UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES ÉCONOMIQUES ET SOCIALES

University of Twente
The Netherlands

ALTRAN

mobihealth
putting care in motion

Toward Mobile Web 2.0-based Business Methods: Collaborative QoS-information Sharing for Mobile Service Users

presented by Hong Chen

Altran B.V, the Netherlands

Katarzyna Wac, Richard Bults, Bert-Jan van Beijnum, Hong Chen, Dimitri Konstantas, book chapter in *Mobile and Ubiquitous Commerce: Advanced E-Business Methods*, M. Head, (Ed.), IGI Global, vol. 4 (2009)

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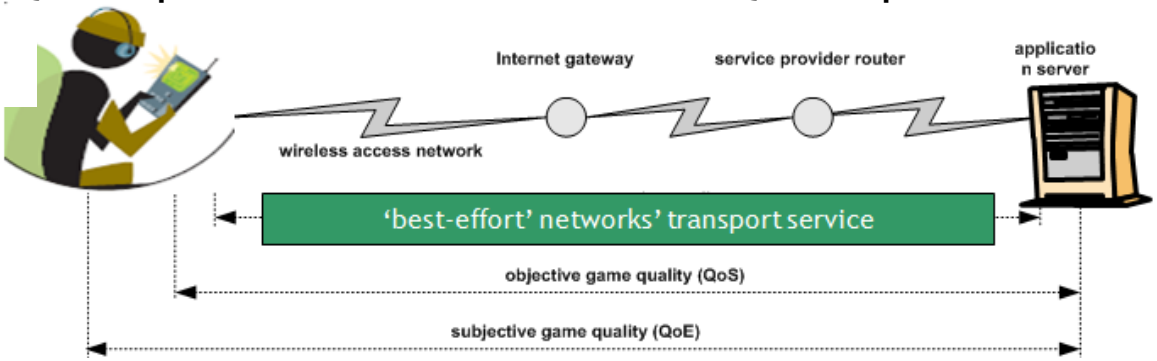
Cyprus, 2nd - 4th February 2009

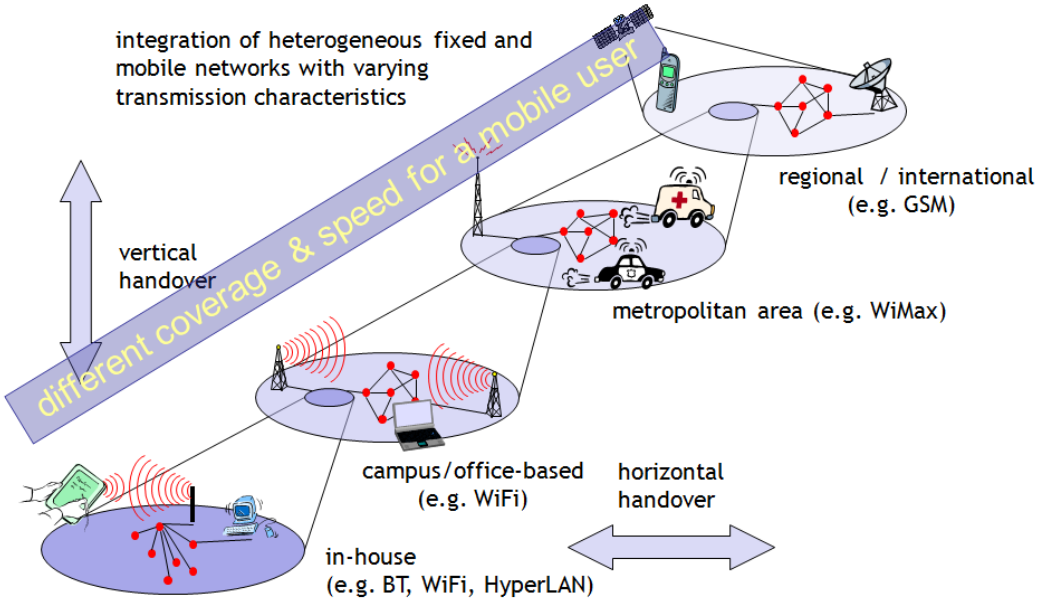
Situation and complication

Global GSM and 3GSM Mobile Connections*
3,039,369,495

- Fast growing mobile applications and services
- Users have QoE-expectations and therefore QoS-requirements



- Success of delivery depends on QoS-provided by underlying heterogeneous networks



(ITU, 2003; ITU, 2005; ITU, 2006; GSMWorld, 2008)

The "openness" issue

- Traditional QoS-management
  - admission control, resource negotiation reservation techniques
    (Chalmers, 1999; Seitz, 2003; Bless, 2004; Saldatos, 2005; Gomez, 2005; ITU-T, 2006)
- The openness of the Internet makes SP sign SLA with ISP to guarantee QoS. Limitation: user-base
- SP over fixed internet ignores the above QoS management solutions learn to cope with best effort services by QoS estimation. This is feasible because:
  - Regularity of Internet traffic (Claffy et al., 1998)
  - QoS info gathering does not cause service degradation (Michaut & Lepage,2 005)
- SP over Mobile faces a more complicated problem: the solution for fixed SP doesn't work.
  - drive-tests done on main streets in the cities and on highways (Cuevas, 2006)
  - user 'lock-in' by MNOs, MVNOs (Buschken, 2004)
- If user "lock-in" is removed. i.e. a user is free to choose mobile network operators, the remained problem is : from a MoSP persepctive

  How to choose the most appropriate WNO

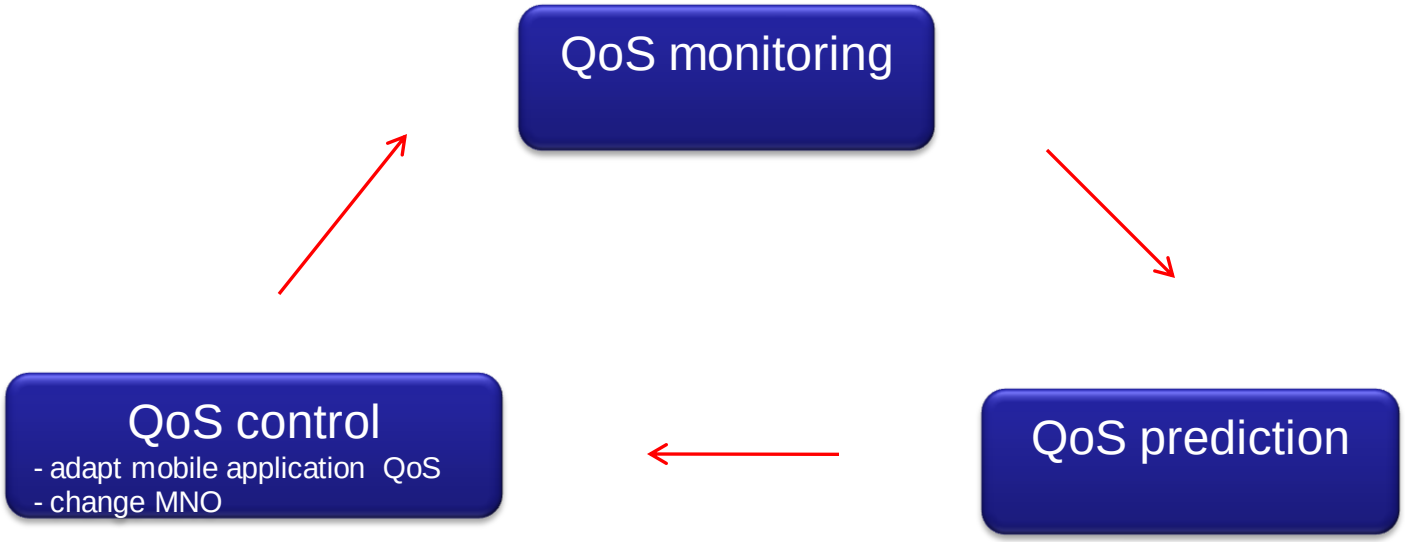
  Given a QoS/QoE requirement @ specific location + time

The proposed solution: QoSIS.net

QoS-management via Mobile Web 2.0

QoS-Information Service (QoSIS)- an enterprise

- continuous QoS-monitoring/info gathering and prediction
- based on collaborative QoS-information sharing for these users (build upon Mobile Web 2.0 paradigm)



(Wac, et al. 2005a; Wac, et al. 2006a; Wac, et al. 2007; Wac, et al. 2008a)

QoSIS.net – QoSIS Service Provider

The MCM-business model framework used for QoSIS.net business viability analysis

1 *features of the service*
   - design and operation of the service provided by an enterprise to its customers (i.e. the enterprise product)

2 *features of the service medium*
   - characteristics of means with which service is delivered and that may influence service interactions (e.g. service is mobile)

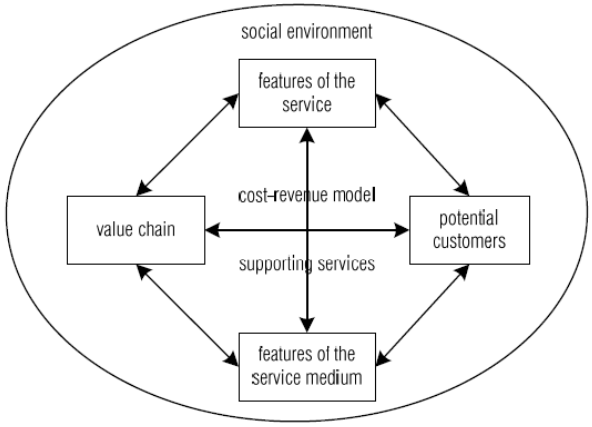
3 *potential customers*
   - aspects of target groups of customers (i.e. market segments), their expected service's value-added

4 *value chain*
   - players involved in delivery of the provided service and their inte

5 *cost-revenue model*
   - financial model explaining contribution of players in value chain

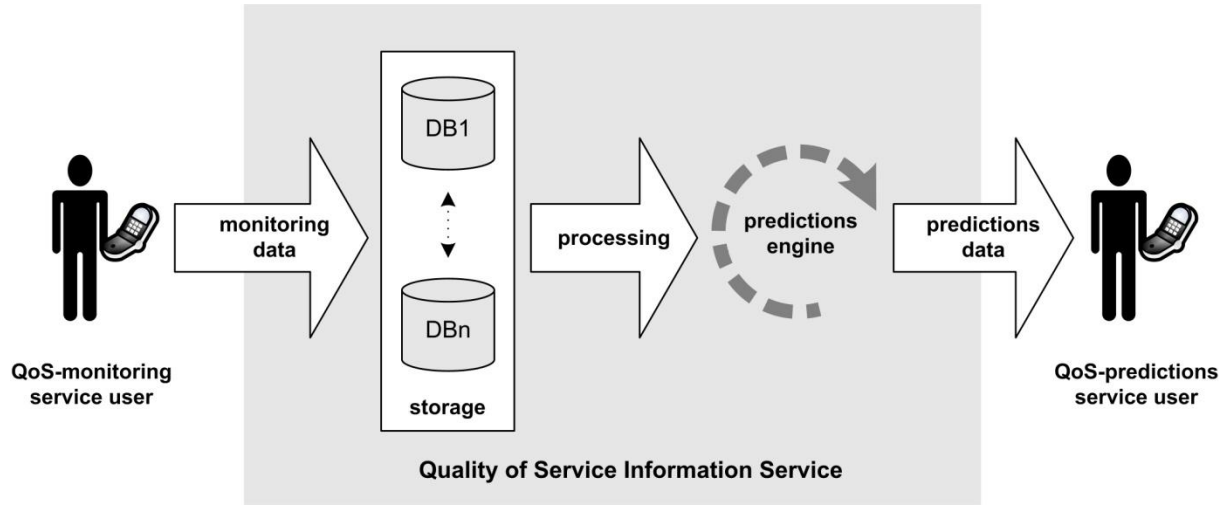
6 *flow of supporting services*
   - necessary for delivery of the service provided to customers

7 *social environment*
   - external influences – social, ethical aspects influencing the way the business is designed, implemented and operated



(Hoegg & Stanoevska-Slabeva, 2005)

Business feasibility analysis (I): features of the service



- Functional requirements
  - QoS-monitoring and information storage
  - QoS-information processing
  - QoS-predictions acquisition and disseminations
- Non-functional requirements
  - performance, e.g. speed
  - minimal comm./processing/storage overhead
  - power consumption
  - cost, data security/privacy
  - scalability
  - fault tolerance, traceability

Business feasibility analysis (II): service medium

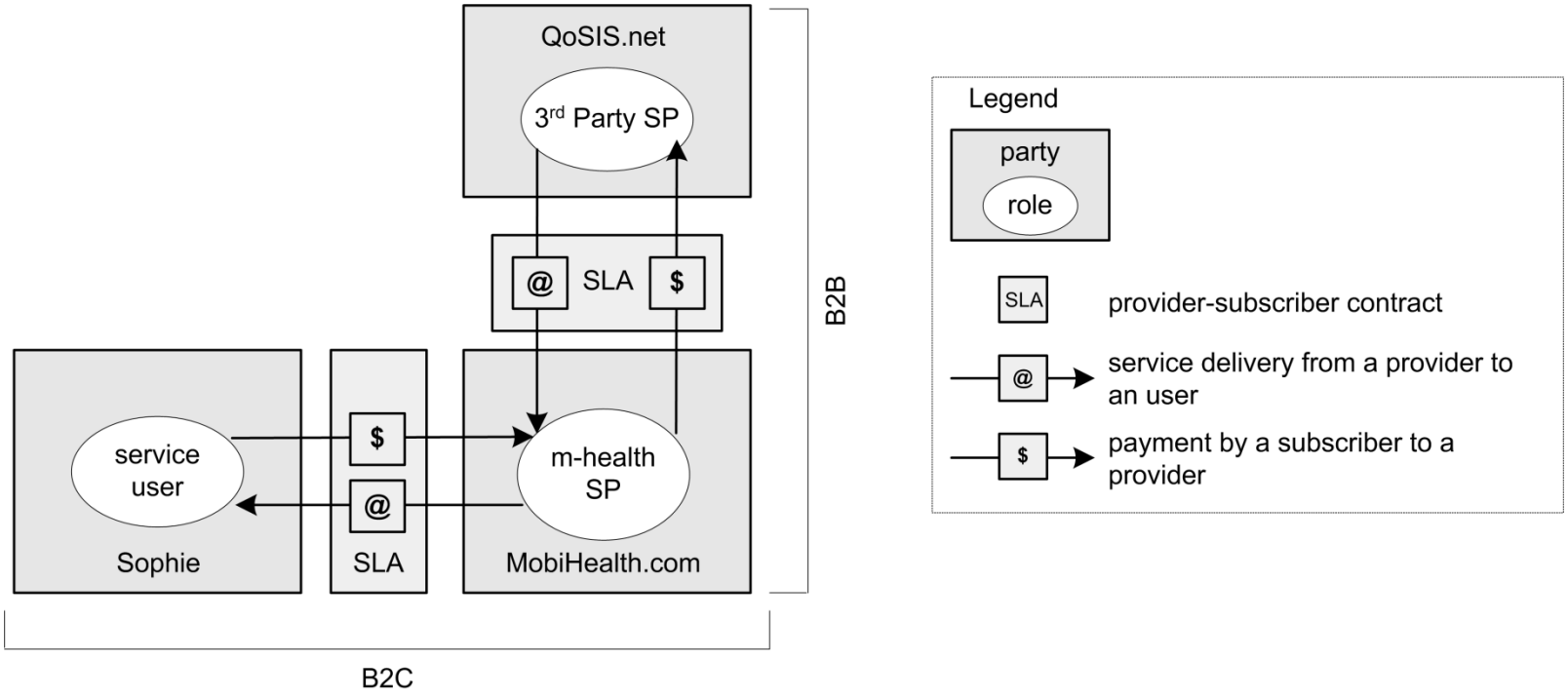
- QoS-Predictions Service is a mobile service itself
  - provided to its users from server on the Internet, accessible via a wireless medium

Business feasibility analysis (III): potential customers

- customers in a Business to Business market segment
  - Mobile Service Providers and MNOs/MVNOs acting as Mobile Service Providers
- customers in a Business to Consumer market segment
  - mobile service end-users (i.e. customers of Mobile Service Providers)

Business feasibility analysis (IV): value chain (a)

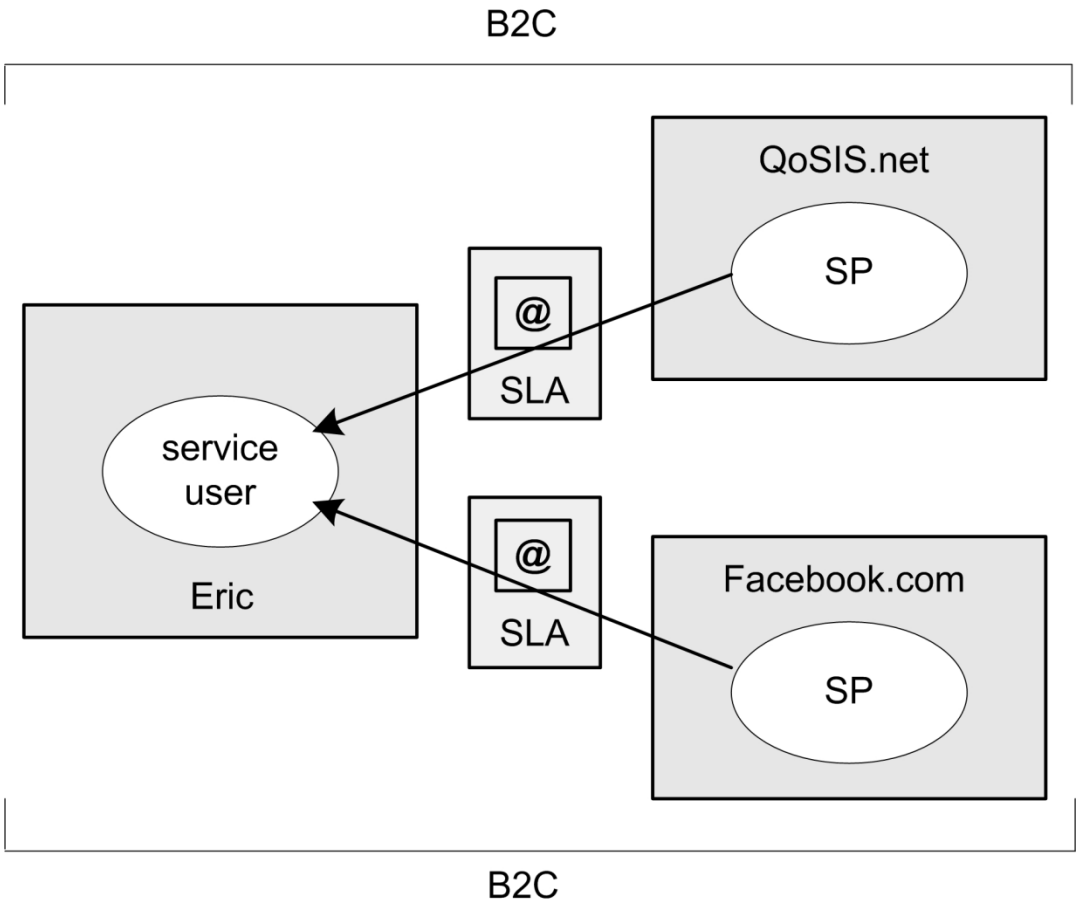
- B2B: 3rd Party SP for MobiHealth.com m-health SP



Sophie is a chronic obstructive pulmonary disease (COPD) patient

Business feasibility analysis (IV): value chain (b)

- B2C: SP for Facebook.com user



Business feasibility analysis (V): cost-revenue model

- Costs
  - QoSIS.net:
    - setup and maintenance of its services
    - marketing : mainly for B2B, while “word-of-mouth” for B2C
  - QoSIS.net customers
    - Ownership of location-determination technology-enabled mobile device (e.g. GPS) with (multiple) wireless network interfaces
    - QoS-predictions service usage : communication/processing/storage
- revenues
  - B2B: monthly fee or per-transaction fee
  - B2C: free for end-users, QoSIS.net can setup an affiliation program
  - QoSIS.net can sell (anonymized) user profile and QoS-information to MNOs and Mobile Service Providers

Business feasibility analysis (VI): supporting services

- QoSIS.net
  - B2B: services for business-partnership management
  - B2C: web-service for social network of QoSIS.net users, attracting new customers

Business feasibility analysis (VII): social environment

- competition amongst QoSIS.net customers (mobile service providers and network operators) requires QoSIS.net to be a trustworthy enterprise
  - dependable security mechanisms
- user-privacy consent
  - location-information, i.e. privacy sensitive information is acquired from users in an anonymous form

QoSIS.net: Conclusion

effective mobile computing: QoS/QoE-management via Mobile Web 2.0

- Proactive QoS-management anywhere-anytime-anyhow
  - QoS-measurement: network delays/effective data-rates not known until measured !
  - networks NOT designed for inverted producer-consumer paradigm applications

- Novel - empowering mobile service providers & their users
  - Beyond current QoS-management frameworks
  - Beyond current user 'lock-in' in network
  - No need for changes in the existing network infrastructures
  - Builds upon a collaborative QoS-information sharing

- Risky: critical mass of users providing QoS-monitoring data (i.e. QoS-measurements)

Case in the domain of mobile health

Body Area Network by MobiHealth BV

- MobiHealth Service Platform™ - Research platform for (remote) monitoring of physiological and context parameters
- Characteristics:
  - fully mobile system
  - market sensor systems
  - personalized
  - real-time transmission

- *Electrocardiogram (ECG)*:* 3-6 leads
  - derived: HR, HR mean, HR variability
- Impedance cardiography (ICG)
- *Blood Pressure (BP)*
- *Photoplethysmography*
- Electrodermal activity
- *Respiration*
- *Galvanic Skin Response (GSR)*
- *Forehead and finger temperature*
- Electromyogram (EMG)
  - for example:
    - M. Zygomaticus major (smiling)
    - M. Corrugator supercilii (frowning)
    - *M. Extensor digitorum (arm extension)*
- Electrooculogram (eyeblink, eye movements)
- *Relative Movement (Acc)*
- perhaps EEG
- …

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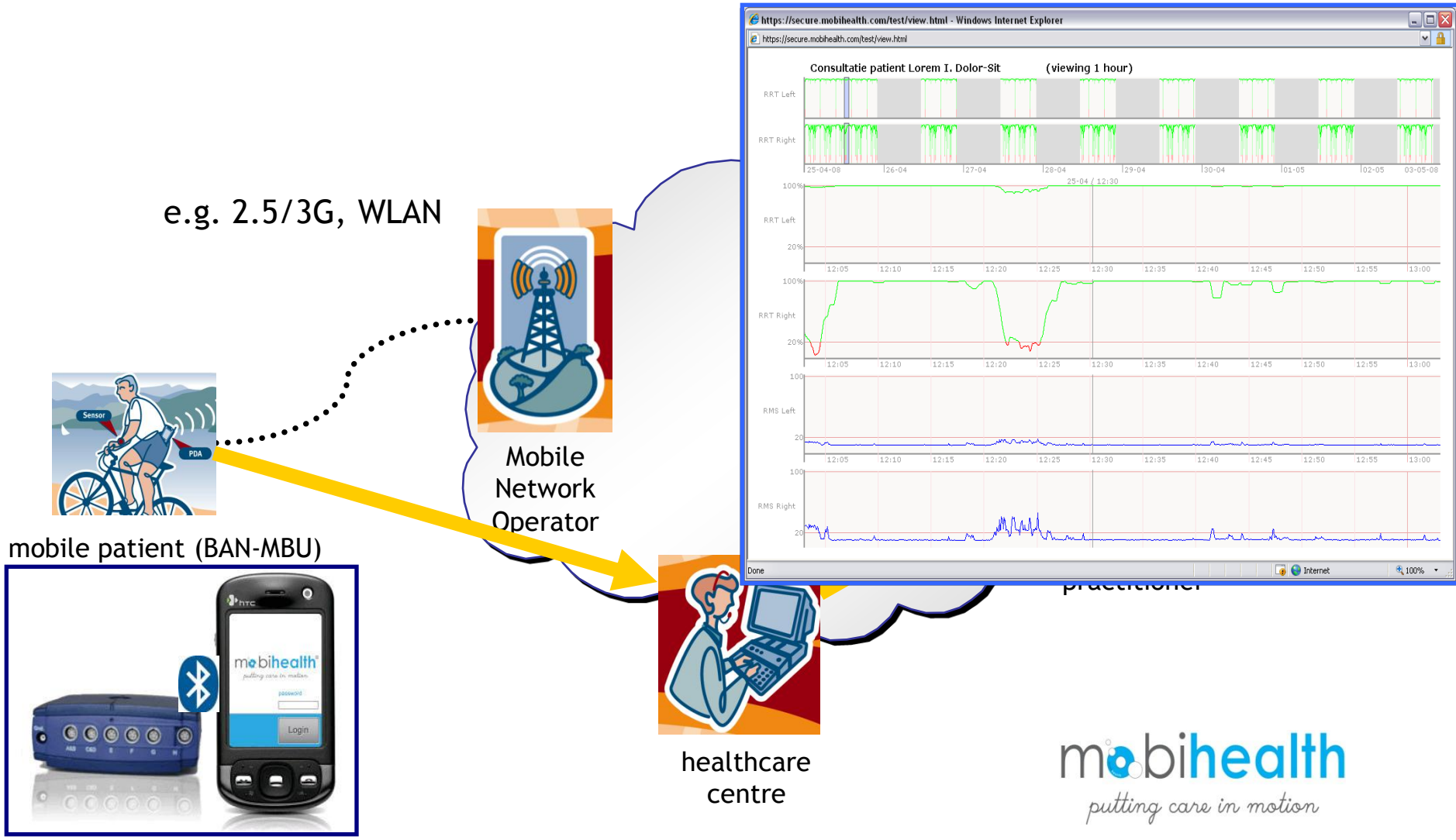
putting care in motion

**already integrated in the MobiHealth BAN*

MobiHealth™ System

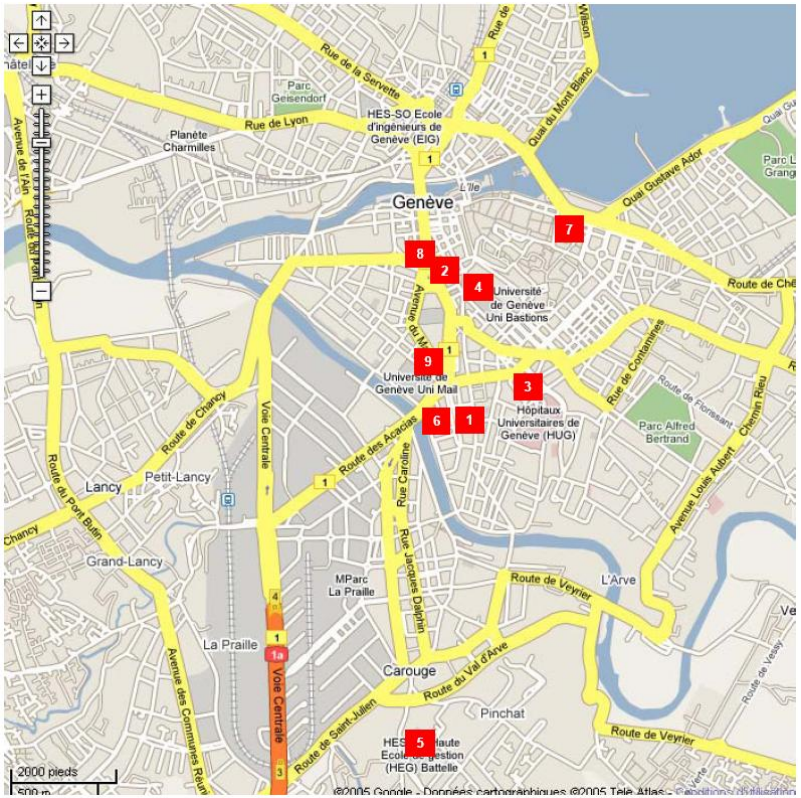


Walk test /drive test

- One month of a MobiHealth user QoS-information collected
- In Geneva city (Switzerland)
  - 9 most visited locations
- Networks: GPRS-Sunrise, WLAN-Unige
- 2 devices carried around
  - to monitor QoS over two different networks at one loc-time
  - to check if data collected by one device improves predictions for the second device

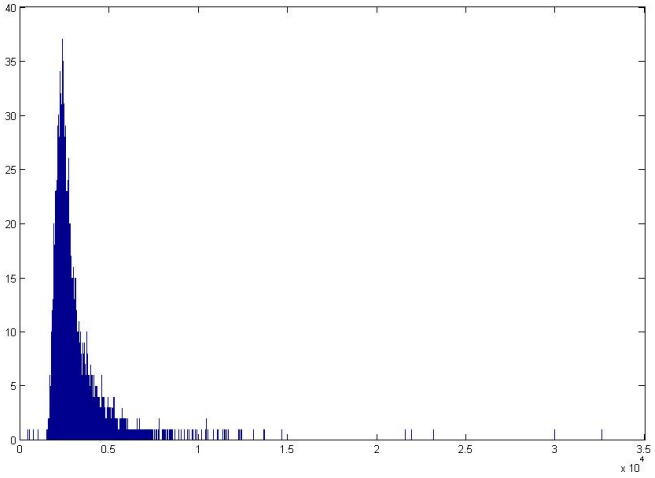
Qtek 9090

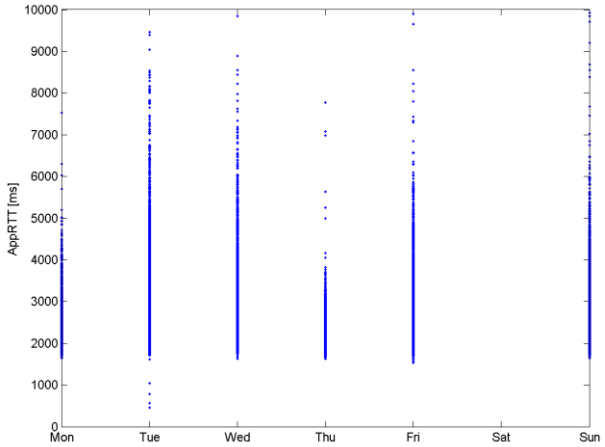
Geneva



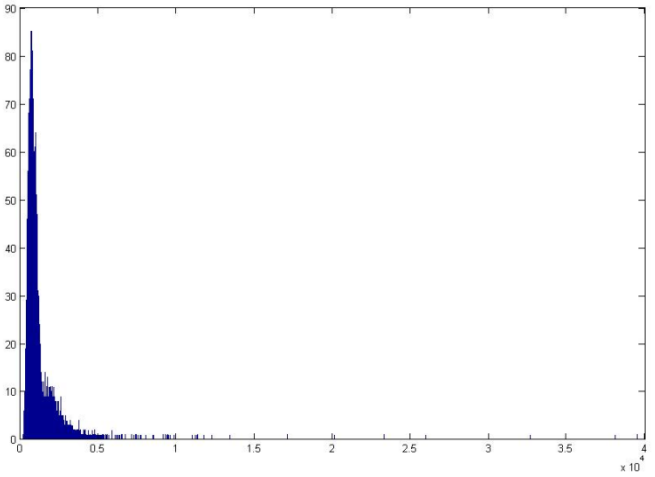
QoS measure: application round-trip delays

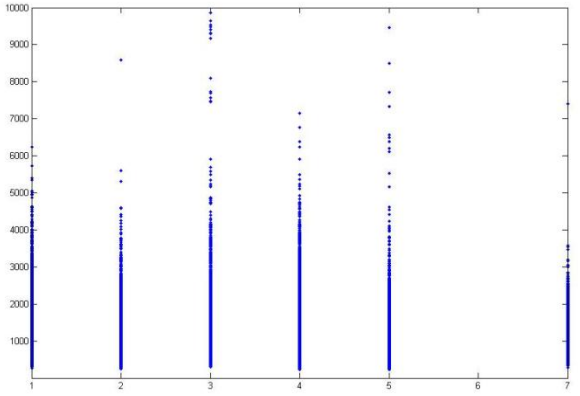
GPRS





WLAN





Day of the Week

Histograms Data Summary

[ms]	mean	std	min	Q25	median	Q75	Q99	max
WLAN	1027	718.85	224	682	836	1111	3320	39476
GPRS	2750	911.29	458	2239	2528	2974	5765	32541

Histograms Data Summary (mean-std)

[ms]	Mon	Tue	Wed	Thr	Fri	Sat	Sun
WLAN	1198 (687)	1029 (510)	997 (726)	1011 (640)	943 (904)	N/A	712 (616)
GPRS	2465 (536)	3017 (1075)	2034 (1185)	2335 (452)	2808 (867)	N/A	2658 (779)

Machine learning techniques used (Weka)

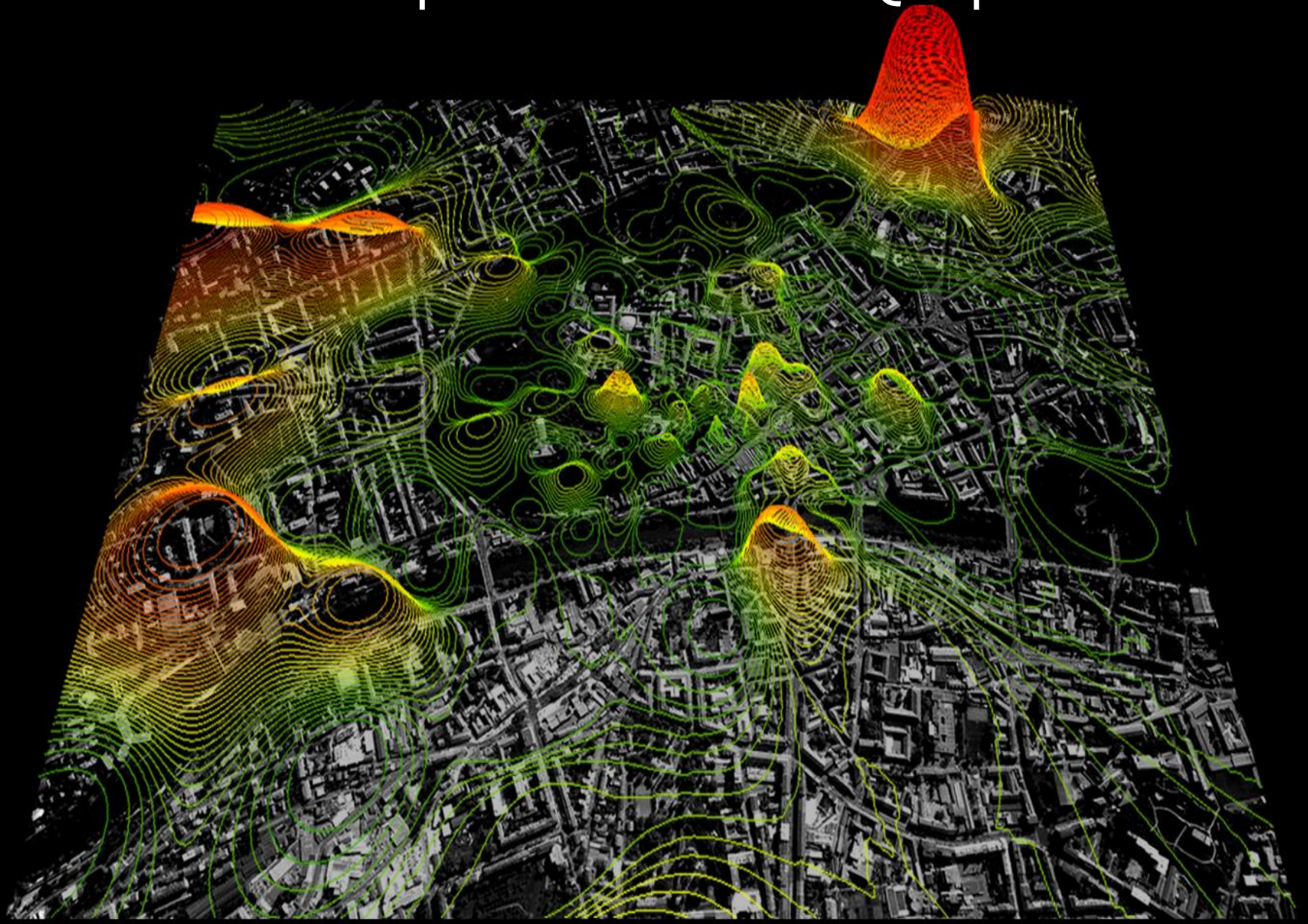
- Bayesian
  - Bayes, Naïve Bayes
- Trees
  - J48, Random Forest
- Rules
  - Part, JRip, Part, ZeroR
- Functions
  - Multilayer Perceptron, SMO (SVM), Voted Perceptron
- Lazy
  - kNN

input: min, hr, DoW, RSSI, batt, loc, WNP, technology, sender data-rate

output: 9 App-RTT prediction cases: low/high (5 thresholds) or 4 or 5 categories

(Witten and Frank 2005) (Wac, et. al. 2009)

Expected outcome: QoS prediction maps



Thanks!

- Questions and collaborations, please contact
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- QoSIS.net is available @
  - http://qosis.net/
  - http://qosis.org/
  - http://qosis.eu/
  - http://qosis.nl/
  - http://qosis.info/
  - http://qosis.biz/