



#### mPlane

an Intelligent Measurement Plane for Future Network and Application Management ICT FP7-318627

# Plans for Using and Disseminating mPlane Knowledge

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#### Abstract:

This deliverable outlines the plans for disseminating mPlane knowledge and describes the dissemination activities and standardization achievements of mPlane after the first year. The document provides detailed dissemination activities undertaken by the project through press release, fact sheet and posters, project website, and the publication of thirty research papers to journals and various conferences and workshops. Furthermore, the document provides mPlane's standardization efforts, with the publication of four IETF RFCs, the establishment of links to various working groups and a tutorial to the international delegates. Finally, the document provides a detail report on the software open source release and covers the exploitation planned in an early phase from all the partners.

Keywords: dissemination, publications, standardization, exploitation, open-source software





### Disclaimer

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## **1** Introduction

The ubiquity of Internet access, and the wide variety of Internet-enabled devices and applications, have made the Internet a principal pillar of the Information Society. Decentralized and diverse, the Internet is resilient and universal. However, its distributed nature leads to operational brittleness and difficulty in identifying and tracking the root causes of performance and availability issues. mPlane infrastructure would be a step forward toward the development of a measurement infrastructure which complement the current Internet's data and control planes. By enabling pervasive measurement throughout the Internet, mPlane benefits everyone: ISPs get a fine-grained picture of the network status, empowering effective management and operation. Application providers gain powerful tools for handling performance issues of their application. Regulators and end-users can verify adherence to SLAs, even when these involve many parties. Customers of all kinds can objectively compare network performance, improving competition in the market.

The mPlane project, in addition to do the research and development activities, also plans to involve stakeholders who are not directly involved in the project by dissemination activities. This will create awareness among the stakeholders (network/service providers, and user communities) about the urgent need of a distributed measurement infrastructure to perform active, passive and hybrid measurements, able to operate at a wide variety of scales and dynamically supports new functionality. Based on that, they will consider the framework and guidelines development to promote and use the mPlane solution in the future Internet design and deployment.

The project will use different dissemination channels in reaching the target audience: European workshops, concertation and Future Internet Assembly (FIA) meetings, internationally established conferences, ICT events (organised by EC); ETSI and IETF groups. In the latter part of the project, the project also plans to use some of the commercial events to reach the business user community. In addition to this, the project website will be kept updated with all the results and public deliverables to reach the wider audience.





## 2 mPlane project overview

## 2.1 Context of the mPlane proposal

The Internet is a global interconnection of networks, with no single organization or administrative entity operating, administering or governing it. This diversity provides the Internet with great flexibility and good resiliency and has driven rapid innovation at the edge. However, the Internet has shown to be fragile to problems arising from interactions among networks and to misbehaving nodes at the edge. It can be difficult, or even impossible, to assess why a given problem is occurring, especially at scales that encompass several of these entities. Even understanding the cause of the degradation in quality has become a daunting task, made even more challenging by the fast and constant deployment of new services and applications. This makes it difficult to take the correct countermeasures when issues arise, thus limiting network management and operational activities. In short, the Internet is often a large, obscure black box, and Network and Application Providers as well as End-Users lack the necessary mechanisms to verify the offered service level and to drill down to the cause of problems therein.

In the case of a service failure or performance issue, for example, it is onerous to pinpoint the cause and restore normal network operations. This is especially the case when a fault occurs in a part of the Internet far away or under a different administrative domain from the network it affects. As a matter of fact, the Internet provides no mechanism so that End-Users, Internet Service Providers (ISP), and Application Providers (AP) can understand the causes behind these problems, especially when they span several of these entities. While tools such as ping and traceroute are ubiquitous and well understood, they are too crude to provide much insight into the root cause of any but the simplest network-related problems. Worse, recent studies show that ISPs are increasingly blocking these tools [4].

Diagnosis of connectivity and performance issues in the complex environment of the modern Internet requires better tools. Take for example the case where a user is experiencing choppy playback when watching a YouTube video. Debugging such an issue is complex: is the user's home router injecting latency or overrunning its buffer? Are DSL lines oversubscribed, causing congestion? Are the ISP network experiencing issues with its routers or switches? Did the Content Delivery Network (CDN) correctly choose the right server for the user's location in the network? Are there congestion and connectivity issues at any other ISP along the path to the YouTube server? Debugging such complex scenarios requires measurement and intelligence that encompasses a number of different entities and players.

Beyond diagnosis, where at least the problem is known, is the estimation of Internet performance under certain circumstances; here the question is not ``Why it doesn't work?'' but rather ``If we try to do something new, will it work?'' Imagine a potential end-customer looking for the best ISP for a planned expansion and for an application that has particular performance requirements. Which of the available ISPs would be the best choice? Which CDN provider will best support the application?

Currently, there is no way for potential customers to judge what sort of service to expect from ISPs or Application Providers until they have signed a contract. Even then, the performance they experience may not reflect that of other customers of that ISP.

Another problem regarding performance measurement has to do with the protection of Internet users' rights. National-level agencies charged with protecting such rights (for example AGCOM in Italy, or OFCOM in UK) have difficulties in verifying that the promised performance is delivered and





Service Level Agreement (SLA) are met, especially when targeting high-speed access, e.g., capacity higher than 20Mb/s.

Common to all of these examples is the lack of a coherent method for monitoring and measuring network activity from vantage points throughout the network, from the edges to the core, from user terminals to the servers providing present and future services, crossing the boundaries between providers and customers, and allowing measurements to be carried out in cooperation. The interdependency and complexity of the Internet is ever growing. Only by building a measurement plane for the Internet that mimics the structure of the Internet itself, disentangling the maze of complex relationships among layers and actors, we can understand the root causes behind availability and performance issues, and work to remedy them by enabling effective network management and operational procedures. Quoting Eric Schmidt – Google CEO – ``The Internet is the first thing that humanity has built that humanity doesn't understand, the largest experiment in anarchy that we have ever had.'' The mission of mPlane is to shed light on the operational obscurity of the Internet, to better understand it, and ultimately better manage it.

## 2.2 The mPlane vision and how to achieve it

To address the above considerations, we believe that only through a better understanding of the Internet's currently obscure dynamics we can begin to provide effective network management and operation frameworks. The architecture of the Internet has long been based on the existence of a data plane (which carries packets) and a control plane (which controls routing). In mPlane, we introduce a third plane, the measurement plane.

mPlane consists of a Distributed Measurement Infrastructure to perform active, passive and hybrid measurements; it operates at a wide variety of scales and dynamically supports new functionality. A Repository and Analysis layer collects, stores, and analyses the collected data via parallel processing and data mining. Finally, an Intelligent Reasoner iteratively drills down into the cause of an evidence, determining the conditions leading to given issues, and supporting the understanding of problem origins. By enabling pervasive measurement throughout the Internet, mPlane benefits everyone: ISPs get a fine-grained picture of the network status, empowering effective management and operation. Application providers gain powerful tools for handling performance issues of their application. Regulators and end-users can verify adherence to SLAs, even when these involve many parties. Customers of all kinds can objectively compare network performance, improving competition in the market. mPlane will significantly advance the state of the art in Internet measurement, from innovative probe technology to intelligent algorithms for distributed data analysis. The development of the Reasoner is a key result that will allow structured, iterative, automated analysis. An emphasis on open, standard interfaces will speed adoption and increase the impact of the project.

# 2.3 Technical arrangement

The mPlane technical vision is separated into three layers, representing increasing hierarchy of organization and value of knowledge up the stack: monitoring and measurement, repository and analysis, and supervision.

• The measurement layer combines a set of new (software and hardware) programmable mPlane probes with legacy probes adapted to the mPlane measurement layer interface into a com-







Figure 2.1: The mPlane architecture.

mon, large-scale, distributed measurement layer, which is concurrently accessible to a wide set of stakeholders (ISPs, Application Providers, Regulators, Researchers, and so on).

- The repository and analysis layer provides an efficient framework to store and process the large volumes of data collected by the measurement layer.
- The mPlane supervisor controls the actions and synthesizes the results of the far-flung probes and repositories, and iterates on these results to drill down to the root cause of a specific issue and/or investigate the relationship underlying a general phenomenon. This iterative analysis, supported and automated by an intelligent reasoner, is sorely missing in present measurement systems, and is one key element of the measurement plane.

Figure 2.1 shows the system architecture of mPlane with these layers.

## 2.4 Project objectives

Through its Integrating Project strategy, mPlane aims at addressing all the key aspects essential in monitoring and measurement approaches for the Future Internet. mPlane's ultimate goal is to (i) define an architecture for the mPlane platform, (ii) develop a set of flexible, programmable and high-performance probes and interfaces, (iii) define standard repositories for collection and query





of measurement data, (iv) design and implement an intelligent reasoner, and (v) prototype and demonstrate mPlane capabilities and benefits on realistic use cases.





## 3 Dissemination and Standardization activities planned

The dissemination and standardization activities planned in the project can be grouped in eight major areas:

- Project press release, factsheet and presentation;
- Project website;
- Research papers (aiming at disseminating research results);
- Talks and presentations focused on specific project objectives and tasks;
- Standardization contributions;
- Participation in concertation and Future Internet Assembly (FIA) activities;
- Open source release;
- Exploitation activities.

Table 3.1 reports the plans for dissemination and education activities, while Table 3.2 outlines the standardization activities planned within the mPlane project.





Objective	Approach	Outcome	Specific Actions	Key Performance
				Indicator
Awareness cre-	On-line dissemi-	Reaching the	Project website,	Web-site up and
ation: involving	nation with public	worldwide audi-	including software	running from
public	information and	ence and commu-	repositories and	month two until
	news related to	nities of interest	collection of tools;	the end of the
	the topics.		brochures and	project; newslet-
			posters.	ter issued three
				times a year and at
				least three press
				releases.
R&D community	Publish the	Reaching the R&D	Participate in the	At least ten top-
dissemination	project results in	community in-	European and in-	tier conference
	suitable events	volved in related	ternational confer-	journal publications, five
		areas of research	results prosents	journal publica-
			tion and exchange	IFFF special issue
			know-how	on mPlane-related
				tonics
Scientific dis-	Lectures and	Reaching the sci-	Organize seminars	One post-graduate
semination and	continued dis-	entific community,	and PhD schools,	school lasting
Education	semination of	researchers and	also with hands-on	for one week;
	project results for	both under- and	experiences.	one series of
	under- and post-	post-graduate		Dagsthul seminar;
	graduates as well	students		at least one under-
	for the scientific			graduate project
	community.			work.
Industrial dis-	Venues of differ-	Reaching Industry,	Organize work-	At least one in-
semination	ent target groups	Regulatory Agen-	shops and ah-hoc	dustrial workshop
	to exchange ex-	cies, Policy makers	meetings.	and one workshop
	periences and	and interest groups		with Regulatory
	advances with			Agencies and pol-
	respect to the			icy makers; at least
	state of the art in			two presentations
	mplane			at operator events.
	menane			

Table 3.1: Plans for dissemination and Education activities within the mPlane project.





Standards Body	Specific Group Targeted	Details of Contribution
	IPFIX (IP Flow Information	Extensions to the IPFIX
IETF	Export) - OPS Area	protocol to take into ac-
		count application-layer
		parameters, and passive
		and active performance
		measurement.
	IPPM (IP Performance Met-	Extensions to the IPPM
	rics) - TSV Area	framework metrics, pos-
		sibility to extend IPPM to
		passive measurements.
	NETCONF (Network Con-	Extensions of the NETCONF
	figuration) - OPS Area	protocol to take into ac-
		count measurement probe
		coordination.
IRTF	NMRG (Network Manage-	Contribute mPlane con-
	ment Research Group)	trol interfaces to con-
		figure probes. Possibil-
		ity to generate enough
		interest to spin-off a
		working/research group
		(through a BOF)
	NCRG (Network Complex-	Proposals based on mPlane
	ity Research Group)	technology that help oper-
		ators to regain control over
		their complex networks.
ETSI	Technical Committee	Extensions of ``User related
	Speech Processing, Trans-	QoS parameters definitions
	mission and Quality As-	and measurements" (ETSI
	pects (TC STQ)	EG 202 507-4) to capacity
		greater than e.g., 20Mbps.
ITU-T	Study Group 12 on Perfor-	Contribute mPlane metrics
	mance and Quality of Ser-	definitions and mapping of
	vice (QoS)	metrics to user-perceived
		quality.

Table 3.2: Plans for standardization activities within the mPlane project.





## 4 Initial dissemination activities

## 4.1 Project press release, factsheet and presentation

The project issued a press release at the beginning of the project, so that the information about the project activities planned can be distributed widely, so as to develop contacts with other associated research groups and projects towards wider cooperative work in the planned research activities. POLITO made the press release and it is available at the project website

https://www.ict-mplane.eu/public/news/mplane-national-newspaper-la-stampa

and at

http://www.lastampa.it/2012/11/06/tecnologia/mplane-misura-internet-permigliorarla-rko51Rg6ufJ7RUR9orgpj0/pagina.html.

The project factsheet provides project overview, partners involved and contractual information of duration and budget. The factsheet is made available on the project website that can be downloaded from the project *website: http://www.ict-mplane.eu*.

Newsletters are issued to all subscribers whenever relevant updates are available and are collected and publicly accessible at *https://www.ict-mplane.eu/public/news*.

Finally, the project presentation with details of technical activities and project structure is available on the project website: *http://www.ict-mplane.eu*.

## 4.2 The project website

The domain name ict-mplane.eu has been registered for the specific dissemination activities of the project. The project website is http://www.ict-mplane.eu. The web site is mostly meant for dissemination at large and designed accordingly; the main focus is put on a clear structure that enables the reader to quickly and easily find information. With its website the mPlane consortium wants to inform the stakeholders about the project status and results. To reach this in an effective way, the following aspects are considered:

- Use of a simple and clean structure in order to be quickly understood by the visitor. Allow fast and easy access to all available information. This should be done by considering the widely used "three clicks" rule for website design.
- Provide the information of the project on different levels of detail, allowing users with diverse backgrounds and experiences to understand the content.
- Provide continuously updated information on results that are achieved in the various working areas (e.g. publications addressing architecture, distributed root-cause analysis mechanisms, standards, and so on) of the project. This information should enable the visitor to get a quick overview of the approach taken and the main results achieved.
- Provide information on related events like conferences in a news flash.
- Provide all public deliverables and mPlane papers for download.





• Possibly make use of existing (preferably open source) software.

The website will have both static and dynamic content. The static content consists of information giving an overall introduction to the project, and a dynamic part, containing current news and achievements of the project. The static content is not expected to be significantly changed for the duration of the project. The dynamic content is updated at a regular basis.

### 4.3 Research papers

The project partners have been very active in publishing number of public papers in the international conferences and journals to inform the technical community with the results achieved in the project time to time. Some of the papers during the start-up phase were submitted before the start of the project, with advance information about mPlane project to create awareness of project activities planned among the research community.

The list below reports the research papers published in the first year in different Conferences and Workshops. Notably, some of the papers also received distinction and awards for the presented work (highlight in red).

The full list, together with the papers, is also publicly available on the project website at *https://www.ict-mplane.eu/publications*.

- 1. del Rio, P M S., D. Rossi, F. Gringoli, L. Nava, L. Salgarelli, and J. Aracil, "Wire-speed statistical classification of network traffic on commodity hardware", ACM Internet Measurement Conference (IMC), Boston, MA, 2012.
- 2. Bermudez, I., M. Mellia, M. Munafo', R. Keralapura, and A. Nucci, ``DNS to the rescue: Discerning Content and Services in a Tangled Web'', ACM Internet Measurement Conference (IMC), Boston, MA, 2012.
- 3. Drago, I., M. Mellia, M. Munafo', A. Sperotto, R. Sadre, and A. Pras, "Inside Dropbox: Understanding Personal Cloud Storage Services", ACM Internet Measurement Conference (IMC), Boston, MA, ACM, 2012. **IRTF Applied Networking Research Prize 2013**.
- 4. Vallina-Rodriguez, N., J. Shah, A. Finamore, Y. Grunenberger, K. Papagiannaki, H. Haddadi, and J. Crowcroft, ``Breaking for commercials: characterizing mobile advertising'', ACM Internet Measurement Conference (IMC), Boston, MA, ACM, 2012.
- 5. Y. Gong, D. Rossi, C. Testa, S. Valenti, and D. Taht, "Interaction or Interference: can AQM and Low Priority Congestion Control Successfully Collaborate", ACM CoNEXT, 2012.
- 6. Trammell, B., and D. Schatzmann, ``On Flow Concurrency in the Internet and its Implications for Capacity Sharing'', Proceedings of the Second ACM CoNext Capacity Sharing Workshop (CSWS), Nice, France, 2012.
- 7. Kuehlewind, M., S. Neuner, and B. Trammell, ``On the state of ECN and TCP Options on the Internet'', Passive and Active Measurement Conference (PAM), Hong Kong, 2013.
- 8. Chirichella, C., D. Rossi, C. Testa, T. Friedman, and A. Pescape, "Remotely Gauging Upstream Bufferbloat Delays", Passive and Active Measurement (PAM), Extended Abstract, 2013.





- 9. Arumaithurai, M., J. Seedorf, M. Dusi, E. Monticelli, and R. Lo Cigno, "Quality-of-Experience driven Acceleration of Thin Client Connections", IEEE International Symposium on Network Computing and Applications, 12, 2013.
- 10. Trammell, B., A. Finamore, and M. Mellia, ``A Measurement-Centered Approach to Latency Reduction'', ISOC Workshop on Reducing Internet Latency, London, England, 2013.
- 11. Casas, P., M. Seufert, and R. Schatz, "YOUQMON: A System for On-line Monitoring of YouTube QoE in Operational 3G Networks", Proceedings of the 31st IFIP Performance Conference, ACM Performance Evaluation Review, vol. 41, no. 2, 2013.
- 12. Chirichella, C., and D. Rossi, ``To the Moon and back: are Internet bufferbloat delays really that large'', IEEE INFOCOM Workshop on Traffic Monitoring and Analysis (TMA), 2013.
- 13. Gong, Y., D. Rossi, C. Testa, S. Valenti, and D. Taht, ``Fighting the bufferbloat: on the coexistence of AQM and low priority congestion control'', IEEE INFOCOM Workshop on Traffic Monitoring and Analysis (TMA), 2013.
- 14. Grimaudo, L., M. Mellia, E. Baralis, and R. Keralapura, ``Self-Learning Classifier for Internet Traffic'', The 5th IEEE International Traffic Monitoring and Analysis Workshop (TMA), 2013.
- 15. Gong, Y., D. Rossi, and E. Leonardi, "Modeling the interdependency of low-priority congestion control and active queue management", 25th International Teletraffic Congress, ITC 25, 2013. Runner up for the Best Paper Award
- Casas, P., P. Fiadino, and A. Bär, "IP Mining: Extracting Knowledge from the Dynamics of the Internet Addressing Space", 25th International Teletraffic Congress, ITC 25, 2013. Best Paper Award.
- 17. Bermudez, I N., S. Traverso, M. Mellia, and M. M. Munafo', ``Exploring the Cloud from Passive Measurements: the Amazon AWS case'', The 32nd Annual IEEE International Conference on Computer Communications (INFOCOM), Turin, Italy, 2013.
- 18. Fiadino, P., A. Bär, and P. Casas, ``HTTPTag: A Flexible On-line HTTP Classification System for Operational 3G Networks'', IEEE INFOCOM Demo/Poster Session, Turin, Italy, 2013.
- Casas, P., and P. Fiadino, ``Mini-IPC: A Minimalist Approach for HTTP Traffic Classification using IP Addresses'', 4th International Workshop on Traffic Analysis and Classification (TRAC), 2013.
- 20. Testa, C., Rossi, D., Rao, A. and Legout, A., Data Plane Throughput vs Control Plane Delay: Experimental Study of BitTorrent Performance, In IEEE P2P'XIII, Trento, Italy, September 2013.
- 21. Rossi, D., Nicolas, Y., Wolff, D. and Finamore, A., I tube, YouTube, P2PTube: assessing ISP benefits of peer-assisted caching of YouTube content . In IEEE P2P'XIII, Trento, Italy, September 2013.
- 22. Bellante, W., Vilardi, R., and Rossi, D. On Netflix catalog dynamics and caching performance . In IEEE CAMAD, Berlin, Germany, September 2013.
- 23. Apiletti, D., E. Baralis, T. Cerquitelli, S. Chiusano, and L. Grimaudo, ``SEARUM: a cloud-based SErvice for Association RUle Mining'', The 11th IEEE International Symposium on Parallel and Distributed Processing with Applications (ISPA), 2013.





- 24. Papadimitriou, D., F<sup>I</sup>brega, L., Vil<sup>I</sup>, P., Careglio, D., and Demeester, P., ``Measurement-based Experimental Research Methodology'', Lecture Notes in Computer Science (LNCS), Vol.7586, 2013.
- 25. Drago, I., E. Bocchi, M. Mellia, H. Slatman, and A. Pras, "Benchmarking Personal Cloud Storage", ACM Internet Measurement Conference (IMC), Barcelona, 2013.
- 26. Pastorelli, M., Barbuzzi, A., Carra, D., Dell'Amico, M.; Michiardi, P., ``HFSP: size-based scheduling for Hadoop'', BigData 2013, IEEE International Conference on BigData, Santa-Clara, 2013
- 27. Vallina-Rodriguez, N. and Aucinas, A. and Almeyda, M. and Grunenberger, Y. and Papagiannaki, D. and Crowcroft, J., ``RILAnalyzer: a Comprehensive 3G Monitor On Your Phone'', Internet Measurement Conference (IMC), 2013.
- 28. Vanaubel, Y. and Pansiot, J.-J. and Mérindol, P. and Donnet, B. "Network Fingerprinting: TTL-Based Router Signatures". In Proc. ACM/SIGCOMM Internet Measurement Conference (IMC). October 2013.
- 29. Detal, G. and Hesmans, B. and Bonaventure, O. and Vanaubel, Y. and Donnet, B. "Revealing Middlebox Interference with Tracebox". In Proc. ACM/SIGCOMM Internet Measurement Conference (IMC). October 2013.
- 30. Papadimitriou, D., and Demeester, P., ``Multi-agent Statistical Relational Learning Application to Distributed Control Processes'', 2nd European Teletraffic Seminar (ETS 2013), Blekinge Institute of Technology, Karlskrona, Sweden, September 30 - October 02, 2013.

### 4.4 Journal paper publications

The list below reports the research papers published in the first year in different Journals:

- 1. Simoncelli, D., M. Dusi, F. Gringoli, and S. Niccolini, ``Stream-monitoring with blockmon: convergence of network measurements and data analytics platforms'', SIGCOMM Comput. Commun. Rev., vol. 43, pp. 29–36, 2013.
- 2. Bagnulo, M., P. Eardley, T. Burbridge, B. Trammell, and R. Winter, ``Standardizing large-scale measurement platforms'', SIGCOMM Comput. Commun. Rev., vol. 43, pp. 58–63, 2013.
- 3. Traverso, S., Ahmed, M., Garetto, M., Giaccone, P., Leonardi, E., Niccolini, S., ``Temporal locality in today's content caching: why it matters and how to model it'', SIGCOMM Comput. Commun. Rev., vol. 45, 2013.

## 4.5 Talks, project presentations, seminars

This section reports the talks, presentations and seminars that were made during the first year of the project by all the partners, together with a summary of each. All presentations slides are also available at *http://www.ict-mplane.eu/public/talks*. Beyond the reported talks, each partner made sure to introduce and mention the scope of the project at every occasion they introduced their institution (commercially or in academic circles) and their activities. Furthermore, mPlane has been a gold sponsor for the prestigious ACM Internet Measurement Conference (IMC) 2013.





1. Presentation of mPlane at Future Networks 10th FP7 Concertation meeting, Brussels, Belgium, October 11, 2012.

This talk by POLITO introduces the mPlane project and the addressed problem, i.e., the need of a monitoring plane for the Internet. It further details the system architecture and discusses possible enhancement of current network monitoring systems.

2. Workshop Presentation ``mPlane: A Measurement Platform and its Application to the Cloud'', at Cloud-based Service Platforms for the Future Internet, workshop at Zurich University for the Applied Sciences, Winterthur, Switzerland, 29 November 2012.

A presentation by ETH of the mPlane architecture and its applicability to cloud and virtual network monitoring scenarios.

3. Presentation title: ``The mPlane project for Internet monitoring'', Open Source System Management Conference Wurth-Phoenix, Bolzen, Italy, April 18, 2013.

This talk by POLITO introduces the mPlane consortium and the problem addressed by the project, i.e., a monitoring plane for the Internet. If further focuses on Tstat to show an example of a passive probe that will be integrated in the mPlane system.

4. Invited Talk ``mPlane: Architecture and Interfaces'', at REANNZ, Wellington, New Zealand, 19 April 2013.

This talk by ETH introduced the present state of the mPlane architecture to network operations and measurement staff at REANNZ, the New Zealand research and education network, as part of an effort to disseminate mPlane architecture concepts and to elicit input from network operations groups on its applicability.

5. Presentation of mPlane at the Cyber Security & Privacy EU Forum, CSP 2013, Brussels, Belgium, 19 April 2013.

This talk by FTW introduces the mPlane project to the Measurements-based Analysis community around the privacy and cyber security domains. The talk provides a first overview of the mPlane's architecture, and describes some application use-cases showing the added benefits of the mPlane approach.

6. Presentation title: ``Internet Traffic Monitoring: Discerning Content and Services in a Tangled Web'', at LINCS Workshop, Paris, May 29, 2013.

This talk by POLITO is separated in two parts. The first part introduces the mPlane project and the elements composing the monitoring architecture. To better highlight the need of such system, the second part presents several results related to the recent evolution of Internet application and services.

7. Tutorial ``Applying IPFIX to Network Measurement and Management', with Benoit Claise (Cisco Systems) at IETF 87, Berlin, Germany, 28 July 2013; slides at http://www.ietf.org/ edu/tutorials/ipfix-tutorial.pdf

This tutorial by ETH introduces IPFIX, and describes the protocol at a level of detail sufficient to enable protocol designers and network management tool implementors to determine how to apply IPFIX to their specific problem domains.

8. Talk ``Integrating IPFIX with Pandas for Exploratory Analysis in Research'', at 5th NMRG Net-Flow/IPFIX Workshop, Berlin, Germany, 30 July 2013.





This talk by ETH introduces passive TCP performance features in QoF and an analysis framework for research with passive TCP performance measurement built around python-ipfix, IPython, and pandas.

9. Presentation ``Continuous analytics for traffic monitoring and applications to CDN'', at CoNEXT TPC Meeting, Barcelona, September 5, 2013.

This talk by POLITO is separated in two parts. The first part introduces the mPlane project and the elements composing the monitoring architecture. The second part focuses on the interactions between a passive probe (Tstat), a repository (DBStream) and some algorithms used to highlight Akamai CDN traffic policies.

10. Poster ``Mobile Network Performance Issue Call analysis'', at CoNEXT TPC Meeting, Barcelona, September 5, 2013.

A poster by TID presented during the CoNEXT TPC members, with the core ideas of the project and the contributions from TID.

11. Colloquium Presentation ``A Platform for Measurement Iteration and Automation'', at Chair for Network Architectures and Services, Technical University of Munich, Germany, 13 September 2013.

An update of the April invited talk by ETH, including additional details on interfaces and the mPlane type registry, given to a department colloquium.

12. Presentation of DATI to EuroBSDcon, St. Julians, Malta, September 29, 2013.

This talk by TI introduces Telecom Italia DATI (Deep Application Traffic Inspection) to the BSD community, highlighting the overall architecture, system functionality and scalability as well as an introduction Mplane project and integration main concepts and status.

13. Presentation ``Analysis of lifetime data for distributed systems subject to shared (hidden) risks by means of generalized multivariate model'' at International Conference on Statistical Distributions and Applications (ICOSDA) 2013, Mount Pleasant (MI), October 10-12, 2013.

This contributed talk by A-LBELL examines the lifetime data of distributed systems that are subject to simultaneous failures involving multiple system components by means of a generalized statistical model. Analyzing their behavior is of critical importance to model the robustness and reliability properties of such systems. The main difficulty arises from the absence of information on the underlying common cause(s) of failures risking to affect simultaneously multiple components. Moreover, the spatial distribution of components sharing common risks is not directly derivable from the individual rate of failure occurrence observed for each component taken separately; hence, the interdependence between simultaneously failing components (joint failure events) requires the introduction of generalized multivariate distribution.

14. Talk ``mPlane: A Platform for Measurement Iteration and Automation'', at First NMRG Workshop on Large Scale Network Measurements, 14 September 2013.

An update of the April invited talk and September colloquium talk by ETH, including additional details on interfaces and the mPlane type registry; slides at http://www.ietf.org/proceedings/interim/2013/10/14/nmrg/slides/slides-interim-2013-nmrg-1-2.pdf.





- 15. Presentation of mPlane by FHA with a focus on end host-based measurements to a regional German network operator. The result of that presentation was an agreement to place an mPlane probe into the operator's network.
- 16. Presentation of mPlane by ENST at the Computer Science department of the Shanghai Jiao Tong University.

The talk introduced the general mPlane concepts, as well as providing insights on specific architectural aspects to facilitate probe integration.

## 4.6 mPlane organized workshops and summer schools

### 4.6.1 Summer school on BigData, Turin, October 18-20, 2013

Within the project, we organized the 1st mPlane summer school in collaboration with the FP7 European project BigFoot [2]. The school, organized mostly by POLITO and EURECOM and held at Politecnico di Torino, focused on BigData technologies and covered the following subjects:

- MapReduce programming paradigm;
- Hadoop internals and libraries for BigData analysis;
- Pig and other high level programming languages for BigData;
- Applications to Internet traffic measurement and analysis

The school collected about 40 attendees including participants from both mPlane and BigFoot partners as well as students/researchers from other European universities. Classes held between September 18th and 20th, 2013 and activities have been split between theory and practice. Morning classes focused on theoretical aspects of the Hadoop/MapReduce framework. Instead, in the afternoon students accessed to a laboratory and they were asked to solve some exercices by implementing/modifing MapReduce algorithms and run some analytics on real network data. It is important to underline that all the material used for classes is publicly available on the mPlane portal. This includes an ad-hoc virtual machine preconfigured to contain all the data and software needed to solve the exercises [13].

At the end of the school, all registered students got a certificate of attendance. Moreover, they had to held an exam by showing and commenting the collected results of the exercices done during the 3 days of the school.

### 4.6.2 TMA Workshop, Turin, April 19, 2013

Politecnico di Torino hosted the 5th edition of the International Traffic Monitoring and Analysis Workshop, TMA 2013 (http://infocom.di.unimi.it/index.php/tmawksp.html), which was technically supported by the mPlane project. TMA 2013 was co-located with the prestigious IEEE International Conference on Computer Communications, INFOCOM 2013, which additionally boosted the visibility of mPlane as technical sponsor of one of its workshops.





### 4.6.3 Workshop on Quality of Service, Rome, June 12, 2013

On June 12 2013 FUB and AGCOM (Italian Agency for Communications) organized the workshop "La qualità dell'accesso ad Internet da Rete fissa in Italia" in Rome. In such a workshop FUB and AGCOM presented their activity on the Quality of service monitoring of the Italian wireline access networks carried out in the framework of the MISURAINTERNET project (https://www.misurainternet.it/home.php).

All the Italian TLC operators, enterprises and research institutes took part at such a workshop and it was an opportunity to analyze several topics regarding the quality of the internet network. Alessandro Luciano (FUB president) also introduced and described the mPlane project and the importance for future monitoring of the European Internet networks. All the presentations of the workshop can be found at http://www.fub.it/node/2796.

### 4.6.4 TRAC Workshop, Cyprus, August 2014

FTW and ETH are chairing the 5th edition of the International Workshop on TRaffic Analysis and Characterization, TRAC 2014 (http://trac2014.ftw.at), which is technically supported by the mPlane project. Having mPlane as technical sponsor for international conferences and workshops in the thematics of the project permits to expand its visibility to broader communities, specifically through the dissemination of the Call for Papers, the conference or workshop website, and at the venue of the event itself.

### 4.6.5 TMA Summer School, London, UK, April 2014

ENST is chairing the 1st TMA Summer school. After 5 years as a succesful workshop of renowed conferences (e.g., PAM and INFOCOM), Traffic Monitoring and Analysis (TMA'14) is launching for its 6th edition a standalone event http://www.cs.ucsb.edu/~almeroth/conf/stats/#tma, including a PhD school and seminar. The school, whose program has not been defined so far, will probably focus and leverage on software developed in the mPlane project framework.

As for the previous event, it is worth stressing once more that having mPlane as technical sponsor for international conferences and workshops in the thematics of the project permits to expand its visibility to broader communities, specifically through the dissemination of the Call for Papers, the conference or workshop website, and at the venue of the event itself. Extending this to the PhD school, will ensure and facilitate that mPlane software will actually be used by the research community.





## 5 Initial Standardization activities

This Section describes the standardization achievements of the mPlane project during the first year. The standardization strategy taken is outlined and the concrete activities in the IETF, IRTF and ITU are described.

### 5.1 IETF activities in Year 1

### 5.1.1 IETF working groups

#### **IETF LMAP Working Group**

The IETF has recently formed a working group on *Large-Scale Measurement of Broadband Performance* (*LMAP*)<sup>1</sup>. The goal of the LMAP working group is to standardize a large scale measurement system for performance measurements of broadband access devices such as home and enterprise edge routers, personal computers, mobile devices, set top box, whether wired or wireless. The LMAP working group is chartered to specify an information model, the associated data models, and select/extend one or more protocols for the secure communication.

NEC is contributing to the IETF LMAP WG with a draft "ALTO for Querying LMAP Results" (draft-seedorf-lmap-alto) [11] [12] which proposes to use the IETF ALTO protocol as a query-response mechanism for automatically accessing aggregated LMAP measurement results. This draft has been presented by Jan Seedorf (NEC) at the LMAP BoF during the IETF-86 meeting<sup>2</sup> and during the first official LMAP working group session during the IETF-87 meeting<sup>3</sup>.

FHA participates in the LMAP working group, which is topic-wise closely aligned with the ongoing work at FHA. In particular, FHA tried to have end-user initiated tests to remain in scope of LMAP for two reasons. A) as an important aspect for regulators and B) as an important case for mPlane.

ETH contributes to discussions in the LMAP working group; the architecture under consideration by this group has moved somewhat away from the mPlane draft architecture, and it is significantly less ambitious, but we are monitoring the working group for opportunities to contribute mPlane work to LMAP.

#### IETF IPPM Working Group

Brian Trammell from ETH co-chairs the IP Performance Metrics (IPPM) working group; as an IPPM chair, he is overseeing metric development for large-scale network measurements. Where possible, mPlane will use IPPM measurement protocols and metrics for active measurement.

#### **IETF IE-DOCTORS group of experts**

Brian Trammell from ETH is a member of the IE-DOCTORS group of experts [14] responsible for the maintenance of the IPFIX Information Element Registry, on which work on the mPlane

<sup>&</sup>lt;sup>3</sup>http://tools.ietf.org/wg/lmap/agenda?item=agenda-87-lmap.html



<sup>&</sup>lt;sup>1</sup>http://tools.ietf.org/wg/lmap/

<sup>&</sup>lt;sup>2</sup>http://tools.ietf.org/wg/lmap/agenda?item=agenda-86-lmap.txt



Element Registry will be based. In this capacity, he has already contributed the definitions of Information Elements 401 and 402 (transportOctetDeltaCount and transportPacketDelta-Count) for differentiating headers from payload in passively observed traffic.

### 5.1.2 IETF meetings

Partners participated in the following IETF meetings during the period:

#### IETF 85, Atlanta, USA

Brian Trammell from ETH presented ``Hybrid Measurement using IPPM Metrics'' (draft-trammellippm-hybrid-ps) in IPPM session; the draft has since been abandoned. Nominated for and accepted co-chairship of IPPM working group. Authored ``Textual Representation of IPFIX Abstract Data Types'' (draft-trammell-ipfix-text-adt) after hallway meetings in Atlanta; this will provide the basis for equivalence between mPlane Elements and IPFIX IEs within the mPlane control and direct query interfaces. Co-chaired MILE working group on interdomain security incident information sharing.

#### IETF 86, Orlando, USA

Brian Trammell from ETH co-chaired IPPM working group, oversaw rechartering of working group to align with LMAP (large scale broadband measurement) activity and continue maintenance of IPPM metrics and protocols. Presented ``Textual Representation of IPFIX Abstract Data Types'' in the IPFIX working group. Presented introduction of IPFIX in LMAP BoF, to raise IPFIX as a possible reporting protocol for LMAP.

Jan Seedorf from NEC presented the draft "ALTO for Querying LMAP Results" (draft-seedorf-lmap-alto)[11] at the LMAP BoF<sup>4</sup>.

#### IETF 87, Berlin, Germany

Brian Trammell from ETH delivered IPFIX tutorial as part of IETF edu-team activities on Sunday before the meeting. Presented talk on Pandas for IPFIX analysis at NMRG meeting. Co-chaired IPPM working group. Presented ``A Mechanism for ECN Path Probing and Fallback'' (draft-kuehlewind-tcpm-ecn-fallback) in TCPM (TCP Maintenance and Minor Extensions) working group following on findings in ``On the state of ECN and TCP options on the Internet'' (PAM 2013 paper).

Jan Seedorf from NEC presented the draft 'ALTO for Querying LMAP Results'' (draft-seedorflmap-alto) [12] during the first official LMAP working group session<sup>5</sup>. The feedback received was generally positive. However, it was noted that the proposed mechanism does not strictly fall under the LMAP charter. It is therefore an option to move this work to the ALTO working group in future IETF meetings.

### 5.1.3 RFCs published

Though work on four RFCs updating IPFIX started well before the scope of the mPlane project, these have been completed and published during the project (September 2013):

<sup>&</sup>lt;sup>5</sup>http://tools.ietf.org/wg/lmap/agenda?item=agenda-87-lmap.html



<sup>&</sup>lt;sup>4</sup>http://tools.ietf.org/wg/lmap/agenda?item=agenda-86-lmap.txt



1. RFC 7011 (STD 77) ``Specification of the IP Flow Information Export (IPFIX) Protocol for the Exchange of Flow Information''

This document specifies the IP Flow Information Export (IPFIX) protocol, which serves as a means for transmitting Traffic Flow information over the network. In order to transmit Traffic Flow information from an Exporting Process to a Collecting Process, a common representation of flow data and a standard means of communicating them are required. This document describes how the IPFIX Data and Template Records are carried over a number of transport protocols from an IPFIX Exporting Process to an IPFIX Collecting Process. This document obsoletes RFC 5101.

2. RFC 7012 ``Information Model for IP Flow Information Export (IPFIX)''

This document defines the data types and management policy for the information model for the IP Flow Information Export (IPFIX) protocol. This information model is maintained as the IANA "IPFIX Information Elements" registry, the initial contents of which were defined by RFC 5102. This information model is used by the IPFIX protocol for encoding measured traffic information and information related to the traffic Observation Point, the traffic Metering Process, and the Exporting Process. Although this model was developed for the IPFIX protocol, it is defined in an open way that allows it to be easily used in other protocols, interfaces, and applications. This document obsoletes RFC 5102.

3. RFC 7013 (BCP 184) ``Guidelines for Authors and Reviewers of IP Flow Information Export (IPFIX) Information Elements''

This document provides guidelines for how to write definitions of new Information Elements for the IP Flow Information Export (IPFIX) protocol. It provides instructions on using the proper conventions for Information Elements to be registered in the IANA IPFIX Information Element registry, and provides guidelines for expert reviewers to evaluate new registrations.

4. RFC 7015 ``Flow Aggregation for the IP Flow Information Export (IPFIX) Protocol''

This document provides a common implementation-independent basis for the interoperable application of the IP Flow Information Export (IPFIX) protocol to the handling of Aggregated Flows, which are IPFIX Flows representing packets from multiple Original Flows sharing some set of common properties. It does this through a detailed terminology and a descriptive Intermediate Aggregation Process architecture, including a specification of methods for Original Flow counting and counter distribution across intervals.

### 5.1.4 Drafts in progress

The following contributions are currently in progress:

1. "A Mechanism for ECN Path Probing and Fallback" (draft-kuehlewind-tcpm-ecn-fallback-01)

This work from ETH follows on Kühlewind, Neuner, and Trammell "On the State of ECN and TCP Options on the Internet", PAM 2013, to work to increase the usage of ECN, which (1) improves passive measurability of congestion and loss as well as (2) reducing their impact. Explicit Congestion Notification (ECN) is a TCP/IP extension that is widely implemented but hardly used due to the perceived unusability of ECN on many paths through the Internet caused by ECN-ignorant routers and middleboxes. This document specifies an ECN probing





and fall-back mechanism in case ECN has be successfully negotiated between two connection endpoints, but might not be usable on the path.

2. "Textual Representation of IPFIX Abstract Data Types" (draft-trammell-ipfix-text-adt)

This document from ETH defines UTF-8 representations for IPFIX abstract data types, to support interoperable usage of the IPFIX Information Elements with protocols based on textual encodings. It is designed to allow the definition of a bridge between mPlane Results and IPFIX Records.

3. "Revision of the tcpControlBits IPFIX Information Element" (draft-trammell-ipfix-tcpcontrolbits-revision)

This document from ETH revises the tcpControlBits IPFIX Information Element defined in [10] to reflect changes to the TCP Flags header field since [9]. The publication of this document fulfills a requirement to seek IETF Consensus for changes due to the RFC 7013 process that would modify Information Elements defined by a Standards Track document, in this case, RFC 5102. The change to the tcpControlBits IE brings the registry in line with that supported by the QoF flow meter under development in WP2. The draft was sent to the IESG as an individual submission on 8 October 2013.

4. "ALTO for Querying LMAP Results" (draft-seedorf-lmap-alto) [11] [12]

NEC has contributed a proposal for using the Application-Layer Traffic Optimization (ALTO) Protocol [1] for making LMAP measurements results available to distributed applications. The document argues that there is a need for an intermediate way to provide access to large-scale network measurement results, flexible enough to enable querying of specific and possibly aggregated data. The Application-Layer Traffic Optimization (ALTO) Protocol, defined with the goal to provide applications with network information, seems a good candidate to fulfill such a role. Example use case considered are automatically using LMAP measurement results to improve HTTP adaptive streaming, optimize Website Front End Optimization, estimate of service quality or total download time of webservices, or general troubleshooting of distributed applications.

### 5.2 IRTF activities in Year 1

A-LBELL actively contributes to the NMRG (Network Management Research Group) of the IRTF.

Dimitri Papadimitriou from A-LBELL has participated to the NMRG/IRTF meeting held in Zurich on Oct.14 2013 with a presentation on Hypergraph mining. This contribution aims at extending the set of modeling and analysis techniques beyond graph-based modeling which provides a foundation for phenomena and/or problems involving one-to-one relationships/interactions among entities allowing data analysis and mining to understand relations between these entities. However, graph modeling fails to capture group-level interactions between entities that are of different nature. Indeed, many of the relationships exhibited in various domains including information networks are not restricted to be one-to-one. Building a model that inherently handles many-to-many relationships/ group interactions would better rely on hypergraphs. In a graph an edge can be incident on exactly two vertices whereas each hyperedge in a hypergraph is an arbitrary subset of the vertex set and represents relations between its elements. Thus, many hyperedges may be subsets of other hyperedges. Hypergraphs can model many-to-many relationships among entities attributes enabling





in turn to handling problems such as similarity, clustering and construction of classifiers. Moreover, a probabilistic hypergraph presents not only grouping information, but also the probability that a vertex belongs to a hyperedge. In this way, the correlation information among vertices can be more accurately described. This paper details the foundational principles and techniques underlying hypergraph data mining. The technique is applied the analysis of the relationships between (attributes of) traffic directed to certain Autonomous Systems (AS)/address prefixes (vertex) and content caches/servers (hyperedge). The technique is then extended to probabilistic hypergraphs, which represent the probability that vertices belong to hyperedges and hierarchical directed acyclic graphs which represent relationships between hyperedges.

In general, A-LBELL focus is on statistical analysis of data (incl. parametric and non-parametric methods). Some of these techniques fall in the scope of NMRG and can also help modeling complexity thus potentially applicable in the context of the Network Complexity Research Group (NCRG)/IRTF.

## 5.3 ITU liaison

### 5.3.1 ITU-T SG 13

Several activities of mPlane are of interest of ITU-T SG13 "Future networks including cloud computing, mobile and next-generation networks". Even though specific activities have not yet taken place, here we report the Questions (Q) where mPlane plan to submit proposals for normatives:

- **Q6/13** Requirements and mechanisms for network QoS enablement (including support for softwaredefined networking);
- **Q7/13** Deep packet inspection in support of service/application awareness in evolving networks;
- **Q15/13** Data-aware networking in future networks;
- **Q19/13** End-to-end Cloud computing service and resource management.

Furthermore the mPlane architecture is well compatible with the concept of Software Defined Network and in particular it could build a fundamental tool for the Orchestrator. Therefore we believe that also the following topics could be of interest for a liason between mPlane and ITU-T:

- **Q2/13** Requirements for NGN evolution (NGN-e) and its capabilities including support of IoT and use of software-defined networking;
- **Q3/13** Functional architecture for NGN evolution (NGN-e) including support of IoT and use of software-defined networking;
- **Q8/13** Security and identity management in evolving managed networks (including software-defined networking).

### 5.3.2 ITU-T SG 12

On the other hand activities of mPlane are of interest also for ITU-T SG12 "Performance, QoS and QoE". In particular we report the Questions (Q) where mPlane plan to submit proposals for normative.





- **Q3/12** Speech transmission characteristics of communication terminals for fixed circuit-switched, mobile and packet-switched (IP) networks;
- **QSGD** Quality of Service Development Group;
- **Q9/12** Perceptual-based objective methods for voice, audio and visual quality measurements in telecommunication services;
- Q10/12 Conferencing and telemeeting assessment;
- Q11/12 Performance interworking and traffic management for Next Generation Networks;
- **Q12/12** Operational aspects of telecommunication network service quality;
- **Q13/12** QoE, QoS and performance requirements and assessment methods for multimedia;
- Q14/12 Development of parametric models and tools for multimedia quality assessment;
- **Q15/12** Objective assessment of speech and sound transmission performance quality in networks;
- **Q16/12** Framework for diagnostic functions and their interaction with external objective models predicting media quality;
- Q17/12 Performance of packet-based networks and other networking technologies.





# 6 Initial record of Participation in concertation and future Internet assembly activities

The project is aware of number of concertation activities that EC regularly organize to coordinate the research project results. To this goal, mPlane partecipated and plans to actively participate in the future Internet Assembly in developing the scalable future Internet research agenda.

# 6.1 Workshop on "Computing SLAs in FP7 - Exploitation of Research Results", Brussels, 27 May 2013

In this workshop, organized by the European Commission DG CONNECT in Brussels, 27 May 2013, FUB presented for mPlane the contribution ''MPlane for multilayer SLA''. The talk can be found on the project website at

(https://www.ict-mplane.eu/sites/default/files//public/public-page/talks/399mplanesla2.pdf).

The unit CONNECT E2 "Software & Services, Cloud" of the European Commission is organising an expert workshop focusing on exploiting the research results of projects in the domain of Service Level Agreements (SLAs).

The objective of that expert workshop was to exploit the SLA research outcomes stemming from European projects and deliver recommendations on how to integrate these outcomes into the ongoing policy work on SLAs of the Cloud Select Industry (SIG) Group - set-up by the EC Vice-President Nellie Kroes to help in the implementation of the Cloud Computing Communication actions.

The workshop was structured around different and complementary SLA thematic areas, each one being addressed by the corresponding European and National research projects. Leading researchers from industry and academia presented the results of these projects, emphasizing on tangible outcomes that can form the basis for exploitation and future recommendations.





# 7 Open source release

mPlane has been developing quite a number of tools for the analysis and measure of the Internet infrastructure. The project has released most of those tools as open source to the community and partners are actively involved in the development of them.

# 7.1 IPFIX

ETH has released and continues to maintain the ipfix module for python 3.3 (http://pypi.python. org/ipfix) in the frame of the project. The intention is to integrate this module with the control reference implementation to allow transparent bridging between mPlane Results and IPFIX records. The software is under active development with a live repository at github (http://github.com/britram/python-ipfix) and available under the GNU Lesser General Public License.

# 7.2 QoF

ETH is continuing the development of the QoF TCP-aware flow meter based on YAF. There has not yet been a full alpha release of the software, but prerelease software is available from the public GitHub repository (http://github.com/britram/qof). QoF is available under the GNU General Public License.

## 7.3 mPlane control interface reference implementations

ETH is continuing the development of the mPlane control interface reference implementation, and two active probe implementations (ping and traceroute) designed as examples of how to use the reference implementation to build proxies; this code is not yet released but will be, under the same terms as the python IPFIX module.

## 7.4 Blockmon

NEC is continuolsy developing and maintaining Blockmon, an Open Source stream-processing platform, designed to enable measurement of ever larger networks which is available at the git repository *blockmon.github.com/blockmon*.

### 7.5 Tstat

POLITO is continuolsy developing and maintaining Tstat, an Open Source passive monitoring tool. Moreover, it is currently working on a framework to continuously and efficiently export data from monitoring probes. This framework will be released as Open Source. Together with NEC, there is also the active implementation and integration of Tstat into Blockmon. Together with ENST, a number of methodologies to passively measure one way delay based on transport layer (TCP, TCP)





with TimeStamp) or application layer (uTP header) information have been implemented.

### 7.6 Misurainternet Open source software

The Open source software developed in the framework of the Italian project Misurainternet is at disposal of mPlane and was analysed by ENST. This is the code that permit to measure the QoS in terms of throughput for wireline access network both for users and ISP. In particular the user can download an agent on his computer, where the ISP have active probes located in some specific point of Italy. Please refer to the following web-site for more details: *https://www.misurainternet.it/home.php*.

## 7.7 Hadoop Fair Sojourn Protocol

EURECOM has released a scheduler for Apache Hadoop (hadoop.apache.org), called "Hadoop Fair Sojourn Protocol" (HFSP), using the Open Source Apache 2.0 license. The software is available in a github repository (https://github.com/melrief/HFSP).

## 7.8 PerformanceVisor plugins

NETvisor plans to release mPlane-specific measurement collector and analysis modules for the "PerformanceVisor" (PVSR) framework, which is an existing, commercial product of NETvisor. PVSR modules (plugins) developed under mPlane will be open source and available for free of charge, however in order to use these modules, users need to have valid licenses for the PVSR core. Furthermore, all software developed within mPlane by NETvisor is going to be released as open source.

### 7.9 RILAnalyzer

RILAnalyzer is a tool by TID that provides mechanisms to perform network analysis from within a mobile device. RILAnalyzer is capable of recording low-level radio information and accurate cellular network control-plane data, as well as user-plane data. Such data can be used to identify previously overlooked network and connectivyt management issues and infer how the different configurations interact with application logic, causing network and energy overheads.

We are planning to release full source codes soon. For now it can be used as a binary tool - schema of the data logged for personal analysis are provided. More details at the github repository: http://andriusa.github.io/RILAnalyzer.

# 7.10 GLIMPSE

FHA is developing the GLIMPSE software system. GLIMPSE is a cross-platform end host-based measurement system with a particular focus on network troubleshooting. Part of the default measure-





ment capabilities of GLIMPSE is bandwidth estimation of various forms that target regulatory use cases covered by the IETF LMAP WG. Currently, the software is in no state to publish it as an open source product. It is available to all mPlane project partners but an official release is only planned when the software is stable enough for that. The software will be available under *www.measure-it.net*.

## 7.11 Tracebox

ULg has already released a first version of the tracebox code. The current tracebox is implemented in C++ in about 2,000 lines of code and embeds LUA [5] bindings to allow a flexible description of the probes as well to ease the development of more complex middlebox detection scripts. Several LUA scripts are already available and allows one to detect various types of middleboxes from Application-level Gateways to HTTP proxies. It is open-source and publicly available (see http://www.tracebox.org).

We are currently porting tracebox into scamper [7], a tool used by CAIDA for their Archipelago measurement infrastructure [3].

Network fingerprinting has already been implemented within scamper. ULg plans to include it in the official scamper distribution in the near future. Note that scamper is open-source and publicly available.

For the moment, the source code of MERLIN [8] is available on-demand.

# 7.12 DMFSGD

ULg is developing an implementation for DMFSGD [6]. The idea behing DMFSGD is to infer delay between distance hosts without performing any measurement. The tool is written in Python and contains a measurement module (RTT) and a computation module. The tool, still under construction and evaluation, will be open-source in the near future.

### 7.13 TopHat scanner

ENST is developing tools, including a fast ICMP scanner, for TopHat/TDMI (http://www.top-hat. info) a dedicated measurement infrastructure running over PlanetLab. Given the scale of the PlanetLab ecosystem, and its global reach, this make TopHat/TDMI an interesting candidate for launching active experiments in mPlane. The scanner tool has been implemented in a flexible way, to either allow continuous probing of thousands of machines, or slow probing of a very large number of hosts, in an attempt to continuously map the internet graph.





## 8 Initial exploitation activities

## 8.1 Objectives

mPlane explores new areas for monitoring applications by research and prototyping. However, the outcome of mPlane is also intended to be used by each partner to advance in their particular area. This section is describing the initial usage of results stemming from the mPlane project.

It is worth noticing that to the purpose of exploiting the project as a whole we have started the discussion with institutions such as RIPE and CAIDA which can help deploy the mPlane infrastructure on a broad scale.

## 8.2 Intended Usage of Results

Based on the initial achievements accomplished during the first year of the project, each partner has set the basis for a good exploitation of mPlane results. Here follows the relevant factors and the initial usage of results from each partner, together with plans on how to continue making use of such results.

### 8.2.1 POLITO

POLITO in collaboration with FW have already exploits some of the tools contributed to the mPlane project to handle passive monitoring probes in the operator network. The results of this collaboration will be extended to the other parners of the project and the mPlane system itself.

### 8.2.2 NEC

NEC is actively discussing with business units, such as NetCracker, for the commercialitazion of BlockMon, the high-availability data analytics platform that has been developed throughout the project, towards tier-1 network operators in Europe. A meeting with a tier-1 network operator has already taken place.

### 8.2.3 FUB

FUB operates in the framework of ITU-T SG 13 and in such an environment FUB intends to propose some normative regarding topics that are under investigation in mPlane.

### 8.2.4 NETvisor

NETvisor is planning to incorporate tools and methodologies developed under mPlane into our dayto-day activites as a (Network/Telecommunications) Operational Support Systems (OSS) provider.





### 8.2.5 FTW

FTW stakeholders include multiple industry partners in the telecommunications' sector. Our main exploitation plan of mPlane results concerns transferring them to our industrial partners; together with them, we shall evaluate their commercial applicability and/or adoption. In this direction, we are currently discussing on the feasibility of launching a common industrial project with a national wide Network Operator and a major Network Constructor in thematics directly related to mPlane, specifically around intelligent network monitoring and automatic fault diagnosis.

### 8.2.6 TID

TID is planning to introduce some of the tools developed under mPlane into some of the operations of the provider. Furthermore, we filed one patent related to the mobile phone troubleshooting that we are investigating through mPlane.

### 8.2.7 FHA

FHA is planning to do a first internal software release by the end of the year. Internal here means that the software is being distributed to students to test all components of the system. In parallel, trials with a regional ISP are planned where probe is being deployed. In addition, contact to other ISPs is being sought hoping to deploy additional probes in operational networks of different size and reach.

### 8.2.8 ALBLF

ALBLF is currently exploring the media curation use case. Its goal is to provide a novel type of recommendation systems that use as an input content traffic monitored from the network. Given the early stage of this work and the fact that we've been focusing up to now on our system's feasibility, in terms of exploitation, our plan has been so far to build intellectual property around the topic. We started already executing this plan, as we filed three patent applications relating to the media curation topic. One application concerns the system as a whole and the two others are around methods to infer useful information for our system out of the huge amount of content traffic that is monitored. As the topic progresses, we're evaluating the opportunity to take this use case a step further, to discuss it with the business units and business partners.

#### 8.2.9 FW

FASTWEB intends to early adopt the mPlane system developed by the project and start using it in customer and network operation.





### 8.2.10 SSB

SSB is planning to use the mPlane infrastructure (or parts of it) to integrate and extend the technical means in hand of the company, in order to offer better and more sophisticated consulting services for commercial partners involved in networking activities

#### 8.2.11 ULg

ULg intends to port into scamper tools (tracebox and network fingerprinting) developped within the mPlane context. As such, tools developped by ULg should be part of the official scamper release and used by CAIDA (Cooperative Association for Internet Data Analysis) for their day-to-day measurements. In addition, ULg advertised the tracebox tool to Belgian industrials, mainly those active in the monitoring area. Finally, measurement techniques developped within the mPlane projet will be taught to ULg Computer Science Master students (mainly through the course called ``Network Measurement and Monitoring'').

### 8.2.12 ENST

ENST is planning to integrate TopHat in mPlane, which would allow to launch fairly-large scale active experiments from PlanetLab, which would greatly assist e.g., troubleshooting activities. Furthermore, ENST is also actively developing Tstat plugins, and would like to push these changes, so far tested on offline traces, to the main Tstat branch to leverage the multiple probes where Tstat is already installed.

### 8.2.13 A-LBELL

A-LBELL exploitation of the project results considers on the one hand statistical learning and (hyper)graph mining as part of the network monitoring and analysis system and on the other hand the combination of different analytic dimensions (topology, traffic, information) in order to detect phenomena that can be identified by analyzing each of them separately. These exploitation targets and goals will benefit from the experience gained from the development of the mPlane reasoner in which A-LBELL is involved.

### 8.2.14 TI

Telecom Italia is planning to integrate DATI in mPLane in order to achieve well-known APIs and interfaces for access to data and for the management of probes. Telecom Italia explicitly added in its Technology Plan specific action to be led in upcoming three years in order to have a better conformance to measurements standard interfaces.





### 8.2.15 ETH

ETH is presently applying the python-ipfix and QoF tools developed in the scope of work packages WP1 (Interface Implementation) and WP2 (Probe Development), respectively, in its ongoing research on deployable passive TCP performance measurement and enhanced network flow collection. python-ipfix has already been released open source, and QoF will see initial release by the end of CY 2013. Both tools will be integrated within the mPlane platform in the coming year.

### 8.2.16 EURECOM

EURECOM is planning to use mPlane results and acquired technical know-how, especially the one derived from the preparation of the 1st mPlane Summer School on Big Data, for teaching activities.





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