

EU CHIST-ERA Project Seminar 2016

C3N - Context- and Content-adaptive Communication Networks

macac  - Mobile context-Adaptive
CAching for COntent-centric networking

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MACACO – Background

A phenomena named smartphone ...

Number of mobile-cellular subscriptions **7.085 billion**

(Source: www.statista.com)

Current world population: **7.416871 billion**

(<http://www.worldometers.info/world-population/>)

New Year's Eve in Rio de Janeiro's Copacabana beach.



In 2008



In 2015

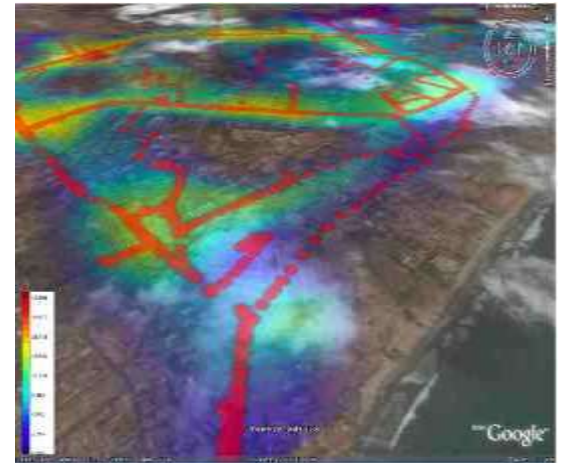
... its steady growth ...



+



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4.1 billion users
worldwide in 2013

- Increasing volume of mobile data between 2014-2018
 - “...worldwide mobile data traffic will increase nearly **11-fold** over the next four years and reach **an annual run rate of 190 exabytes** (10^{18}) by 2018...”
 - 54% of mobile connections will be ‘smart’ connections by 2018

[Cisco VNI Global Mobile Data Traffic Forecast (2013-2018)]

... and the related issues

The New York Times

Customers Angered as iPhones Overload AT&T

By JENNA WORTHAM

Published: September 2, 2009

Slim and sleek as it is, the iPhone is really the Hummer of cellphones.

TWITTER

LINKEDIN

Data offloading solutions are required to deal with such increasing volume of mobile data traffic.

IEEE SPECTRUM

The Great Radio Spectrum Famine

Mobile broadband spectrum. Serving

By Mitchell Lazarus

Posted 30 Sep 2010 | 15:14 GMT

iPhone overload: Dutch T-Mobile issues refund after 3G issues

Data offloading : ... in the Netherlands offers the iPhone and it's now ...

- Use Wi-Fi/small cell access instead of 3G, when possible
- Bring content closer to users, when connectivity is less costly

Of the three mobile network operators in the Netherlands, only T-Mobile sells the iPhone. And only T-Mobile has a large part of its customer base irate from lack of 3G data access, dropped calls, and calls going directly to voicemail even with full 3G coverage.



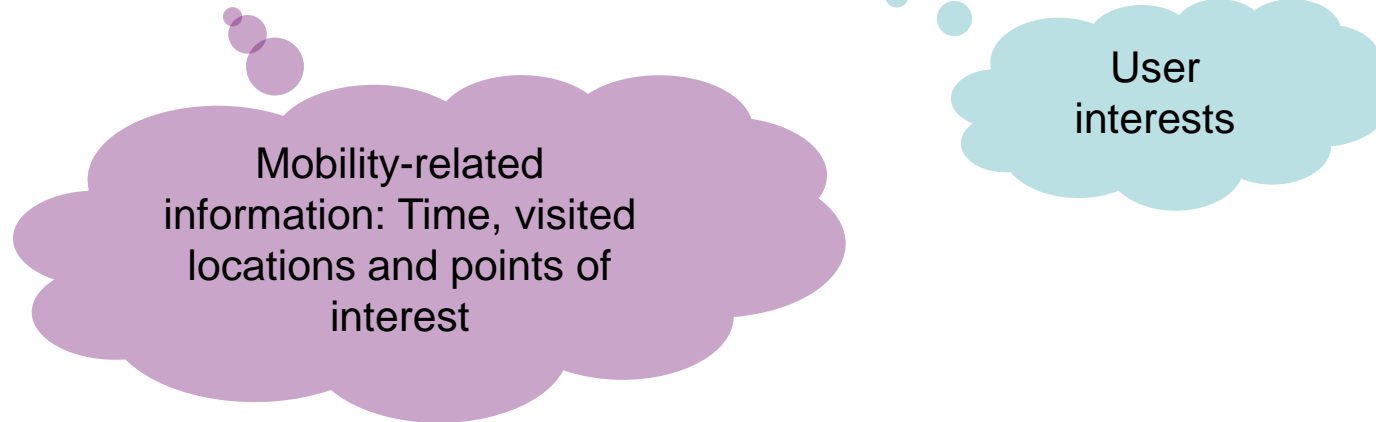
ars technica



MACACO – Key challenges and potential impact of the project

Focus and challenges

- Build **data offloading mechanisms** that take advantage of **context** and **content information**.



- Challenges:
 - **extracting** and **forecasting** the behaviour of mobile users in the three-dimensional space of **time**, **location** and **interest**
 - **'what'**, **'when'** and **'where'** users are pulling data from the network
 - to **prefetch** the identified data and **cache** it at an earlier time
 - at the **mobile terminals** or at the **edge nodes** of the network

Contributions

1. To acquire real world data sets to model mobile node behavior in the **three-dimensional space** *Originality*
2. To derive appropriate models for the **correlation between user interests and their mobility** *Originality*
3. To derive simple and efficient prediction algorithms to **forecast** such correlations *Originality*
4. Design and implement **practical data prefetching** mechanisms *Originality*
Integrate content-centric caching approach with social context awareness and opportunistic resource availability

- Reinforce the European scientific excellence in the **mobile service provision**
 - helping European carriers to offload their cellular traffic
- Strengthen the research field of mobile networks and **human behavior prediction**
- Facilitate development of new **context- and content-aware applications**
- Foster **interdisciplinary research**:
 - MACACO brings together researchers combining experience in:
 - Mobile application development
 - Human mobility characterization
 - Data analytics
 - Social computing



MACACO – Consortium and added value

Consortium



Brazil



UFMG

Pedro O. Vaz de Melo

Collaboration with **Shanghai Jiaotong University** and **Tianjin University**, both in China

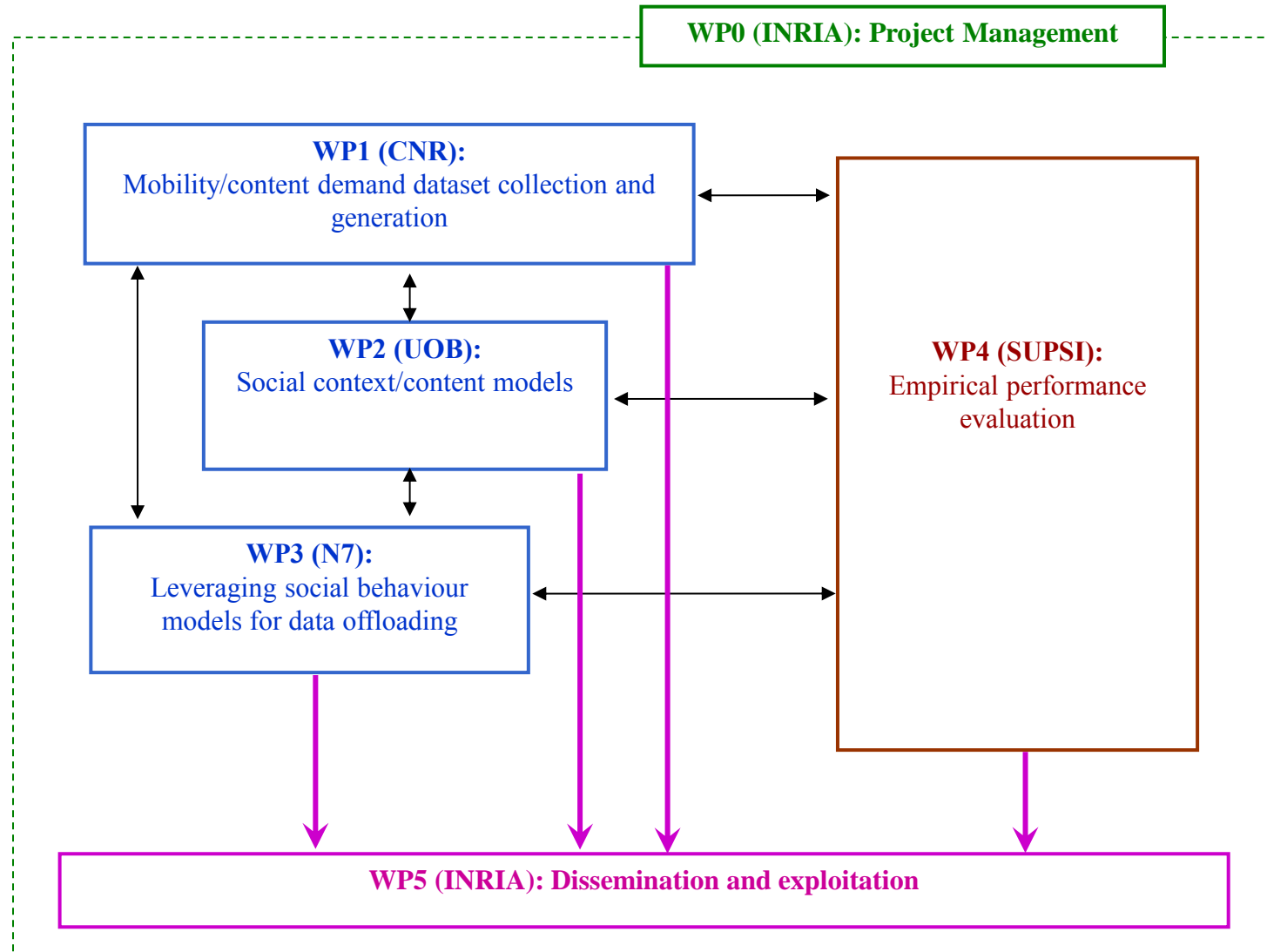
- Collect more data in a big campus environment
- New MACACOApp version was released, adapted to China issues

MACACO consortium : partner skills

	INRIA	N7	UOB	SUPSI	CNR	UFMG
Data collection						
Large scale data generation						
Context prediction models						
Social network analysis						
Opportunistic protocol						
Protocol performance evaluation						
Testbed experimenting						
Protocol standardization						

MACACO organization

- Partners are engaged in all WPs (according to their expertise)





MACACO – Scientific results and outputs

Scientific results – WP1 [Data collection]

- Development of a dedicated mobile phone application for content/context monitoring – **MACACOApp**

- Regular (5-min) **mobility and content data collection**

- Brings together partners' expertise on:

- Android application development
- Energy and storage optimization

- Includes a questionnaire on **users' personality traits**

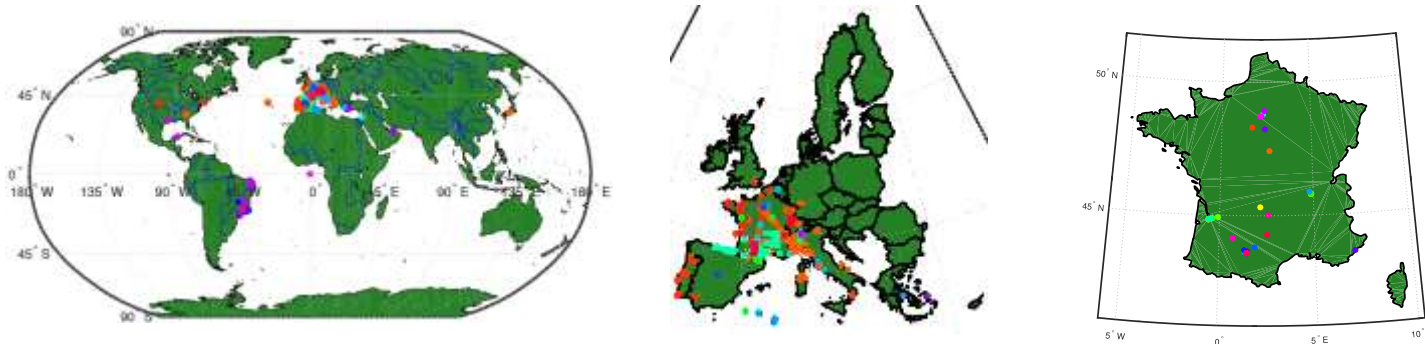
- Localization for France, Italy, UK, Switzerland, PRC

- App available at <https://macaco.inria.fr/macacoapp/>

**Demo
today**

- **Data collection** campaign

- **80+** users, **6** different countries, **3** different continents, **18** months



Scientific results – WP1 [Data collection]

- **Synergies** with other initiatives
 - Collaboration with the French **Priva'Mov** project
 - Mutual access to collected data
 - Joint data collection campaign at ACM Middleware 2014
 - Large-scale datasets
 - **GranData cooperation** and **Orange D4D challenge**
 - **Million users** (low-precision) cellular traces
- **Privacy and security** aspects
 - French law (CNIL) imposes total anonymization of collected traces
 - *...and to delete them at project completion!*
 - MACACOApp follows **best practices** suggested by CNIL
 - SHR256 hash algorithm, anonymized user ID, secure transmission, etc
 - Development of a **k-anonymization algorithm** of spatiotemporal trajectories of mobile users
 - Limitation: only works for large population (large-scale datasets)

Scientific results – WP2 [Context/content models]

- **Profiling access network** state (INRIA, CNR)
 - **Spatio-temporal profiling** of cellular network-wide usage
 - using aforementioned Grandata/Orange D4D datasets
- **Profiling individual user** state (SUPSI, N7, INRIA)
 - **Correlations** between context and content
 - Mobility among Points of Interest versus user interests from browsing
 - Network availability versus content access
 - Trajectories versus generated traffic volume
- Synthetic mobile data **traffic generator** – MDTGen (INRIA)
 - **Models individual users' activity**, in terms of uplink/downlink traffic
 - Based on behavioral classes from large-scale datasets
 - Available at <https://macaco.inria.fr/software>



Posters
today

Scientific results – WP3 [Prefetching & offloading]

- **Prediction** of near future content requests and context changes from (N7, SUPSI, INRIA):
 - **Content** anticipation
 - interest profile of a user, volume of content, etc
 - **Context** anticipation
 - type of connectivity, points of interest, location visiting pattern, etc
 - Predictability of **combined mobility and network usage**
- Pulling/pushing the **right information** at the **right time/place** (UCL, N7)
 - Implementation of a mechanism for **postponing/removal of pushed content** via machine learning on the relevance of information types in different context
 - Implementation of a **prefetching app** that leverages Wi-Fi connectivity to pull data from top-used services in advance



MACACO – Dissemination

- **23 publications** in international conferences and journals
 - Including **IEEE INFOCOM, IEEE PerCom, ACM CoNEXT, IEEE Transactions on Mobile Computing, EPJ Data Science, ACM CHI**
- MACACO **website** on-line since the first month of the project
- Presentation and demo at **Futur en Seine Festival**, June 2014
 - half-day INRIA-Industry meeting
- **Data collection campaign** at the ACM/IFIP/USENIX Middleware 2014 conference
- MACACO **teaching projects** offered to students
 - Android programming for next-gen networking, N7, June 2015
 - SJTU-ParisTech Elite Institute of Technology (SPEIT), July 2015
- **Seminar** at Luchon Summer School, June 2015
 - Large interdisciplinary audience

- **ACM Distinguished Speaker Program** talk
 - Youth Congress on Information Technology (Y4IT), September 2015
- Diffusion at **phys.org**
 - Work on causality analysis of mobile sensing data and behavioral analysis at UCL, December 2015
- Ongoing **patent** submission
 - High-dimensional spatiotemporal data anonymization



MACACO – Sustainability and Valorization

- **Additional funds** received
 - **3-months extension** of an 1-year post-doc contract
 - EU COFUND PRESTIGE program
 - **3-year doctoral** support
 - Joint call Region Midi-Pyrenees and University of Toulouse
- MACACOApp is on **Android Store**
 - Publically available to any Android device
 - Legal requirements duly fulfilled with CNIL (French regulation body for data privacy)
 - Information Sheet and Consensus form translated to 4 languages
- Synthetic Mobile Data Traffic Generator (**MDTGen**) is publicly available
 - At MACACO website, <https://macaco.inria.fr/software/>

Thank you for your attention

The screenshot shows the homepage of the MACACO project. At the top left is the MACACO logo, which consists of the word "macaco" in a lowercase, sans-serif font followed by a stylized icon of a face with large eyes. Below the logo is the project title "Mobile context-Adaptive CAching for COntent-centric networking". A navigation bar contains links for "Home", "About MACACO", "Events", "Consortium", and "Publications". A search box is located on the right side of the navigation bar. The main content area is titled "Home" and contains a paragraph describing the project as a CHIST-ERA European Project. Below the text are logos for the consortium members: Inria, IRIT, University of Birmingham, National Research Council of Italy, UFMG, SUPSI, and INP ENSEEIHT. A "Recent events" section lists "Project starting, November 1, 2013" and "Kickoff meeting, November 25, 2013". A "Sponsors" section features logos for ANR (Agence Nationale de la Recherche), FNSNF (Fonds National Suisse), and EPSRC (Engineering and Physical Sciences Research Council).

macaco

Mobile context-Adaptive CAching for COntent-centric networking

Home About MACACO Events Consortium Publications

Home

MACACO is a CHIST-ERA European Project addressing the topic Context- and Content-Adaptive Communication Networks. It is funded by ANR in France, SNSF in Switzerland, and ESPRC in UK.

It focus on data offloading mechanisms that take advantage of context and content information. Our intuition is that it is possible to extract and forecast the behaviour of mobile network users in the three-dimensional space of time, location and interest (i.e. 'what', 'when' and 'where' users are pulling data from the network), it is possible to derive efficient data offloading protocols. Such protocols would pre-fetch the identified data and cache it at the network edge at an earlier time, preferably when the mobile network is less charged, or offers better quality of service.

UNIVERSITY OF BIRMINGHAM

Inria

IRIT

National Research Council of Italy

UFMG

University of Applied Sciences and Arts of Southern Switzerland

SUPSI

INP ENSEEIHT

Recent events

Project starting, November 1, 2013
Kickoff meeting, November 25, 2013

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ANR

FNSNF

FONDS NATIONAL SUISSE

EPSRC

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