Karlsruhe Institute of Technology

Technology for Pervasive Computing

Global Peer-to-Peer Classification in Mobile Ad-Hoc Networks: A Requirements Analysis

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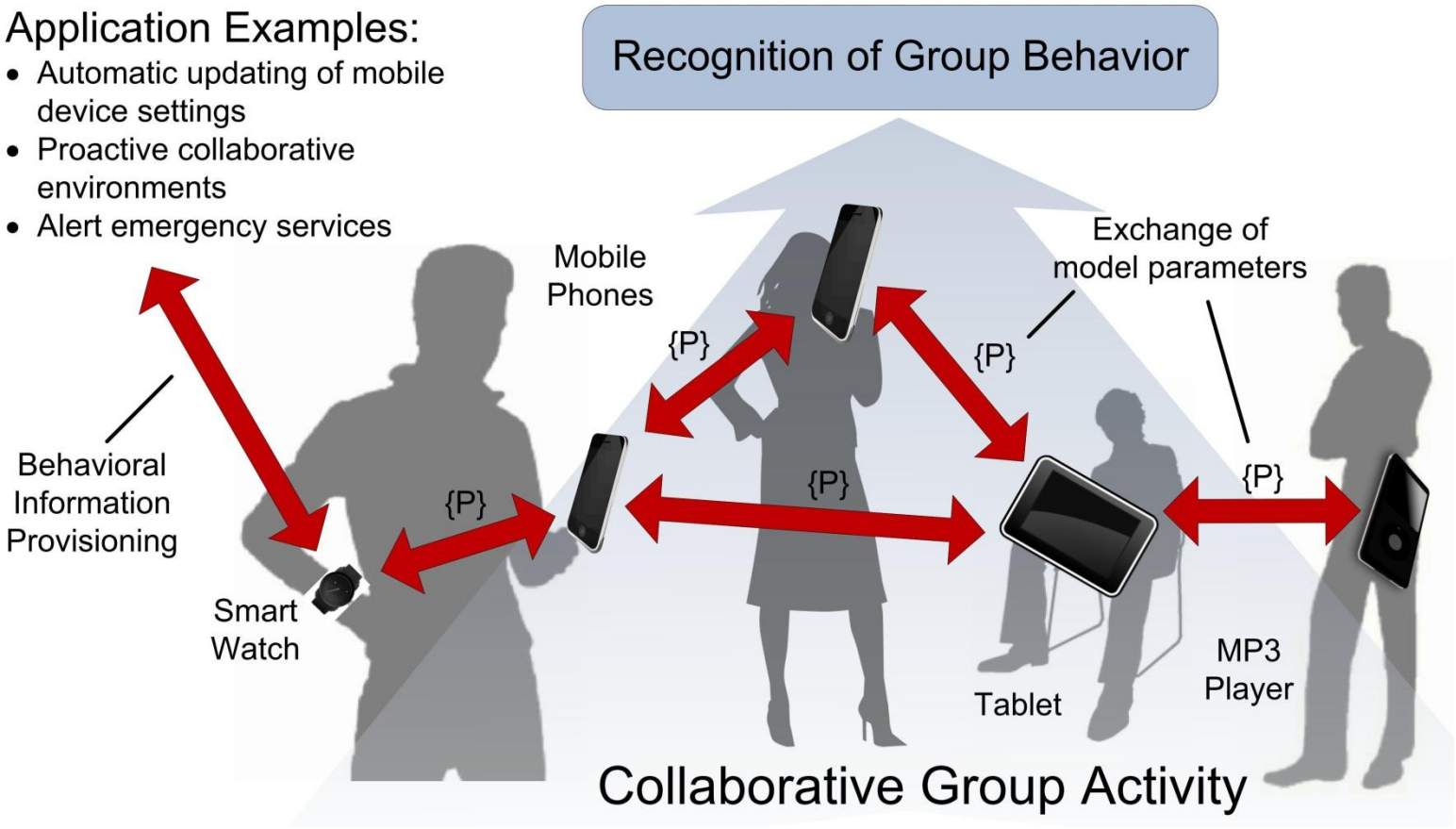
Overview

Motivating Scenario:
Recognition of social group activities using mobile P2P devices

- Define how, what and why
  - What are we trying to recognize?
  - How are we trying to do it?
  - Why is in-network recognition needed?
- Observing Individuality
  - Results from requirements and scenario
  - Why it's necessary
- Requirements Analysis
  - Survival
  - Recovery
  - Mapping ability
- Resources
  - Bounds for distribution
  - Brute force method (upper)
  - Connectionist method (lower)

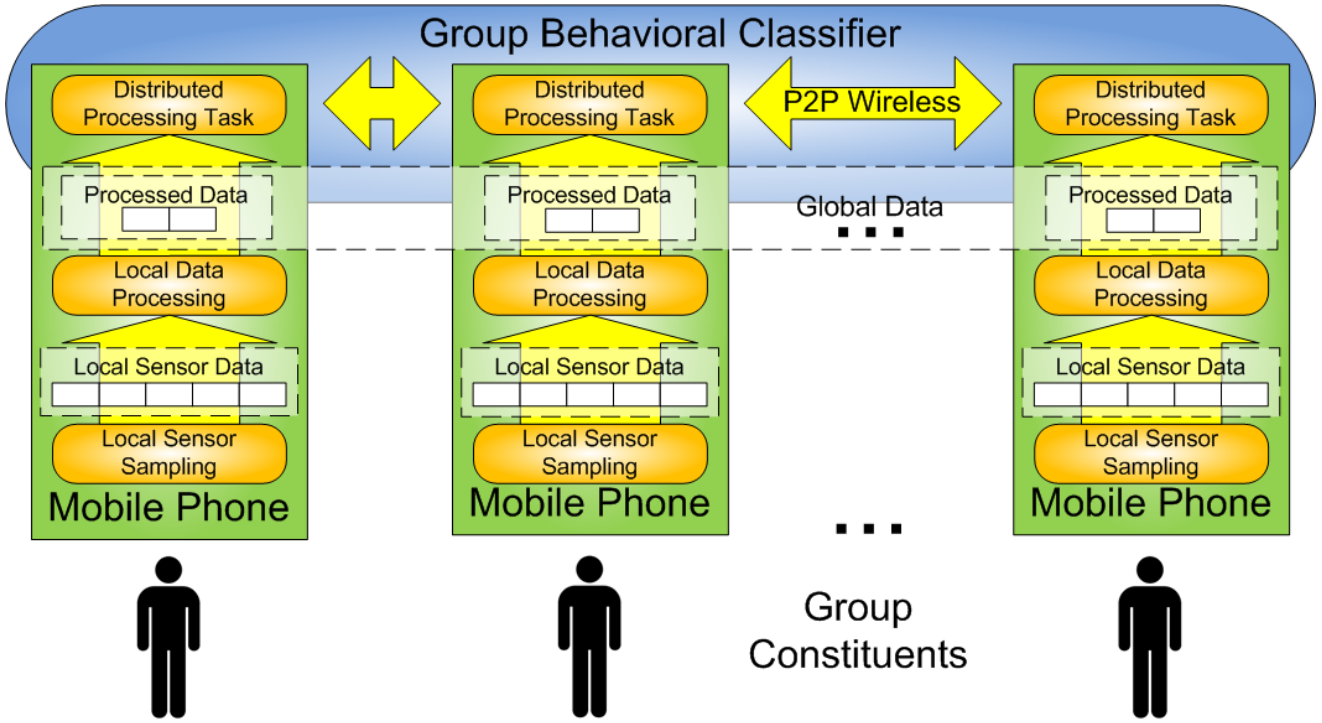
GAR using Mobile P2P Devices



- Devices collaborate to recognize group activity using embedded sensors

The activity recognition community

- My background: human activity recognition based on mobile sensor measurements
- Focus here: distributed input / processing



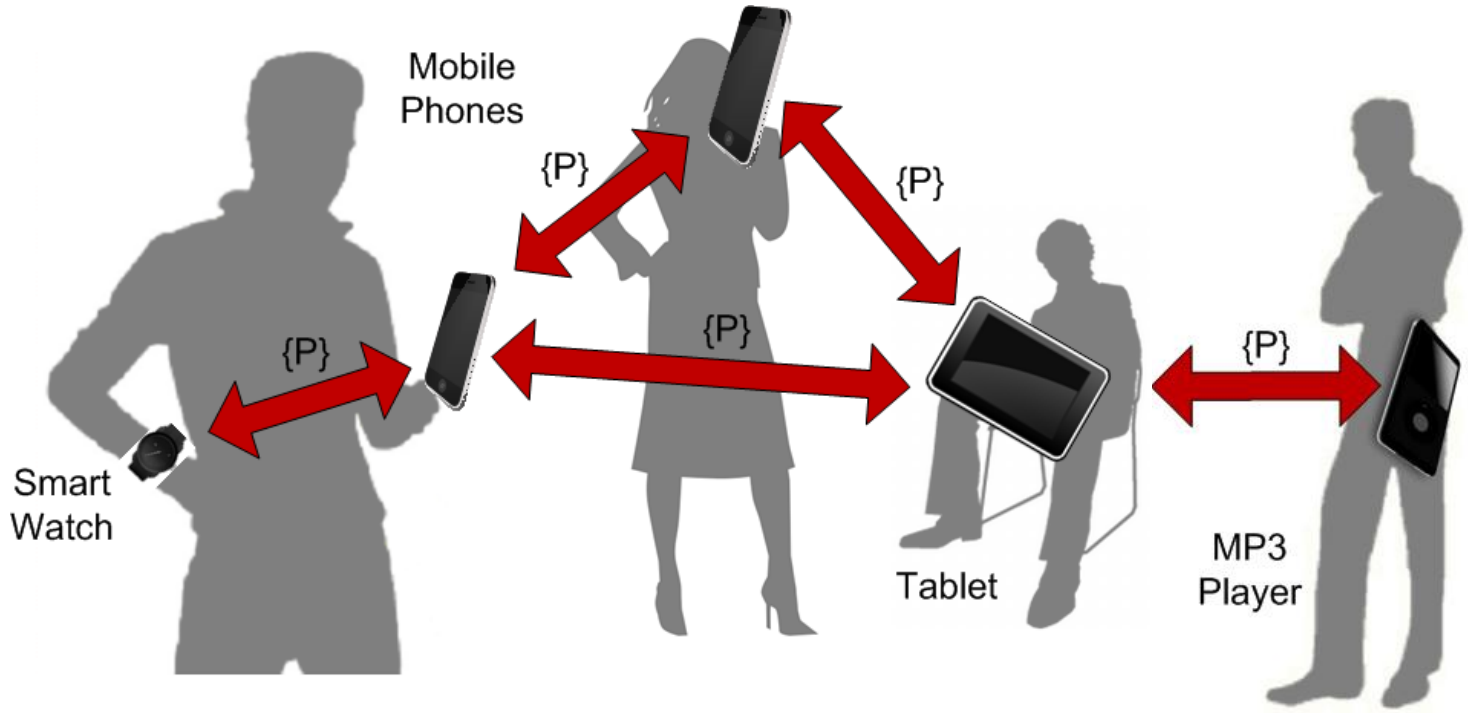
What and Why?

- What are we trying to recognize?
  - Behavior of a group of social individuals
- Why and when on P2P devices?
  - Sporadic access to infrastructure
  - Expensive access (energy, bandwidth, etc.)
  - No access (Autonomous)

James Cridland

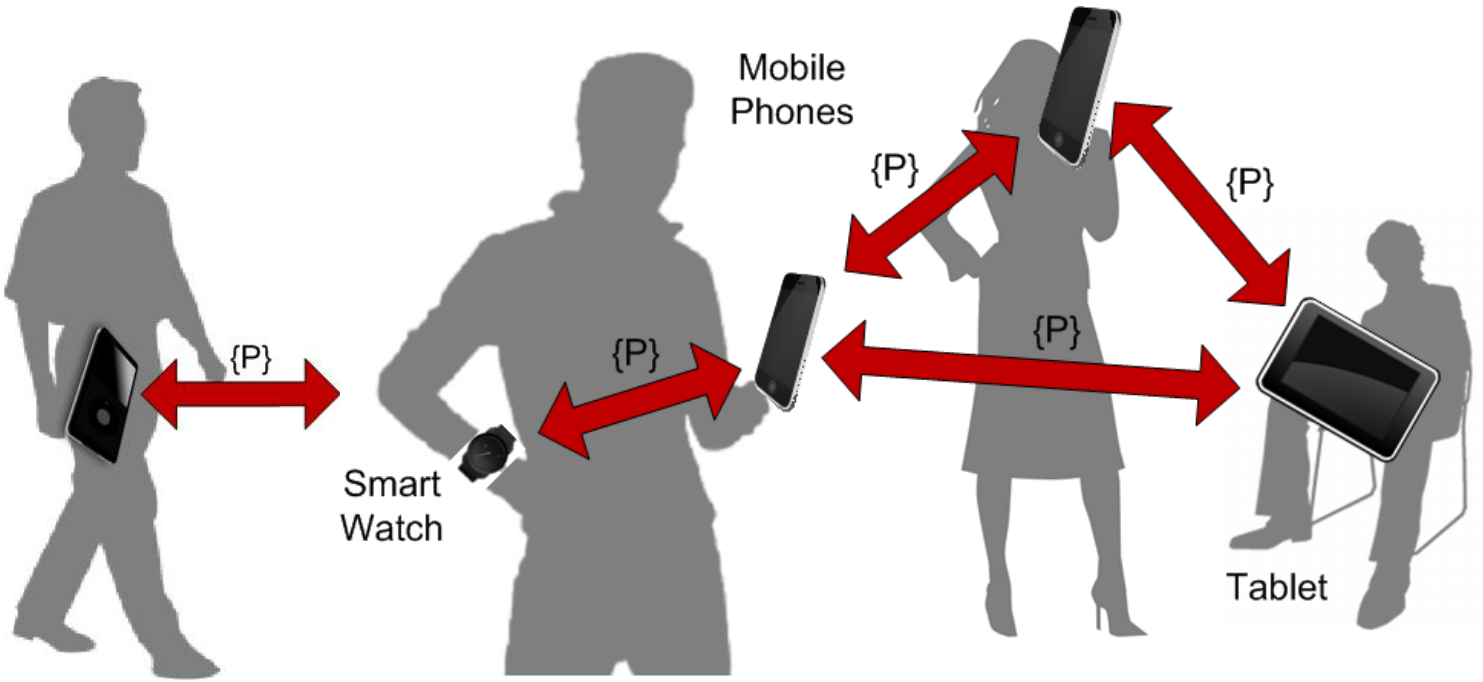
Requirement 1: Survival

- Recognition must survive nodes leaving without loss of recognition capabilities



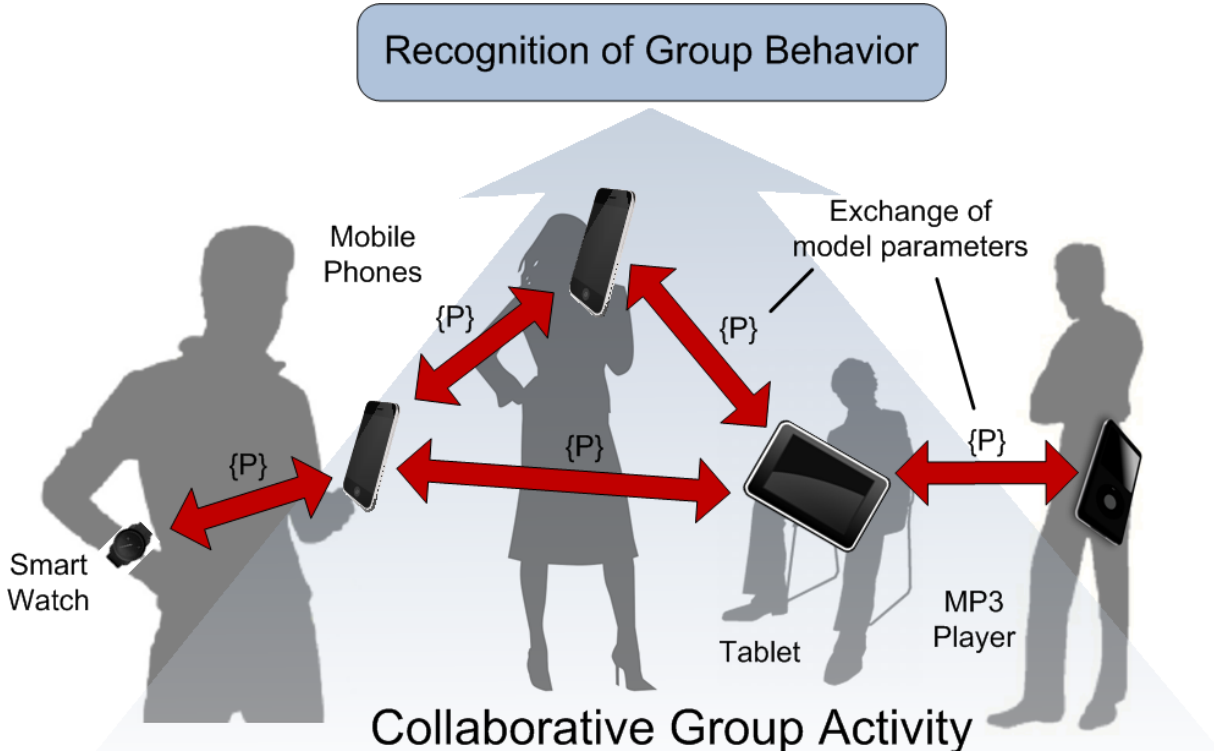
Requirement 2: Recovery

- Recognition must not lose ability as individuals come and go



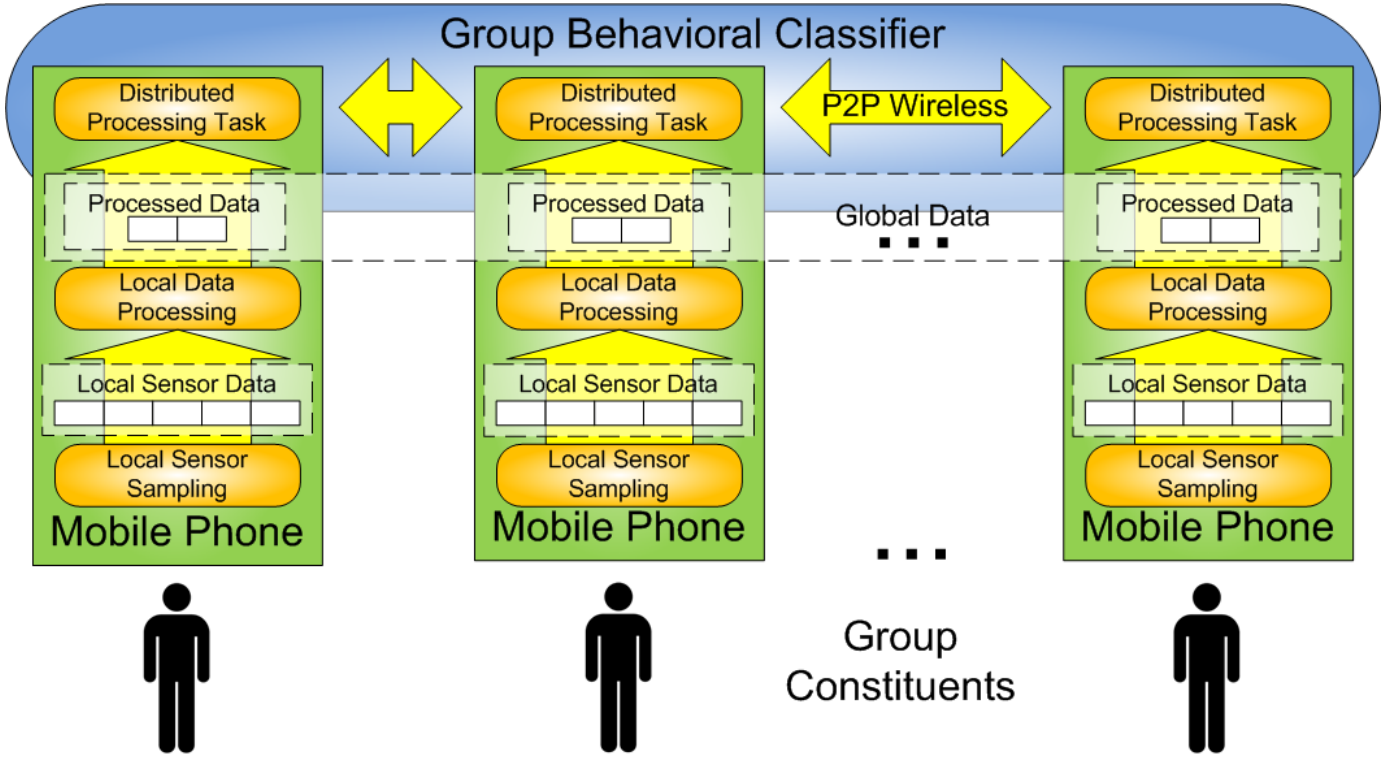
Requirement 3: Mapping Ability

- Which “social” context is to be recognized is not defined
- Approach must be able to model mapping from sensor values to contexts



Observing Individuality

- Assuming nodes are heterogeneous leads to problems!
- Constant subject “throughput” means data from new subjects are constantly introduced to system
- Eventually all original (training) subjects will be replaced



Related Work

- Parallel Computing:
  - Global access to data
  - Or, central merging/computation unit
- Collaborative Methods:
  - Distributed voting
  - Counts vote, not voter
- Organic Computing
  - Multi-agent stigmergy approaches
  - Produce a distributed stigmergic map

Possible solutions

- Several different algorithmic approaches
- Brute force
  - redundant classifier
  - Complete dissemination of all measurement data
- Connectionist approach:
  - distribution of processing units across network
  - Each node input, output and hidden processor
- Self Organizing Maps: distribution of data representation across network

Resource Consumption Analysis

- Assumption: distributed algorithm meeting requirements
- N: number of nodes in the network
- P: total processing load (per classification phase)
- M: total memory required by algorithm

Algorithm	Messages Passed	Processing/ Node	Memory/ Node
Brute Force (Worst Case)	N(N-1)	P	$M + S_G$
ANN	2N	P/N	$M/N + S_L$
Best Case	N	P/N	$M/N + S_L$

Summary

- In-network P2P classification is necessary:
  - No, Restricted, or Intermittent access
- For functionality there are 3 requirements:
  - Survival, Recovery and Mapping
- An upper and lower bound for resource consumption and distribution derived
  - Brute force approach
  - Distributed reasoning approach
- The importance of incorporating role elaborated on

That's All

- Thank You!
  - Questions?