NGHCS: Creating the Next-Generation Mobile Human-Centered Systems

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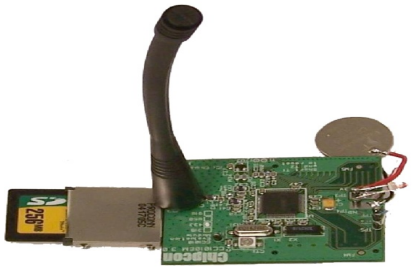
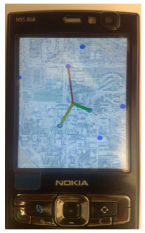
Big Challenges

- New technologies are creating a revolution
  - Tiny, low-power wireless sensor devices with limited computation, communication, storage capabilities
  - Sensor network deployments at large-scale
  - Devices are getting smaller, more mobile and are giving more people access
  - Smart-phones as tools for data sensing, sharing and processing
  - New smartphones are programmable, personal, context-aware, allow user interaction in real-time
  - Participatory sensing systems where people actively participate in the process of sensing, collecting data
- These technologies bring opportunities and challenges



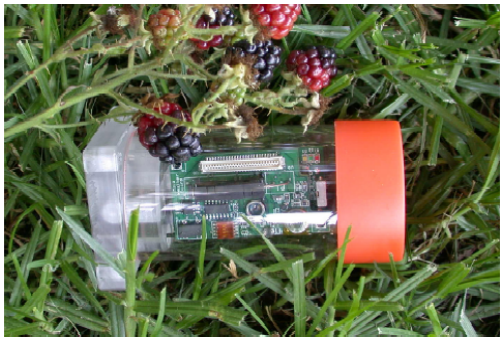


Opportunities created by sensor networks

The use of mobile computing and sensing systems has allowed research to go beyond the reach of traditional applications

Applications:

- Environmental and habitat monitoring
- Seismic and structural monitoring
- Building instrumentation
- Real-time traffic monitoring



Environmental Monitoring

Structural Monitoring

Wildlife Tracking

Habitat monitoring

Mobile Human-Centered Systems

- Humans become focal point of interest (human-in-the-loop): become active producers and consumers of data
- **Mobile devices** as tools for data sensing, collection and processing for the benefit of common citizens
- Improve the quality of the systems with **community feedback**
- Ability to interact with the physical environment in non-intrusive manner opens up huge economical and societal benefits in a wide range of application domains:
  - *transportation*
  - *critical infrastructures*
  - *healthcare*
  - *environmental monitoring*

Scientific Objectives

- Develop a comprehensive solution for mobile human-centered systems that are predictable and reliable
  - Build systems that are predictable, reliable, scalable and adaptable
  - Deal with the scale, heterogeneity, complexity and unpredictability of the systems; understand the tradeoffs
  - Exploit human participation to create “human-centered” computational systems

Example: Emergency Response

Mobile Human-Centered Systems can fundamentally contribute in coping with emergency events

Emergency response environment

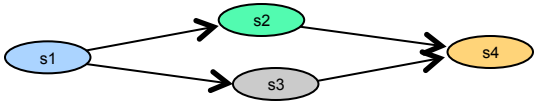
- Unpredictable phenomena
- Heterogeneous, dynamic data (GPS, video) processed in real-time
- Limited resources
- Unreliability in understanding and managing the situation

- Currently, no infrastructure in place to take advantage of such data provided by humans
- Human-in-the-loop can help manage emergencies more effectively
  - improve understanding, prediction and warning of emergencies through real-time processing of data streams potentially including social data
  - result in more informed decisions leading to effective response

Scientific Methodology: Operating under Uncertainty

End-to-end Model

- Distributed real-time applications represented with graph structure
  - Multiple applications, application components distributed on multiple nodes
  - Data streams in large volumes and at irregular and high rates
- Parameters: application QoS demands (i.e., rate demands)



$$r^{req} = \begin{bmatrix} r_1^{req} \\ \vdots \\ r_m^{req} \end{bmatrix}$$

Application rate requirements

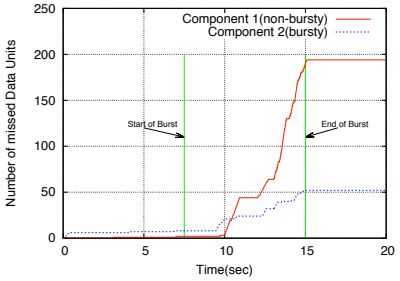
$$u^{c_i} = \begin{bmatrix} u_1^{c_1} \\ \vdots \\ u_k^{c_i} \end{bmatrix}$$

Component resource requirements

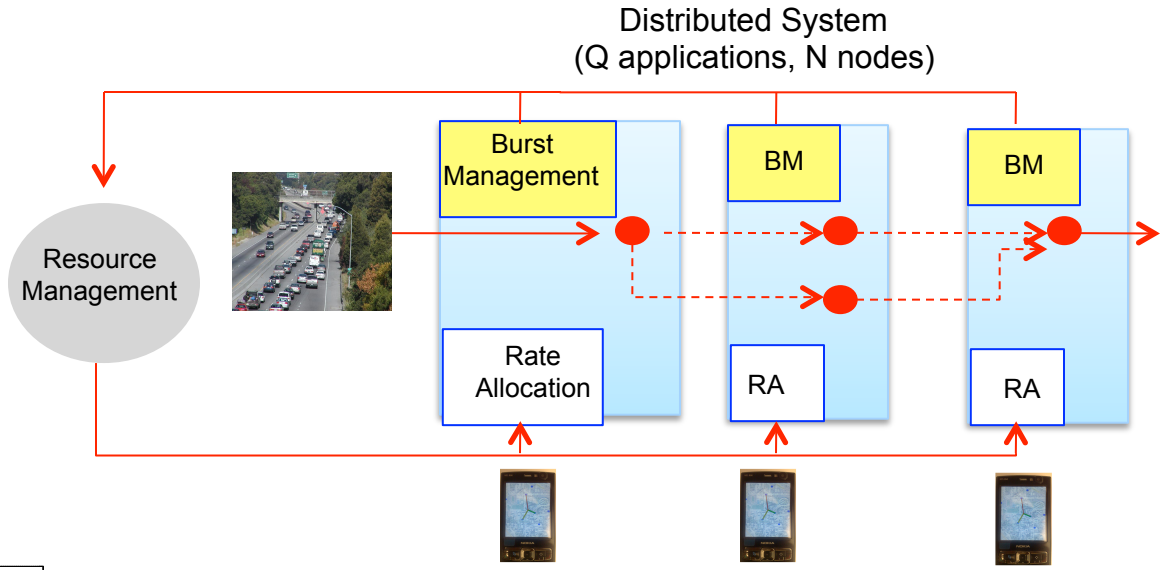
$$A^n = \begin{bmatrix} A_1^n \\ \vdots \\ A_J^n \end{bmatrix}$$

Node resource availability

Problem: Data bursts



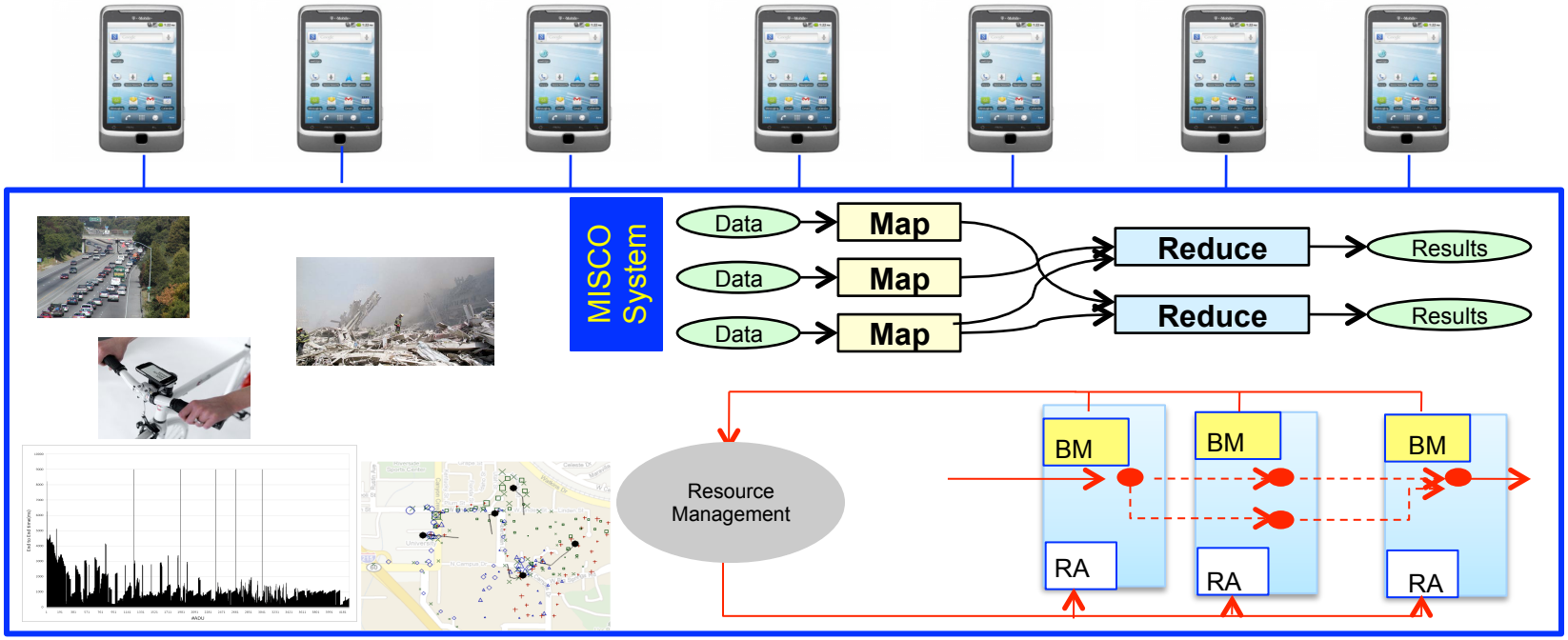
Example of a burst



$$\underbrace{\sum_{c_i \in n} r_{c_i} \cdot u_j^{c_i}}_{\text{Initial resource requirements}} + \underbrace{\sum_{c_i \in n \cap C^q} \delta_q \cdot \frac{r_{c_i}}{r_q} \cdot u_j^{c_i}}_{\text{Additional resource requirements due to a burst}} \leq A_j^n$$

Scientific Methodology: Enabling Human-Centered Applications

- Future mobile human-centered applications should have the following characteristics:
  - Be non-intrusive, easy to develop, use and deploy
  - Exploit mobile devices with rich sensing capabilities in the hands of the crowds
  - Solutions must work effectively even when infrastructure is in duress
- Specific challenges to be addressed:
  - Simplify the system programmability over networks of distributed mobile computing devices
  - Develop end-to-end predictable, reliable human-centered distributed systems

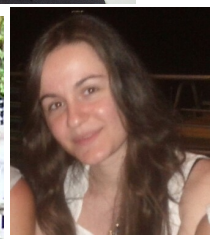
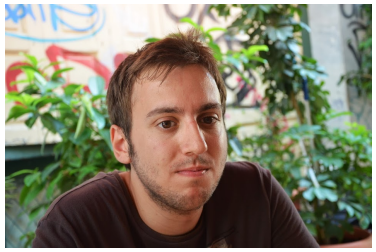


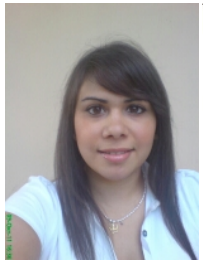
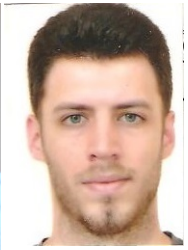
Distributed and Real-Time Systems Group AUEB

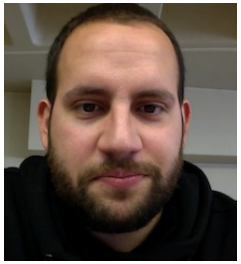
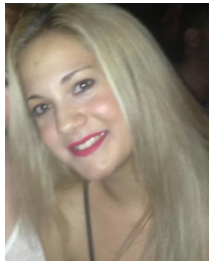
Current Team

- V. Kalogeraki
- I. Boutsis, N. Zaheilas, I. Litou, S. Antoniadis
- M. Minadakis, E. Antypas, D. Tomaras
- S. Karanikolaou, M. Drakouli, P. Nikoletatou
- 1 faculty, 3 PhD students, 6 MS students, 4 Undergraduates
- Collaborating with Industrial Labs (IBM Research, Nokia Research)



Excellence

- Emphasize your areas of excellence
- Show you are the right person for the project proposed
- Impact of the project

Main Researcher

- Highlight your research credentials
  - journal/conference publications
  - citations, h-index
  - distinctions: best paper awards, invited keynotes
  - experience in academia, industry
  - service to scientific community (e.g., PC Chair positions, journal editorial boards, tutorials)
  - participation, leading role in research projects

Preparing the proposal

- Start working on the proposal early
  - Start several months before the deadline (you will most probably need the time to collect the data, articulate the story)

- Plan several weeks for writing
  - Allow enough time for putting together the idea and re-shaping it

- Ask for feedback
  - Ask friends and colleagues to review your proposal
  - Use different opportunities to discuss your ideas
  - Make a presentation and discuss the main ideas

Writing the Proposal

- The project should address an important problem
- The idea and objectives should be clear
- What is the novelty
  - Explain why the problem is hard and why there are no easy solutions
- What is the vision
  - What do you see as the “long-term” vision of the project

Description of the Work

- Description of the Workplan
  - 3 WorkPackages
  - What is the scientific challenge in each WP
- Impact
  - Scientific
  - Societal
  - System development
  - Educational goals
- Emphasize research collaborations

Forms

- A Forms:
  - check eligibility criteria (starting grant, consolidator grant, advanced grant)
  - check restrictions carefully
- B1 Forms:
  - assessed at the 1st step of evaluation
  - extended synopsis of project proposal
- B2 Forms:
  - detailed proposal description
  - assessed at the 2nd step of evaluation
- Host institution binding statement of support

Thank you

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