mPlane

an Intelligent Measurement Plane for Future Network and Application Management

ICT FP7-318627

Demonstration Records

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Abstract:

This public deliverable provides a summary of all the demonstration events in which mPlane was demonstrated, outlining the impact obtained, and the feedback received from the respective communities and venues.

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1 Introduction

1.1 Purpose of the document

This deliverable provides the demonstration reports of the events & conferences where the capabilities and outcomes of the mPlane project was presented. It describes the results of demonstration exercises, how they have been carried out and what the feedback was.

1.2 Structure of the document

This deliverable describes in detail the demonstration of the mPlane project at selected conferences. The deliverable is organized into three main sections, as follows:

- **Introduction**
- **Context of the respective demonstrations**: this section provides the scope of the demonstrations and a list of demonstration events.
- **Demonstration events reports**: this section is divided into two subsections, namely a preliminary and a final demonstration event report, respectively, the first providing a demonstration of activities carried out during the project period, and the latter, summarizing their impact on communities.
- **Conclusion**

2 Context of the respective demonstrations

2.1 Scope of the demonstrations

The wide variety of applications and the complexities of Internet's distributed network lead to operational frailty and difficulty in identifying and tracking the root causes of performance and availability issues.

In this context, to elucidate the current and obscure dynamics of the Internet, the mPlane project has focused on building the Internet measurement plane, by designing a flexible, open platform that allows one to collect, store and process measurements collected from the Internet. Through the demonstration events, we presented the outcome of mPlane project, which aims to provide solutions to identify the root causes of performance and availability issues both from a provider and from a user point of view.

2.2 List of demonstration events

The capabilities and outcomes of the mPlane project was presented within various events. The main events were:

- mPlane industrial workshop at TMA (Barcelona, April 22, 2015)
- mPlane at Future X days (Nozay, June 11-12, 2015)
- mPlane at EuCNC (Paris, June 29-July 2, 2015)
- mPlane at Journée du Conseil Scientifique de l'Afnic (Paris, July 09, 2015)
- mPlane at the Innovation Workshop at Telecom Italia Labs (Turin, July 14, 2015)
- mPlane final workshop (Heidelberg, November 30, 2015)
- 9th EAI International Conference on Performance Evaluation Methodologies and Tools (Berlin, December 14-16, 2015)

3 Demonstration events reports

3.1 Preliminary demonstration event reports

3.1.1 mPlane industrial workshop at TMA

mPlane has been presented at the mPlane industrial workshop co-located at the 7th International Workshop on Traffic Monitoring and Analysis (TMA 2015), Barcelona, April 22, 2015.

During the mPlane industrial workshop, a demo session took place. Its main aim has been to demonstrate the capabilities of the mPlane system in a live environment, showing multiple probes (Telecom Italia DATI, generic pinger and HTTP latency probe, PoliTO Tstat) interacting with a supervisor, managed by means of different interfaces (python CLI, nodejs CLI, WEB GUI).

The capabilities of a reasoner developed during integration activities were presented, inserting network impairments that the reasoner discovered analyzing measures of passive probes (pingers): all communications between all the elements (supervisor, probes, reasoner, GUI) are made by means of on mPlane protocol over HTTPS.

More information on this event are available at http://tma-2015.cba.upc.edu/mplane.

3.1.2 mPlane at Future X days

WeBrowse (Passive content curation use case) has been demonstrated during the Bell Labs Future X days (Nozay, June 11-12, 2015). The FutureX days are open days where Bell Labs researchers and their partners demo their work to visitors from the industry as well as to ALU business units.

The passive content curation use case that aims at helping users discovering relevant content in the web from the simple passive observation of network traffic. The prototype was running live at the campus network of Politecnico di Torino. Since the best way to test WeBrowse is to check how users react to its content, the FutureX days was a great opportunity to test how people reacted on WeBrowse's promoted web stories and articles.

Overall, the stories promoted on WeBrowse attracted the smiles and the curiosity of many visitors. Interesting feedback and discussions occurred with many visitors, particularly, around the issues of privacy, the need or not for personalization, and the deployment of WeBrowse in other networks and environments.

3.1.3 mPlane at the EuCNC

mPlane has been presented as exhibitor at the European Conference on Networks and Communications (EuCNC 2015), in Paris, June 29-July 2, 2015. The presented live demos were:

- Demonstration of the mPlane architecture and protocol: the goal is to demonstrate the approach defined by the mPlane architecture that allows a seamless integration of probes, repositories, and reasoner, orchestrated by a supervisor
- Demonstration of the system integration and reasoning (YouTube video)

- Demonstration of a novel methodology to identify and locate IP Anycast addresses using active measurements
- Demonstration of a novel content curation approach based on passive observation of traffic (WeBrowse)
- Demonstration of a novel YouTube QoE-based monitoring probe for smart phones.
- Demonstration of OTT videos and mobile YouTube troubleshooting

Due to space limits on the boot, we were not able to demonstrate all the available use cases, hence we setup an official mPlane channel over YouTube. It contains videos of the remaining demos, that we played in loop over one screen. An image gallery of EuCNC and feedback after the event is available as a blog entry in the mPlane website.

YouTube channel: https://www.youtube.com/channel/UCHGS6UlUKvGZTyt5DemmPaw
Blog entry in mPlane website: https://goo.gl/PGlMpH

3.1.4 mPlane at Journée du Conseil Scientifique de l'Afnic

mPlane was invited at the #JCSA15, the 5th "Journée du Conseil Scientifique de l'Afnic" [1] which focused on Internet measurement. Afnic is the French "Association Française pour le Nommage Internet en Coopération", which handles the .fr top level domain name (TLD), with about 2.8 million recorded names, as well as handles 17 new generci TLDs.

The #JCSA15 was the 5th in a series of annual events, that receives a very large coverage, with live streaming via webcast [3], and very intense Twitter activity [4]. The event was structured in two parts, with a morning session dedicated to a RIPE Atlas tutorial, and an afternoon session with scientific seminars. Dario Rossi (ENST) represented mPlane [3], covering the essential aspects of the project, in a session where also Daniel Karrenberg (CSO de RIPE) presented RIPE Atlas [2].

3.1.5 mPlane at the Innovation Workshop at Telecom Italia Labs

PoliTO gave an invited talk at the Innovation Workshop at Telecom Italia Labs, July 14, 2015. The aim of the talk "WeBrowse: a Passive Content Curation System" was disseminating the idea of crowdsourced content curation system based on the passive analysis of HTTP traffic flowing in real operational networks. During the talk PoliTO presented the architecture of the system and the modules composing it. Lastly, as a proof of concept, the prototype was presented, namely WeBrowse (http://webrowse.polito.it), which is deployed in the premises of Politecnico di Torino and builds on the mPlane protocol to support the interactions among the several modules composing the system.

3.1.6 9th EAI International Conference on Performance Evaluation Methodologies and Tools

The GLIMPSE measurement probe was presented by FHA at an invited talk and demonstration at the 9th EAI International Conference on Performance Evaluation Methodologies and Tools in Berlin,

December, 2015. The talk introduced the mPlane architecture, the capabilities of the developed probe as well as the benefits of using a distributed measurement platform to gain network insights and troubleshooting information. The demonstration took place in between talks as poster sessions where FHA showed the probe itself as well as multiple measurement results from an HTTP download speed measurement campaign.

More information on this event are available at http://valuetools.org/2015/show/home.

3.2 Final demonstration event report

The mPlane workshop took place at NEC Laboratories Europe on November 30, 2015, in conjunction with CoNEXT 2015, the 11th International Conference on Emerging Networking Experiments and Technologies.

The workshop featured presentations and talks from measurement experts who spoke about topics related to the main concepts of building an Internet measurement plane, supplemented by presentations about the entirety of the mPlane reference architecture and components, and a demonstration of the use cases that have been performed.

During the workshop, each participant was given a set of brochures that included the agenda, an overview of the project, and detailed information about the architecture and use cases.
Following the presentation sessions, workshop attendees moved to the dedicated demonstration area, where the applicability and functionality of the use cases and the flexibility of the built system was established/shown. In the demonstration area, the participants had the opportunity to discuss and learn more about the specific use cases, through the prepared posters and parallel sessioned live demos.

By including invited speakers among industrial partners, this workshop brought together practical use cases relevant to operators and providers and discuss topics about proactive and reactive troubleshooting for network communications at a scale.

3.2.1 Attendee profile

There was a great deal of interest in the workshop: we received 44 registrations (the complete list can be found at https://goo.gl/V3PXqk), and more than 35 final participants, of which about 55% were from respective mPlane partners and about 45% from Universities, Research Centers or companies in Europe.

Below, we give some insights into the participants backgrounds:

- 65% of participants are within the 34-41 age range.
- 53% of participants attend more than two conferences per year.
- 81% of participants have Master's or Doctoral degrees.
- 40% of participants are Researchers or Professors.
- 40% of participants are Network Planning or Service Quality Engineers.

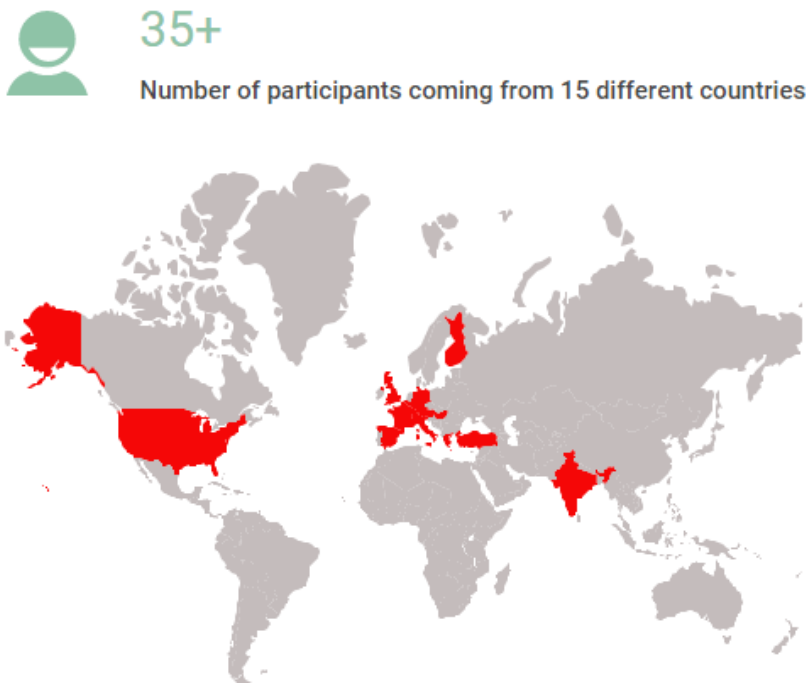


Figure 1: Attendee profile

3.2.2 Agenda of the event

The following presentations/demos were presented during the final demonstration workshop organized in Heidelberg:

- **Overview of the mPlane project**
  M. Mellia, mPlane General Project Coordinator
- **mPlane architecture and principles**
  B. Trammell, WP1 Leader (Use Cases, Requirements and Architecture)
- **Keynote: "Is measurement still an afterthought?"**
  Dr. Balachander Krishnamurthy, AT&T Labs – Research
- **mPlane live demo**
  F. Invernizzi, WP5 Leader (Integration, Deployment, Data Collection, Evaluation)
- **Keynote: "Content distribution on next generation cellular networks"**
  Prof. Fabián E. Bustamante, Northwestern University
- **mPlane components: probes**
  Á. Bakay, WP2 Leader (Programmable Probes)
- **mPlane components: repositories**
  M. Milanesio, WP3 Leader (Large-scale data analysis)
- **mPlane components: reasoners**
  P. Casas, WP4 Leader (mPlane Supervisor: Iterative and Adaptive Analysis)

- **A framework for the historical analysis and real-time monitoring of BGP data**
  Dr. Alberto Dainotti, Center for Applied Internet Data Analysis (CAIDA)
- **Demonstration plans and architecture**
  A. E. Kahveci, WP6 (Demonstration)
- **Use case demonstrations**
  Use case leaders

3.2.3 mPlane Live Demo

The purpose of this demo was to show a live, running example of an mPlane architecture application, on top of the integration system build in the context of WP5 activities.

The demo architecture runs on little hardware appliances physically carried and showed during the demo, with probes (TI DATI, Tstat, pinger, HTTP latency), a supervisor and a reasoner, representing a complete and plausible demo context (2). On startup the WP5 reasoner (3) builds a static

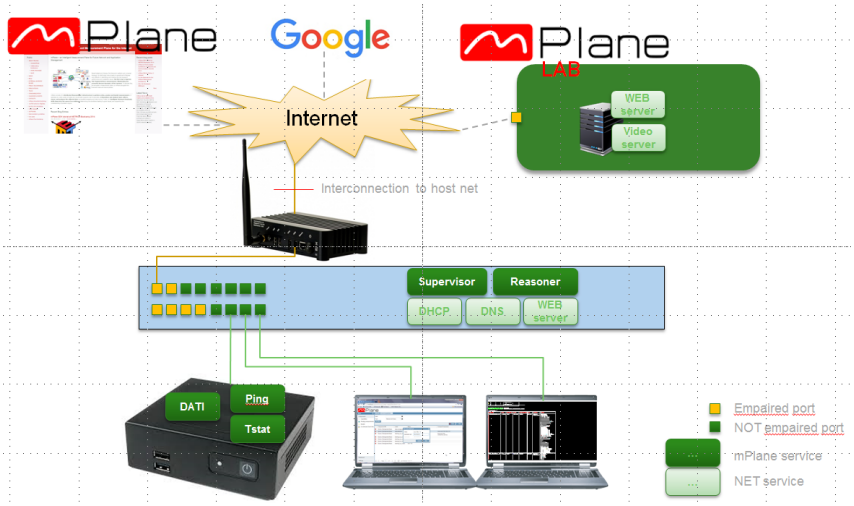


Figure 2: WP5 demo architecture

network topology graph based on a json description, calculate shortest path trees from any point to any point in the network, speaks using mPlane protocol with the supervisor in order to discover available measures and finally maps measures on the network graph.

After this startup phase, the reasoner iteratively issues measures to probes by means of mPlane specifications in order to keep samples in a circular array per LAN (graph nodes) and periodically elaborate statistics of the network status.
The result is a json description of the network status that can be visualized in the supervisor GUI.

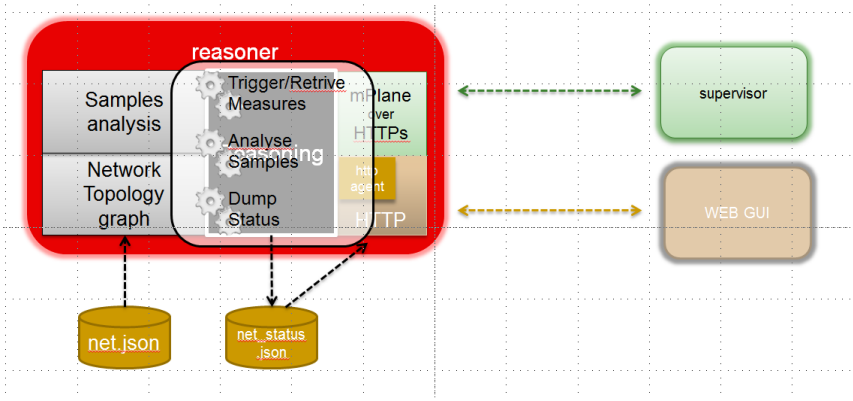


Figure 3: WP5 demo reasoner

3.2.4 Use case demonstrations

During the workshop, partners demonstrated the capabilities of the following use cases:

- Estimating content and service popularity for network optimization
- Passive content curation
- Mobile network performance issue cause analysis
- Quality of Experience for Web browsing
- Active Measurements for Multimedia Content Delivery
- Anomaly detection and root cause analysis in large-scale networks
- Verification and certification of service level agreements

Shown below a description of what has been demonstrated for each use case and the received input from the participants.

Estimating content and service popularity for network optimization

This demo presented a method to accurately estimating the popularity of online contents; specifically we looked at estimating the popularity of web-pages and online video. The demo showed how these estimations can be used to optimize the network by reducing the network load, and user experience through selecting the which contents to cache early.

Briefly the content and service popularity modules built on the data collection tools provided through the Tstat inteface. These provide the data is used to build models (offline phase), and to later on evaluate the popularity of contents for selective caching (online phase). The data for the offline phase is provided via a database interface, while the online data is received via the Tstat live traffic capture interfaces.

In the demo, we showed how based models built using previously captured web content, and web video traffic can be used to optimize the performance of networks. Specifically, the selective caching methods in the demo enable the network operator to reduce the load on their network, and the latency of user traffic by selectively caching content based on its expected future popularity. Figure 4 shows the user interface for the content popularity estimation and the service optimization outputs.

Figure 4: Content popularity estimation and cache performance reporting.

Feedback during the event was positive. Observers showed interest in the underlying algorithms, and the use case of replying such caches at the very edge of network where resources are limited, received support and interest.

Passive content curation

WeBrowse has been demonstrated during the mPlane final workshop. The demo showed how the mPlane framework can be used to instantiate and launch the content curation use case.
The output of the demo is two fold. It first shows the WeBrowse web page which features a col-

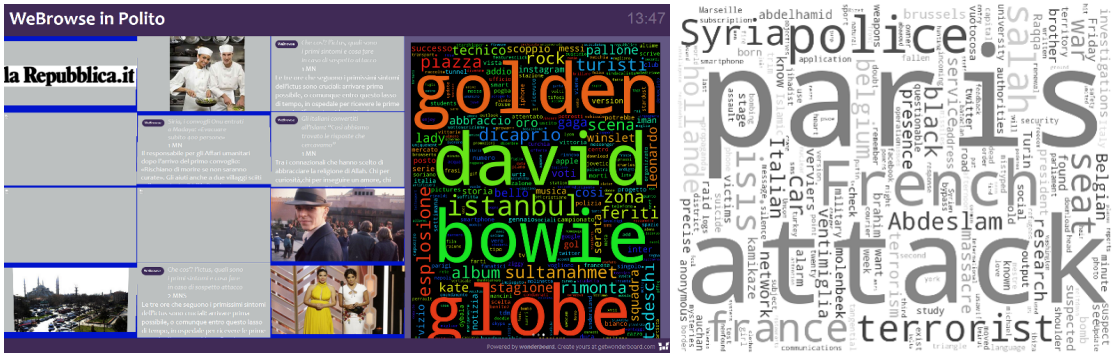


Figure 5: WeBrowse board and wordcloud

lection of the hottest content in the web at the moment. The second shows how the reasoner can provide insights about most popular web content in different time periods and presents them in terms of both most popular web pages as well as most popular topics discussed in the web in the form of a word cloud. In Figure 5 it is shown a significant wordcloud of the topics featured on the web in the day following the Paris attacks (November 2015).

Mobile network performance issue cause analysis

In this demo, we demonstrated the ability of the mPlane architecture to facilitate the root cause analysis (RCA) of video delivery. For this purpose, a set of mobile devices (Android phones and tablets), Wi-Fi access points and video servers were set up. In the demo, the participants were free to watch a video while we injected a set of impairments. While the video was playing the passive probes that were developed for the project collected a set of measurements from all layers and uploaded to the repository.

An example is shown in Figure 6. Finally, the reasoner automatically detects the video session and

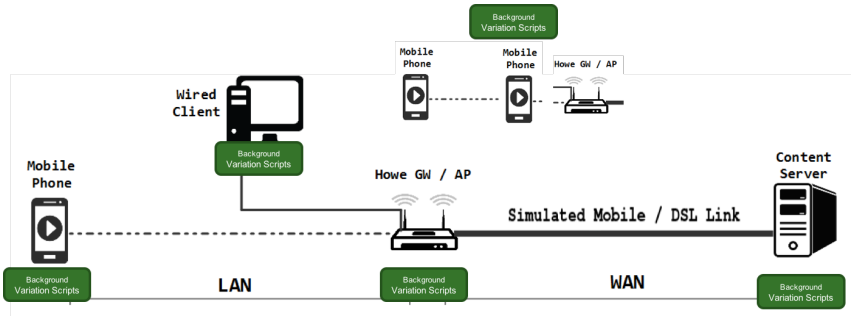


Figure 6: Mobile RCA demo architecture.

attempts to estimate the quality of experience and the root cause of a problem. The data can be requested using the integrated supervisor and the reference implementation. The last step is to visualize the result of the machine learning estimation as shown in Figure 7.

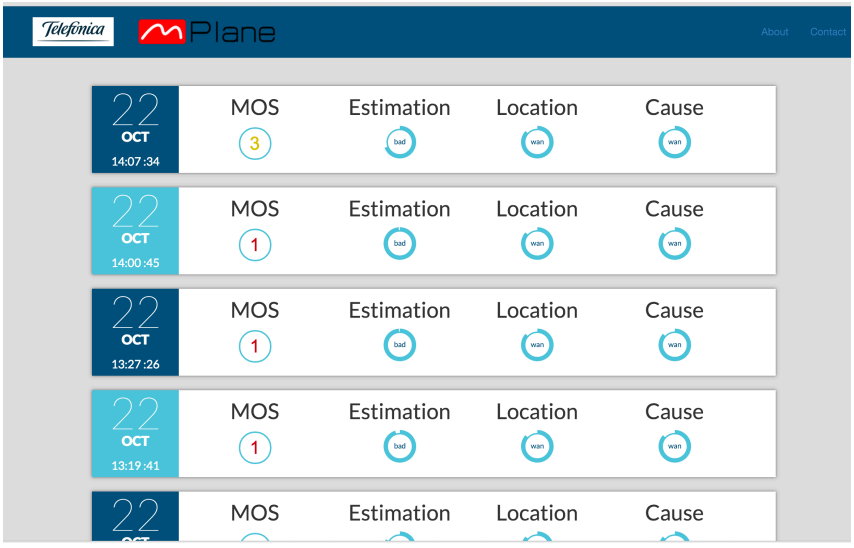


Figure 7: Mobile RCA demo visualization.

Overall people were positive with the accuracy and the speed at which the classifier was able to predict the video quality. People showed particular interest in the features used, how do we measure them and what kind of machine learning algorithm has been used.

Quality of Experience for Web browsing

The use case was demonstrated showing two browsing sessions carried by the Firelog probe.

In the first web browsing session, no impairments were added and we showed the overall process taking place during the measurement. In particular, we explained the active measurement phase, in which the Firelog probe performs active measurements, namely *ping* and *traceroute* against the IP addresses collected by the browser.

In the second experiments (with impairments), we showed that even if the page load time was slightly touched, yet the Diagnosis algorithm was able to identify a problem in the local area network (in which the impairments were inserted), pinpointing the importance of active measurements in order to have the complete picture of what is really happening *under the hood* in a web browsing session.

The integration within the mPlane architecture was part of the discussion, and we underline that, being the Firelog probe fully integrated, it would be straightforward to integrate other measurements from different probes to further enhance the Diagnosis process.

Active Measurements for Multimedia Content Delivery

This use case demonstrates a consistent set of mPlane Components and their communication fully in compliance with the mPlane protocol.

The problem domain here is monitoring and root cause analyzing of video content delivery networks that work ”over the top” of the TCP/IP protocol set, i.e. consists of content servers delivering media streams over the classic unicast routing mechanisms. The latest of these protocols (HLS, MPEG-DASH, etc.) all support some level of adaptivity, i.e. the server offers content in various qualities (and bandwidths), and if a client experiences poor download bandwidth for a certain quality it can switch back to a lower level which downloads faster.

The demonstration includes a redundant pair of content servers in the FASTWEB data center and several customer locations (i.e. emulated FASTWEB residential subscribers). There are various probes deployed either in the DC, in the provider network, but also in the subscriber premises of selected ”customers”. The demonstrated scenario starts with some constant basic-level monitoring of probes, i.e. occasional downloads of varying content by the residential probes, to verify availability and sufficiency of bandwidth toward any of the content servers.

All these ”routine” verification data is collected by the repository (EZ-Repo), which stores recent measurements for about 24 hours. The repository is periodically (every 60 seconds) queried by the Reasoner, for preset, topology-aware evaluations of service quality. Whenever some abnormal or degraded condition is indicated by any of these queries, the Reasoner automatically configures ”diagnosis tests” on further probes. These measurements are more focused and more frequent than the routine tests. Once the result of these measurements is also available, the Reasoner will decide which of the hypotheses have been supported and presents the results on its ”service diagnosis” dashboard.

The use case demo makes extensive use of the supervisor GUI as shown in Fig. 8, which is a complete, web-based interface for presenting the state and history of mPlane components’ operations: one can view capabilities, pending and finished specifications, and also the results of those specs. In addition, it is also possible to present single or multiple Results in chart views, also with live

updates of new data. The mPlane GUI also incorporates a ”Dashboard” capability where users can configure customized screens that present system status and history using well-known visual tools like charts, tables, gauges, maps and other indicators. As for the probe side, the Multimedia Con-

Figure 8: Multimedia Content Delivery UC Dashboard

tent Delivery UC primarily relies on the OTT Probe developed in WP2. It is an mPlane probe which receives OTT content URL-s as part of the specifications, and starts the downloads from the URL-s specified. While doing this, the probe emulates an adaptive client, i.e. switches between content qualities as required.

Anomaly detection and root cause analysis in large-scale networks

In this use case demo we have shown two different application scenarios.

In the first part of the demo, we have made a proof of concept for the mPlane Anomaly Detection modules, showing how these can effectively detect anomalous behaviors related to QoE-based performance metrics, and help in the root cause analysis investigation. This part of the demo was based on historical YouTube traces.

The second part of the demo showed how to use the mPlane mpAD Reasoner to orchestrate the live collection and analysis of passive and periodic active measurements, and to trigger on the fly further active measurements. In particular, this part of the demo used active measurements returned by DisNETPerf (periodic/continuous, based on RIPE Atlas, see [5]), and the RIPE Atlas mPlane proxy instantiation (reactive, on-demand). The presentation and introduction to the different parts of the demonstration was done through the aid of posters, particularly describing the functioning of the anomaly detection modules and the reverse traceroute capabilities provided by the DisNETPerf module.

Figure 9 shows a snapshot of the different steps followed during the demo (note: for practical and reporting reasons, the dates showed in the figures do not correspond to the date of the demo, but the results are exactly the same), including part of the results in the different GUIs. Starting on the upper left corner, the mPlane public Supervisor running at FASTWEB premises in Milano (`http://demo.ict-mplane.eu:9892/`) shows the main registered capabilities which compose this demo (anomaly detection modules and RIPE Atlas integration modules). The upper right corner depicts the instantiation of the Anomaly Detection Reasoner, showing in particular the ex-

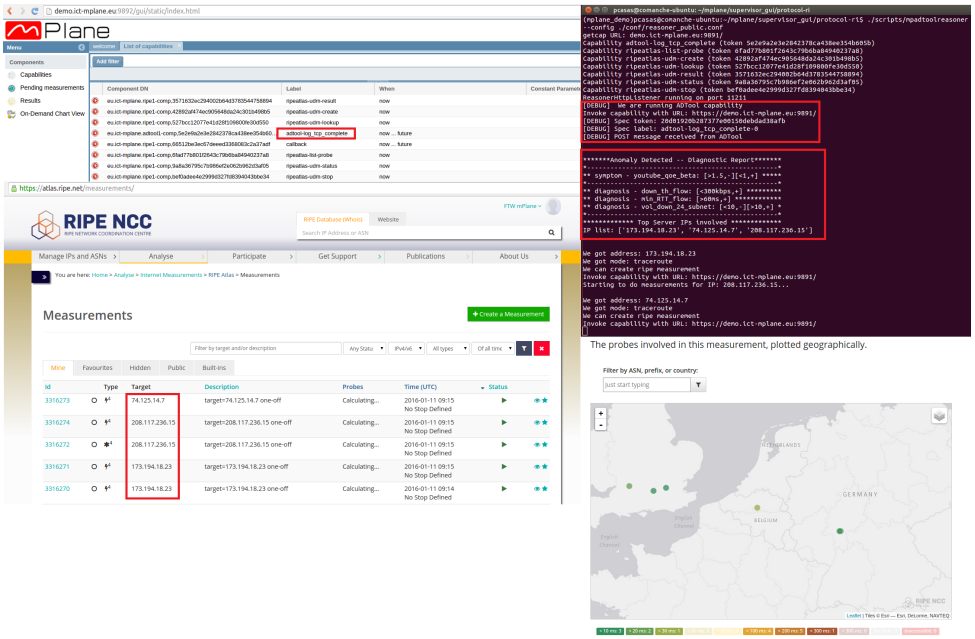


Figure 9: Detection and diagnosis of anomalies in YouTube - demo.

ecution of the Anomaly Detection capabilities, the detection of an anomaly impacting YouTube's QoE, a list of IP addresses of some of the involved YouTube servers, and the subsequent instantiation of active measurements on these IPs using DisNETPerf and the RIPE Atlas framework. The lower part of the figure shows some of the instantiated active measurements on the aforementioned list of YouTube server IPs, using the RIPE Atlas measurement GUI. In particular, the lower left corner shows the instantiation of traceroute measurements towards these IPs, as well as the starting phase of the DisNETPerf module [5], in which the YouTube IP address 208.117.236.15 is pinged from multiple distributed RIPE Atlas probes (selected based on topological-based notions). The lower right corner of the figure actually shows these RIPE Atlas probes on a map, including a color code reflecting the RTT values obtained from the ping measurements towards the selected YouTube IP.

The feedback received during the demonstration was very positive and encouraging. Attendees recognized the flexibility and virtues of the mPlane approach: in particular, they recognized how easy it was to run this use case with so many geo-distributed components, including the mPlane public Supervisor running at FASTWEB premises in Milano, commanded by the AD Reasoner running locally at Heidelberg in an end-user laptop, detecting anomalies on the traffic monitored at PoliTO premises in Turin and instantiating new measurements on the fly from geo-distributed probes in Frankfurt, London, Paris, and so on using the RIPE Atlas distributed framework. All this is done without having to access a single piece of private ISP data, which was also highly appreciated and recognized by the attendees during discussions.

Verification and certification of service level agreements

Four different partners (FUB, NEC, FASTWEB, Telecom Italia) were involved in the demonstration of the use case and the results confirmed the reliability of the mSLAcert approach for the SLA verification and certification. In particular, such a test verified that the mSLAcert probe (based on UDP

test) allows us to correctly measure the line capacity of links also having a " high bandwidth x delay product", that are the typical conditions where TCP tests are not reliable.
In Fig. 10, we present the demo network including all the four operating nodes. Use case components (SLA Server and SLA Agent) were distributed to the following premises: FUB, NEC, FASTWEB and Telecom Italia.

All the components of the use case were integrated with the public Supervisor, located in FASTWEB

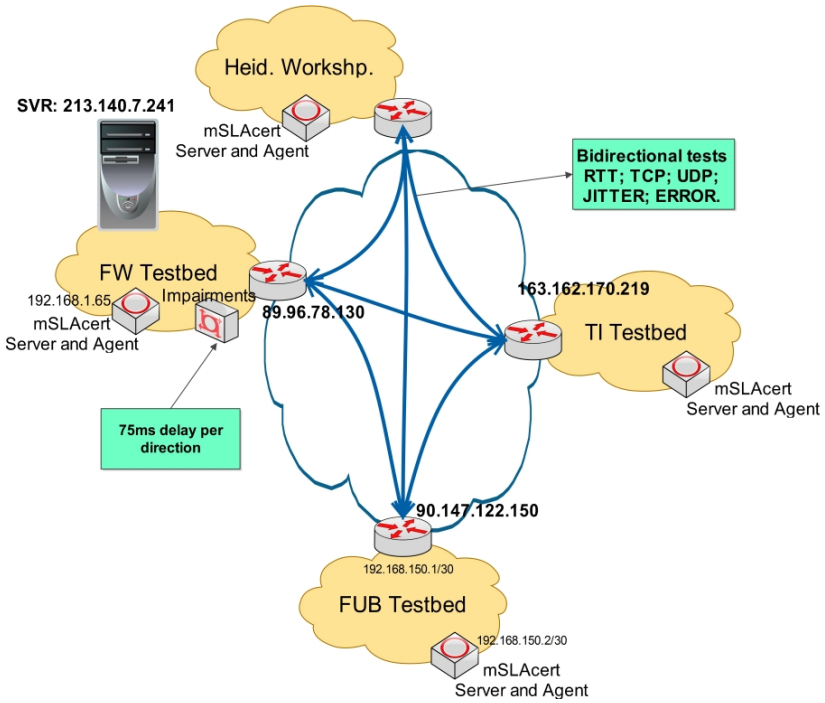


Figure 10: SLA demo architecture.

premises where network impairments are also applied. For sake of brevity, we will report only two tests that were executed. Firstly, the SLA test based on TCP is reported.

As it can be seen in Figure 11, we measure the maximum capacity as 50 Mbps, while the line capacity that is reserved on both sides is 100 Mbps. Therefore, the SLA based on TCP of Figure 11 does not allow us to measure the maximum available line capacity, under the introduced impairments (a delay of 75ms per direction). This is the typical case where it is required to adopt an UDP test in order to execute SLA measurements. Therefore, the complete tests of SLA, with TCP and UDP protocol are shown in Figure 12.
As it can be seen in Figure 12, the UDP test measures a maximum capacity of 92 Mbps, while the TCP test only measures 43 Mbps. As it can be seen in Figure 12, the connections show a relevant jitter and this impairment induces other limits in the reliability of the measurements based on TCP tests. Conversely, UDP tests are independent of RTT and jitter and therefore UDP protocol can be assured as the best approach for the line capacity evaluation.

The results shown in this test confirmed the importance of the mSLAcert probe in the evaluation of the line capacity related to the access network (from the central office to the user modem), also in the presence of high RTT and jitter (Fig 12).

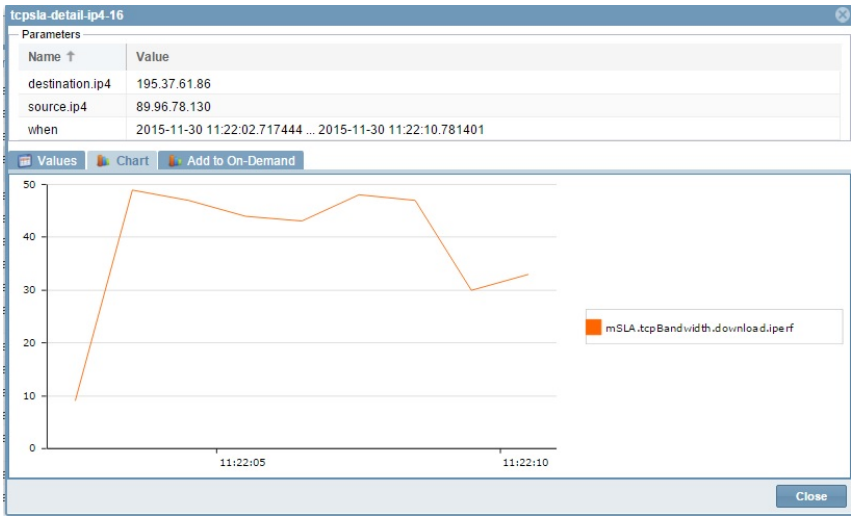


Figure 11: SLA test based on TCP, RTT of 150ms

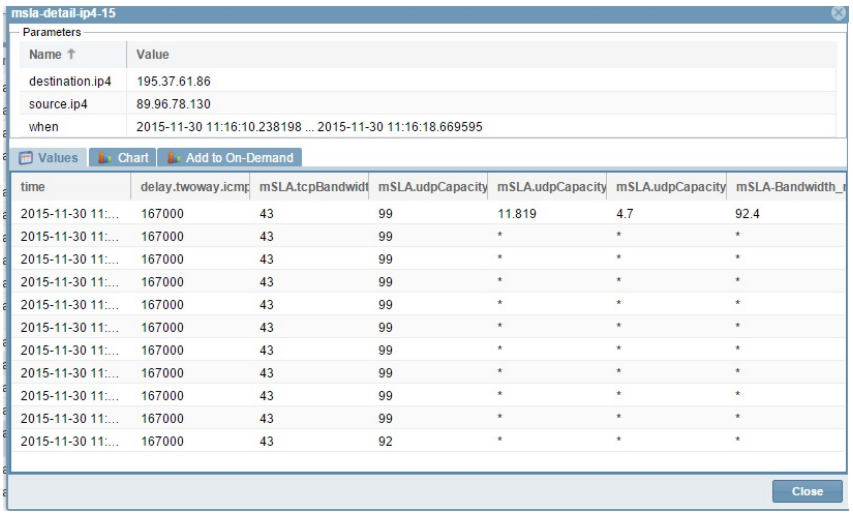


Figure 12: SLA test with TCP and UDP.

3.2.5 Other activities demonstrated

During the workshop, partners also demonstrated other mPlane activities. Shown below a description of the other activities demonstrated and the received input from the participants.

Anycaster

Use of anycast IP addresses has increased in the last few years: once relegated to DNS root and top-level domain servers, anycast is now commonly used to assist distribution of general purpose content by CDN providers. Yet, most anycast discovery methodologies rely so far on DNS, which limits their usefulness to this particular service. This raises the need for protocol agnostic methodologies that should additionally be as lightweight as possible in order to scale up anycast service discovery. Our anycast discovery method allows for exhaustive and accurate enumeration and city-level geolocation of anycast replicas, with the constraints of only leverages a handful of latency measurements from a set of known probes. The method, exploits an iterative workflow to enumerate (optimization problem) and geolocate (classification problem) anycast instances. The method is so lightweight and protocol agnostic that we were able to perform several censuses of the whole IPv4 Internet (during March 2015). A web interface (http://perso.telecom-paristech.fr/~drossi/anycast) with our census results was showed in the final workshop in Heidelberg, see Figure 13.

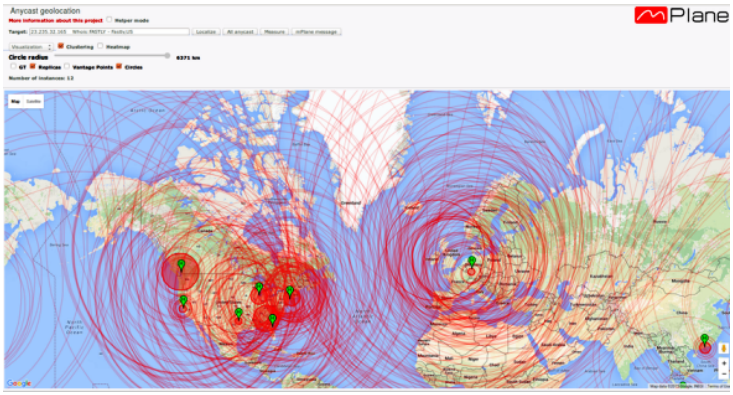


Figure 13: Anycaster demo snapshot

GLIMPSE

To show that the mPlane architecture can be used outside of one of the use cases specified by the consortium, GLIMPSE was demonstrated at the workshop in Heidelberg. GLIMPSE is an active network measurement tool intended to be installed on an end-users device at home or on a mobile device such as a smartphone or tablet. It can executed centrally defined measurements delivered by a supervisor as well as measurements the users schedule themselves to be executed on their devices. It comes with a web-based dashboard, where users can visualize the executed measurements and define their own measurement schedules. All of this was shown as part of the demo, including graphs of ongoing measurement campaigns. Part of the demo were also live probes measuring over a 3G home gateway.

The demo walkthrough started with an overview of where GLIMPSE can be deployed together with

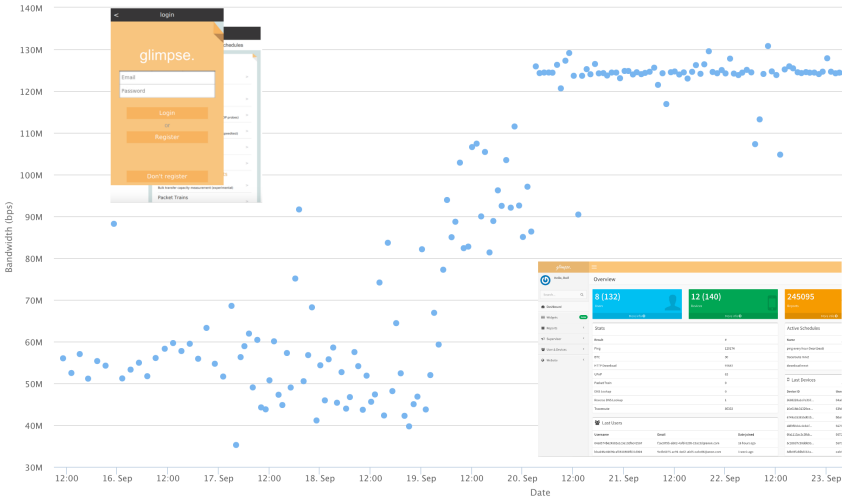


Figure 14: GLIMPSE demo snapshot

some of the data gathered so far during the beta-testing phase of the software (see Fig 14) The feedback received was very positive, the graphical results shown lead to interesting discussions. As the main focus of GLIMPSE is the end-user, some really helpful insights and suggestions from users but also from employees of ISPs could be gathered to further improve GLIMPSE in future releases.
This demo was also the basis for a demo in Berlin as part of the ValueTools 2015 conference.

ECN path transparency

The ECN Path Transparency demonstration, built on ETH's Pathspider tool, demonstrates the benefits of direct integration of tools over the mPlane protocol for research purposes. Pathspider is built as a hybrid component-client with its own web-based user interface. Its purpose is to test connectivity to an arbitrary remote target on the Internet, both with and without a protocol feature enabled, in order to determine whether connectivity is impaired for that feature. In order to separate endpoint- from path-related connectivity impairments, Pathspider uses mPlane to coordinate tests from multiple vantage points simultaneously: if the feature causes connectivity impairment from all vantage points, the impairment is presumed to be at or close to the target; if only from some vantage points, the impairment is presumed to be on-path.

For purposes of the demo, TCP Explicit Congestion Notification (ECN) was tested, with a client/webui in Heidelberg, and components on five different VMs running at DigitalOcean in Amsterdam, London, Singapore, San Francisco, and New York.
The demonstration used Pathspider's web user interface to illustrate the multiple stages of this measurement. First, the user selects a set of targets (on the order of hundreds), either web servers (which will be resolved to IP addresses at a single vantage point, via a DNS resolution capability) or peer-to-peer nodes (based on a BitTorrent DHT crawler capability). The target IP addresses are then sent back to the client, which distributes them to the components. Each component tests connectivity (via a connectivity status capability) to each of the targets, both with and without ECN, determining any ECN-dependency on connectivity. The results are then sent back to the client, which displays aggregate statistics (how many targets are ECN-safe, how many have endpoint-linked ECN

connectivity dependency, how many have path-linked dependency, and so on) as well as allowing the user to drill down into routes to a specific target.

If this option is selected, the client instructs each component to find packet modifications along the path to the target (via the scamper/tracebox component built by ULG, used unmodified in this demo), displaying the traceroute from five sources to one target, and allowing the user to inspect each node (via an external hyperlink to the RIPEstat facility).

3.2.6 Comments, general impressions and feedback from the audience

This section will focus on the overall experience of the participants, as well as how the mPlane project and its results were received. We created an online questionnaire in order to obtain information from participants on how they perceive the mPlane project and its outcomes.

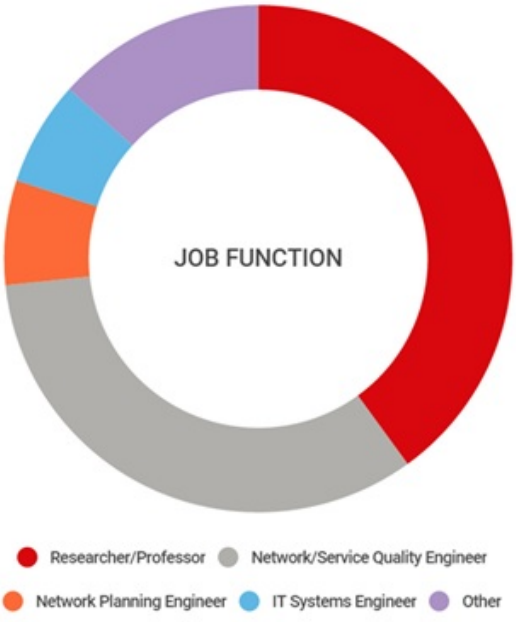
After concluding the mPlane workshop, we began collecting feedback from the participants via the online survey, with the aim of capturing the opinions of those who had attended, and see whether the algorithms and the use cases presented during the workshop were found to be useful or not. In addition to the many positive informal responses received during and after the workshop, we received 21 replies to the survey, with an average of about 50% survey completion.

We will begin by highlighting some of the more significant results, followed by a detailed per-question breakdown of the survey.

Feedback: mPlane workshop Heidelberg Demonstration Results (based on the online survey responses received):

- 62% thought that the overall presented solution is very useful
- 80% thought that they would very likely or somewhat likely use the overall presented solution
- 76% thought that the use cases presented are positive or very positive

Attendees:



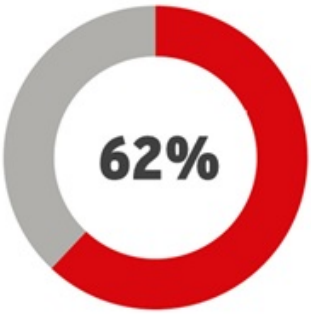
Percentage of survey participation:

~50%

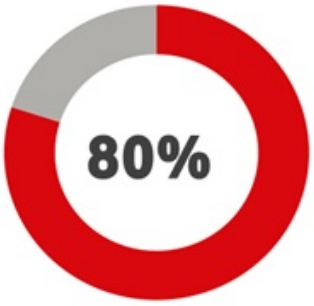
Percentage of respondents who attend at least two conferences a year:

53%

Overall project feedback:



Percentage of respondents who find the overall presented solution very useful



Percentage of respondents who think they would likely use the overall presented solution

Use case feedback:

As seen from the responses, the overall feedback towards the project's results was very positive and encouraging.

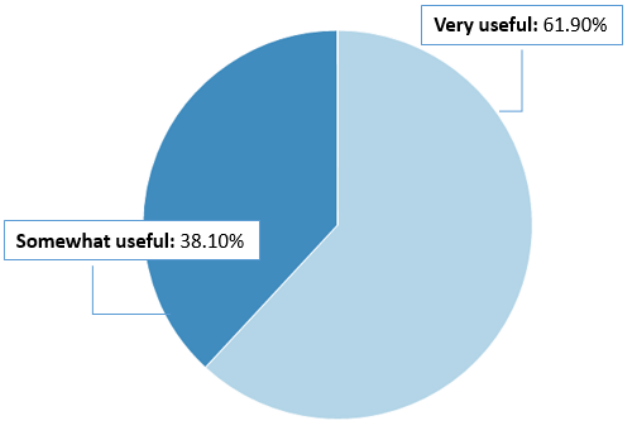
mPlane Heidelberg Demonstration Feedback Reports
The details of the feedback received for each question can be found below:

Question 1

How useful did you find the overall presented solution?

Question1

Options	Quantity	%
Very useful	13	61.90%
Somewhat useful	8	38.10%
Not very useful	0	0.00%
Useless	0	0.00%
Total	21	100%

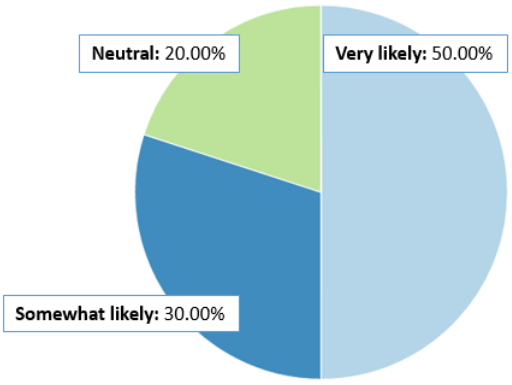


Question 2

How likely is that you would use some of the presented solution?

Question2

Options	Quantity	%
Very likely	10	50.00%
Somewhat likely	6	30.00%
Neutral	4	20.00%
Somewhat unlikely	0	0.00%
Very unlikely	0	0.00%
Total	20	100%



Question 3

How would you rate the following use cases

Question3

Matrix Chart

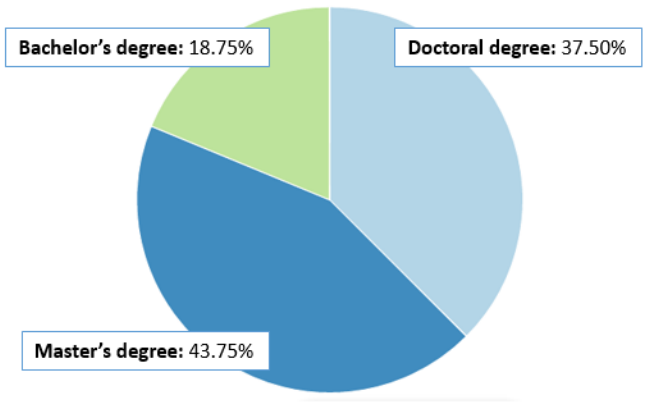
	1	2	3	4	5
Estimating content and service popularity for network optimization	0	0	4	7	5
Passive content curation	0	2	2	8	4
Active measurements for multimedia content delivery	1	0	2	7	6
Quality of Experience for Web browsing	0	0	5	7	4
Mobile network performance issue cause analysis	0	0	4	7	5
Anomaly detection and root cause analysis in large-scale networks	0	0	3	6	7
Verification and certification of service level agreements	0	1	3	7	5

Question 4

What is the highest level of education you have completed?

Question4

Options	Quantity	%
Doctoral degree	6	37.50%
Master's degree	7	43.75%
Bachelor's degree	3	18.75%
Other	0	0.00%
Total	16	100%

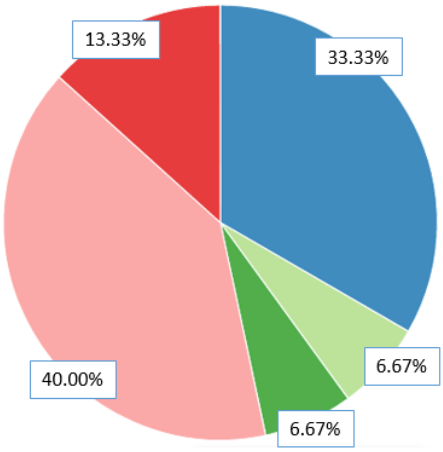


Question 5

What is your expertise about the topic of the mPlane project?

Question5

Options	Quantity	%
Network Administrator/Manager	0	0.00%
Network/Service Quality Engineer	5	33.33%
Network Planning Engineer	1	6.67%
IT Systems Engineer	1	6.67%
Researcher/Professor	6	40.00%
Other	2	13.33%
Total	15	100%

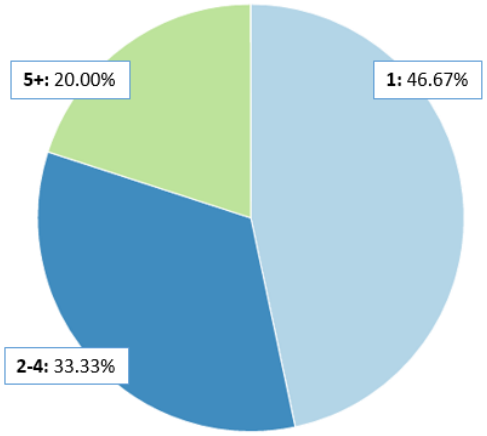


Question 6

How many conferences per year do you attend on average?

Question6

Options	Quantity	%
1	7	46.67%
2-4	5	33.33%
5+	3	20.00%
Total	15	100%

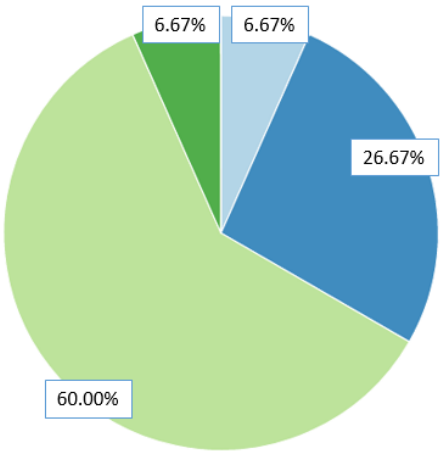


Question 7

Select your Age

Question7

Options	Quantity	%
18 - 25	1	6.67%
26 - 33	4	26.67%
34 - 41	9	60.00%
42 - 55	1	6.67%
55+	0	0.00%
Total	15	100%



Here follows a set of photo showing important moments of the mPlane workshop and live demonstration.

Figure 15: A presentation and the audience at the workshop

Figure 16: Attendees at the live demo

Figure 17: Use case live demos

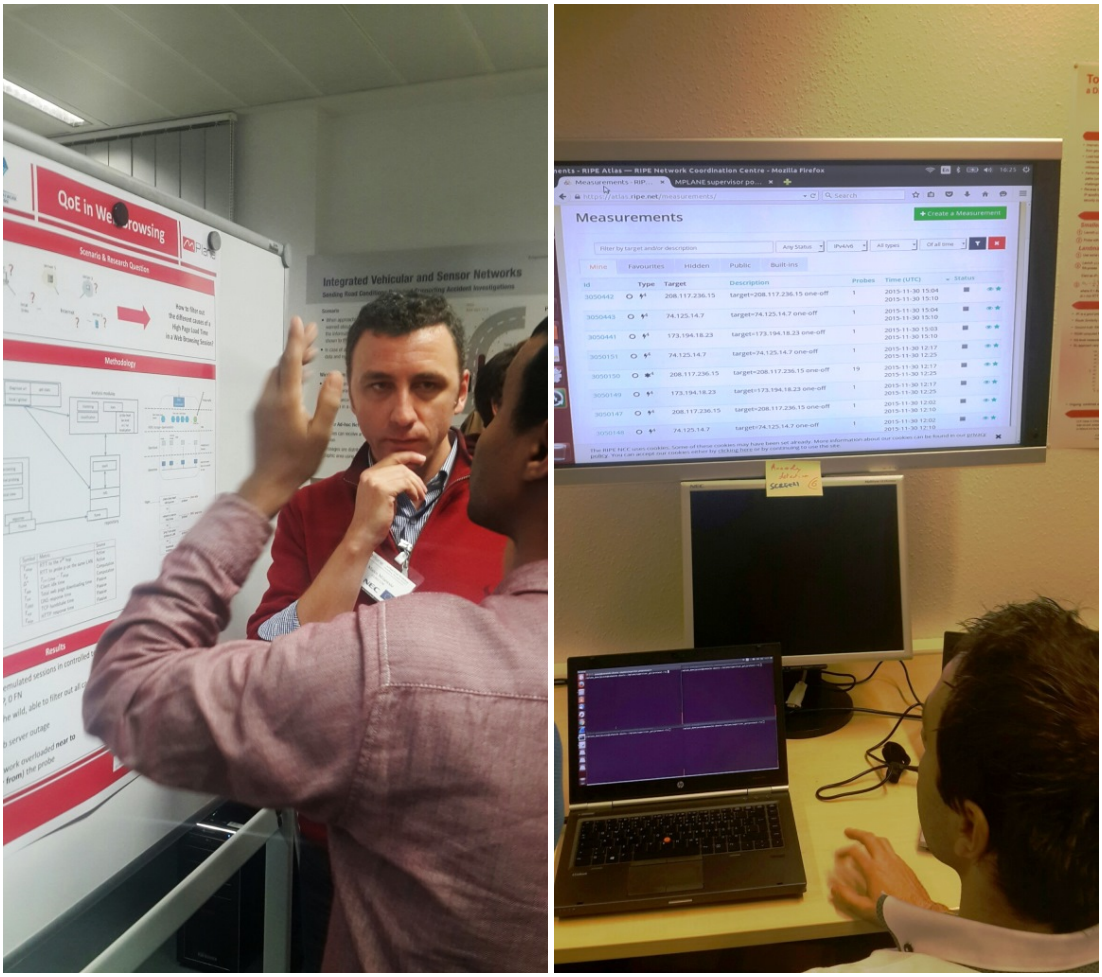


Figure 18: Use case live demos

4 Conclusions

The mPlane partners have organized and participated in various events, where they have introduced the mPlane project and demonstrated the capabilities of the built system.

During the demonstration events, we received very positive reviews and feedback from the respective participants, and mPlane has put great effort into properly disseminating the results of the project, namely through the mPlane workshop which took place on November 30, 2015, in conjunction with CoNEXT 2015.

In conclusion, dissemination of the mPlane results has been successful and very well received.

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