



# COHERENT CODING AND COMMUNICATIONS OVER HETEROGENEOUS TECHNOLOGIES

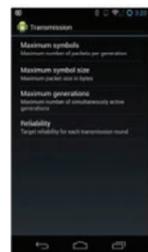
Current mobile devices are equipped with a large number of wireless interfaces for communication. However, they typically choose a single interface to communicate at every time given the inherent challenges of managing heterogeneous interfaces. COHERENT leverages network coding as a key technique to ease this process and provide improved throughput, lower delay, and higher reliability to data flows. The COHERENT team not only provided theoretical results on this topic on a wide set of applications (including satellite, vehicular, and cellular communications), but also delivered two demonstrators implementing the most promising ideas.

Current mobile devices are equipped with a multitude of wireless interfaces that offer diverse bandwidth, error rate and latency, at different energy and economic costs. In this scenario, multi-homing allows end devices to be simultaneously connected to multiple network interfaces, thereby increasing reliability and QoS of content delivery. Currently, mobile devices choose the interface to use according to static, pre-defined priorities: use Wi-Fi if possible, 3G otherwise, and Bluetooth for specific applications. This is consistent with today's business model for mobile connectivity, but it is not necessarily efficient in terms of providing QoS, managing network resources, extending battery lifetime or decreasing economic costs. COHERENT envisions that, in the future, the interface to use will be chosen according to application and user requirements, as well as device and network conditions. Moreover, multi-homing opens up the possibility to use different interfaces simultaneously for different applications, depending on their QoS requirements, available battery life and importance to the user, which can be expressed as acceptable economic costs. This potential can even be exploited for different data flows within a same application, each of which may use different interfaces, e.g. a video-conference can be split into audio over UMTS for better quality and video over Wi-Fi for lower cost for the user. Optimal and adaptive resource allocation algorithms that choose what and how much data to send/request through each available interface based on network conditions, user applications, and energy requirements are thus instrumental to leverage the full potential of multi-homing.

COHERENT delivers fundamental knowledge and a proof-of-concept for network coding as a key enabler of efficient networking for multi-homed devices. By exploiting the multiple, coexisting technologies in the end terminals, e.g., Wi-Fi, Bluetooth, WiMAX, UMTS, COHERENT shall focus on developing resource allocation and decision algorithms developed to optimise the use of the multiple available technologies, leveraging advanced coding techniques. Our view is that the optimal trade-off between energy efficiency, quality of service, network resources optimization, and economic costs can only be achieved by fully exploiting synergies amongst heterogeneous wireless networks (HWN) through multi-homing. The existing heterogeneous mobility platform developed by previous projects (PANORAMA and LTE\_Mob) between Instituto de Telecomunicações (IT) – Aveiro and Portugal Telecom Inovação (PTIN) shall be used for practical evaluation and demonstration of the developed algorithms and methodologies. Conversely, the platform's functionality will be enhanced with joint coding and resource allocation algorithms.



- Interface configuration**
  - Enable / Disable
  - Maximum transfer rate
  - Target addresses
- File browser**
- Transmission status**
  - Control: start/stop
  - Progress
  - Statistics



Tunable parameters  
Study impact of each parameter

Fig.1 -

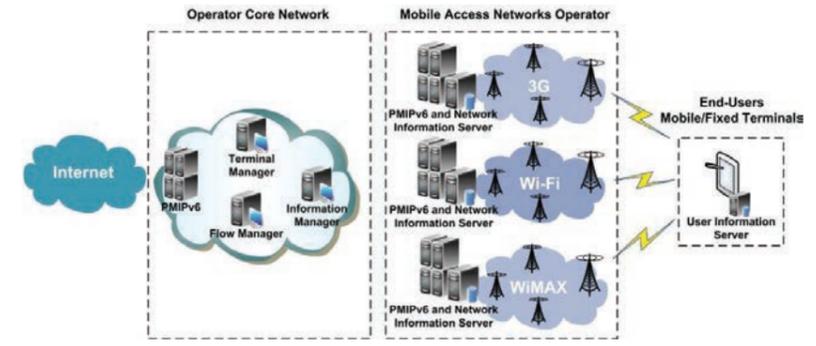


Fig.2 -

## ACHIEVEMENTS

The COHERENT project demonstrated network coding-based resource allocation and decision algorithms for efficient multi-homing leveraging a pre-existing mobility platform deployment carried-out by IT – Aveiro and PTIN, which already combines Wi-Fi, UMTS and WiMAX. The COHERENT team also provided an Android demonstrator capable of using several wireless interfaces, e.g., Bluetooth, WiFi, 3G, simultaneously to provide improvements in throughput and delay. Achievements of this project include two demonstrators (one in Android devices and one for vehicular technologies), invited presentations at ETSI SCN Working Group and at the COST action IC1105, and a number of publications to date (2 accepted journal, 1 submitted journals, 1 journal in preparation, 5 accepted conference papers, 1 book chapter under submission).

PROJECT TEAM			PUBLICATIONS	
DANIEL LUCANI (PI)	PhD	NS Porto	- Moreira, D. E. Lucani, "Coded Schemes for Asymmetric Wireless Interfaces: Theory and Practice" accepted to IEEE Journal on Selected Areas in Communications, expected publication March 2015 (Impact Factor: 4.138).	
SUSANA SARGENTO	PhD	NAP Aveiro	- N. Capela, S. Sargento, Multihoming and network coding: A new approach to optimize the network performance, Comput. Netw. (2014), http://dx.doi.org/10.1016/j.comnet.2014.09.002.	
ANA AGUIAR	PhD	NS Porto	- A. Moreira, D. E. Lucani, "On Coding for Asymmetric Wireless Interfaces," accepted to the International Symposium on Network Coding (NetCod), pp.149-154, Boston, USA, Jun. 2012.	
FAUSTO VIEIRA	MsC	NS Porto	- Capela, N.; Sargento, S., "Optimizing network performance with multihoming and network coding," Globecom Workshops (GC Wkshps), 2012 IEEE, vol., no., pp.210,215, 3-7 Dec. 2012	
ANDRÉ MOREIRA	PhD Student	NS Porto	- C. Pereira, A. Aguiar, D. E. Lucani, "Dynamic Load Allocation for Multi-homing via Coded Packets," IEEE Vehicular Technology Conference (VTC), pp. 1-5, Dresden, Germany, June 2013	
NELSON CAPELA	PhD Student	NAP Aveiro	- F. Vieira, D. E. Lucani, N. Alagha, "Codes and Balances: Multibeam Satellite Load Balancing with Coded Packets," in Proc. IEEE International Conference on Communications (ICC), Ottawa, Canada, Jun. 2012	
CARLOS PEREIRA	PhD Student	NS Porto	- F. Vieira, D. E. Lucani, N. Alagha, "Load-Aware Soft-Handovers for Multibeam Satellites: A Network Coding Perspective," in Proc. the 6th Advanced Satellite Multimedia Systems Conference (ASMS), pp.189-196, Baiona, Spain, Sept. 2012.	

INDICATORS	
FUNDING	49 K€
DEVELOPED DEMONSTRATORS	2
MSC THESIS COMPLETED	1
PHD THESIS ONGOING	3
JOURNAL PAPERS	2
CONFERENCE PAPERS	5
BOOK CHAPTER	1

URL  
[http://www.it.pt/project\\_detail\\_p.asp?ID=1548](http://www.it.pt/project_detail_p.asp?ID=1548)