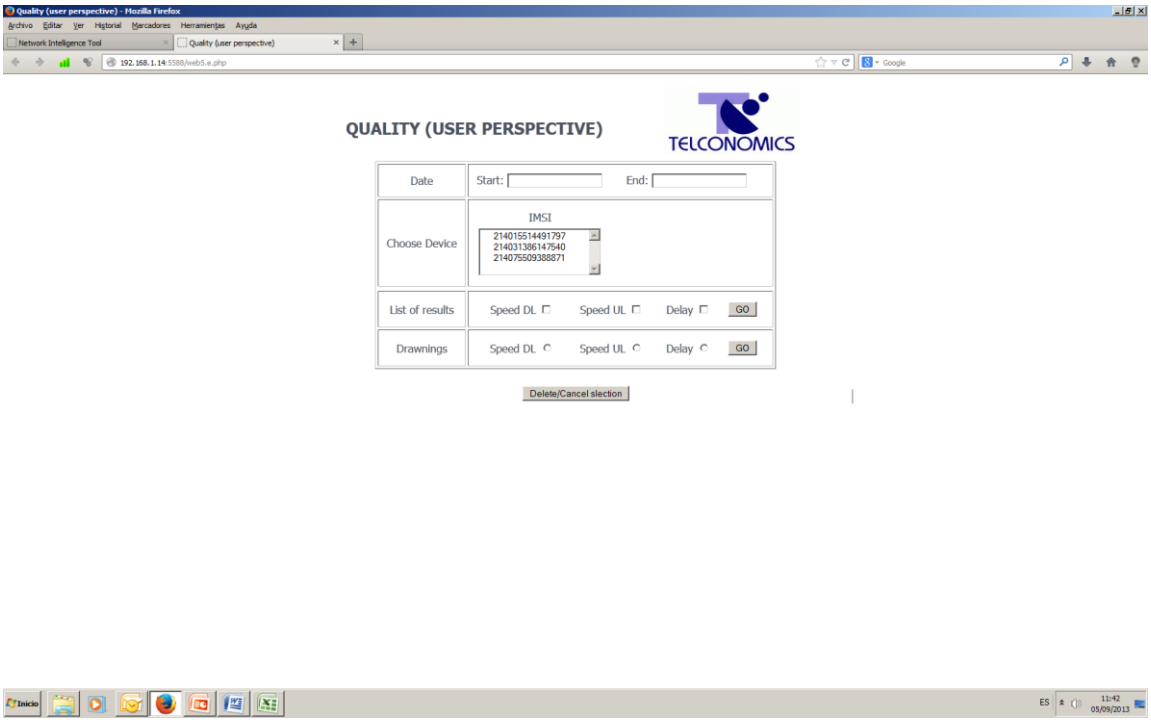
Screenshot 2: If the operator has chosen to run a network performance analysis, the application allow him/her to introduce some filtering criteria, typically a time period, a certain location or group of locations, vendor and technology and so on.



Screenshot 3: Based on defined criteria, the application will produce and present the result.



Screenshot 4: In this case the operator has chosen to run a quality analysis (user perspective) so the application allow him/her to introduce the filtering criteria, typically a time period, a selection of the different devices used to run the tests and the parameters under analysis.



Screenshot 5: Based on defined criteria, the application will produce and present the result.