EU CHIST-ERA 2012 call – C3N
Context- and Content-adaptive Communication Networks

macaco - Mobile context-Adaptive Caching for COntent-centric networking

Katia Jaffrès-Runser
University of Toulouse, INPT-ENSEEIHT, IRIT

3rd CHIST-ERA Project Seminar
March 5, 2014. Istanbul, Turkey
MACACO - Context and Motivation
The smartphone phenomena

Smartphones have the potential to be:
- visually-aware
- sonically-aware
- always-connected
- directionally-aware
- location-aware
- motion-aware

In 2013, 4.1 billion users worldwide

- New potential for wireless and pervasive applications
  - Wireless Social networking, global sensing, content distribution …
- 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)]
New demands: Increased data usage

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

Data offloading: use Wi-Fi/small cell access instead of 3G if possible
Focus and intuition

• **Current data offloading solution:**
  – Use WiFi connectivity if available and if not, use 3G.

• **Our focus**: a more intelligent data offloading strategy
  – Build data offloading mechanisms that take advantage of **context** and **content information**

• **Intuitions:**
  – to **extract** and **forecast** 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 **pre-fetch** the identified data and **cache** it at an earlier time
    • at the mobile terminals or at the edge nodes of the network
Project contributions

1. To acquire real world data sets to model mobile node behaviour in the three-dimensional space

2. To derive appropriate models for the correlation between user interests and their mobility

3. To derive simple and efficient prediction algorithms to forecast the node’s mobility and interests

4. To output data pre-fetching mechanisms
   1. To integrate content-centric caching approach with social context awareness and opportunistic resource availability

5. To design a federated testbed for (no commercial interest):
   1. Content and context data collection
   2. Assessment of off-loading solutions
MACACO Project organization
Project Consortium

- 6 international partners
  - INRIA coordination
  - 5 European partners and 1 Brazilian Institution
    - INRIA, N7, SUPSI, UOB, CNR, UFMG
  - 4 funded and 2 non-funded institutions
  - Funding organizations: ANR, SNSF, EPSRC

- Funding ~1M€ for a total effort of 277 MM
MACACO organization

- Duration: 36 months, 6 Work Packages
## MACACO consortium: partner skills

<table>
<thead>
<tr>
<th>Skill</th>
<th>INRIA</th>
<th>N7</th>
<th>UOB</th>
<th>SUPSI</th>
<th>CNR</th>
<th>UFMG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data collection</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large scale data generation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Context prediction models</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social network analysis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opportunistic protocol</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protocol performance evaluation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testbed experimenting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protocol standardization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WP0</td>
<td>TASK 0.1</td>
<td>TASK 0.2</td>
<td>M0.1</td>
<td>M0.2</td>
<td>D0.1</td>
<td>M0.3</td>
</tr>
<tr>
<td>-----</td>
<td>----------</td>
<td>----------</td>
<td>------</td>
<td>------</td>
<td>------</td>
<td>------</td>
</tr>
<tr>
<td>WP1</td>
<td>TASK 1.1</td>
<td>TASK 1.2</td>
<td>M1.1</td>
<td>M1.2</td>
<td>D1.2</td>
<td>M1.3</td>
</tr>
<tr>
<td>WP2</td>
<td>TASK 2.1</td>
<td>TASK 2.2</td>
<td>TASK 2.3</td>
<td>M2.1</td>
<td>M2.2</td>
<td>D2.1</td>
</tr>
<tr>
<td>WP3</td>
<td>TASK 3.1</td>
<td>TASK 3.2</td>
<td>TASK 3.3</td>
<td>M3.1</td>
<td>M3.2</td>
<td>D3.1</td>
</tr>
<tr>
<td>WP4</td>
<td>TASK 4.1</td>
<td>TASK 4.2</td>
<td>TASK 4.3</td>
<td>M4.1</td>
<td>M4.2</td>
<td>D4.1</td>
</tr>
<tr>
<td>WP5</td>
<td>TASK 5.1</td>
<td>TASK 5.2</td>
<td>TASK 5.3</td>
<td>M5.1</td>
<td>M5.2</td>
<td>D5.1</td>
</tr>
</tbody>
</table>

**Project timeline**

- **YEAR 1**
  - Nov 2013: Kickoff, Paris
  - Nov 2014: Project Seminar, Istanbul

- **YEAR 2**
  - Nov 2014: Focus on WP1 in this presentation

- **YEAR 3**
  - Nov 2015

**Key Activities**

- **Data collection / generation**
- **Social context/content models**
- **Data offloading algorithms design**
- **Performance evaluation – Testbed / Simulation**
• **Goal**: providing datasets coupling mobile users’ movement patterns & service demand (*unavailable to date*)!
  
  – Collection of a significant *real-world* data sample
    • Small-scale (~100 smartphones with dedicate monitoring software)
  
  – Generation of *synthetic* mobility/usage datasets
    • Large-scale (order-of-thousand simulated users in urban scenarios)

---

**Task 1.1** – collecting real-world data

**Task 1.2** – generating synthetic scenarios

**Task 2.1** – characterization of user behaviors
Data collection

• To configure smartphones to **continuously** collect user’s context and content information
  – Context = location, networking environment (3G, WiFi, BT), motion (accelerometer, proximity)
  – Content = apps that have created traffic in up and downlink, native browser URLs

• The testbed may be composed by users:
  – Using the acquired MACACO smartphones
  – Using their own smartphones with the deployed application installed
    • Incentivizing Android users (work colleagues, students, family, etc) to participate of the testbed
  – The **same application** for the two cases
  – In the **5 countries of MACACO**
Progress on WP1 – data collection

Discussion started at Kickoff meeting on 11/24/2014

Current status:

• Software developments for data collection:
  – First beta version of the data collection application for Android smartphones is available
  – Client – server application for uploading gathered data

• Tested on 3 types of smartphones for reliability
  – Samsung Galaxy S3, Wiko Stairway and Motorola Moto G

• Remaining tasks in software development
  – Finalize tests and improve user interface
  – Extend application to be shared on the Android Marketplace for different smartphones
  – Enforce data privacy rules
Data collection phase

- Volunteers recruiting
  - Students
    - Simple to recruit at universities,
    - Has specific habits, with a very predictable social structure
    - Should not only concentrate on them
  - Colleagues, friends
    - Different habits depending on profession.
    - Not a very homogeneous population: maybe harder to analyze
- Find appropriate incentivizing method
  - Students: Application that provides in-school services (class schedule, student phone repository, ...)
  - Colleagues, friends? ... open question.
Organizational setup

• Timeline related to WP1.1
  – March 2014: Version 1.0 of data collection application
  – April 2014 – May 2014: Data collection at N7, UOB and SUPSI

• Timeline related to WP2.1 and WP1.2
  – Mai-Nov. 2015: large scale simulation using traces of WP1.1
    • Manpower WP1.1
      – 3-month internship at N7 for data application development finalization (March-May 2014 at N7)
      – 3-month PhD at N7 support for supervision and roll out of data collection testbed, first analysis (May-July 2014 at N7)
    • Manpower WP1.2
      – 12-month post-doc at INRIA to work on large scale simulation
    • Manpower WP2.2
      – PhD recruitment at UOB to start in May or June 2014
    • Manpower WP3
      – 12-month post-doc at N7 to start in October 2014
Milestone of 1st year

• WP5, Task 5.1 (month 2; December 2013)
  – Website finalization

• WP1, Task 1.1 (month 5, February 2014; month 9, May 2014)
  – Progress in real-world data collection

• WP2, Task 2.1 (month 9; May 2014)
  – Progress in the characterization, usage and protection of user behaviour

• WP1, Task 1.1 (month 12; October 2014)
  – Report on real-world data collection

• WP2, Task 2.1 (month 12; October 2014)
  – Report on user behaviour modelling

• WP4, Task 4.1 (month 12; October 2014)
  – Progress in the empirical evaluation framework

• WP0 Tasks 0.1 and 0.2 (month 12, October 2014)
  – CHIST-ERA annual scientific report
Collaborative set-up

- Orange Labs invitation as Industrial Advisor
  - In progress

- We will build upon our experience with FP6 Haggle, MOTEL (SUPSI internal project), and FP7 SCAMPI testbeds.

- PRIVA'MOV project (IMU LABEX), Marco Fiore (CNR) implication
  - Goal: to develop and deploy a privacy-aware crowdsensing platform to collect mobility traces from real users equipped with Android tablets
  - Collaboration already started
  - MACACO will share data collection and analysis experiences with PRIVA'MOV participants
Issues encountered if any

- No specific issues have been encountered so far.

- Main risk highlighted in the proposal are related to a delayed real-world data collection

- Currently, the outcome of Task 1.1 of WP1 is in line with the proposed timetable.

Thus, the data collection phase should be started as expected in the upcoming months.
MACACO publications


2. Eduardo Mucelli Rezende Oliveira, Aline Carneiro Viana, Routine-based network deployment for data offloading in metropolitan areas. *IEEE WCNC*, April 2014


MACACO web site: macaco.inria.fr

Mobile context-Adaptive CAching for COntent-centric networking

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 focuses on data offloading mechanisms that take advantage of context and content information. Our intuition is that if it is possible to extract and forecast the behaviour of mobile network users in the threedimensional space of time, location and interest (i.e. 'what', 'where' and 'when' 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.
Any questions?