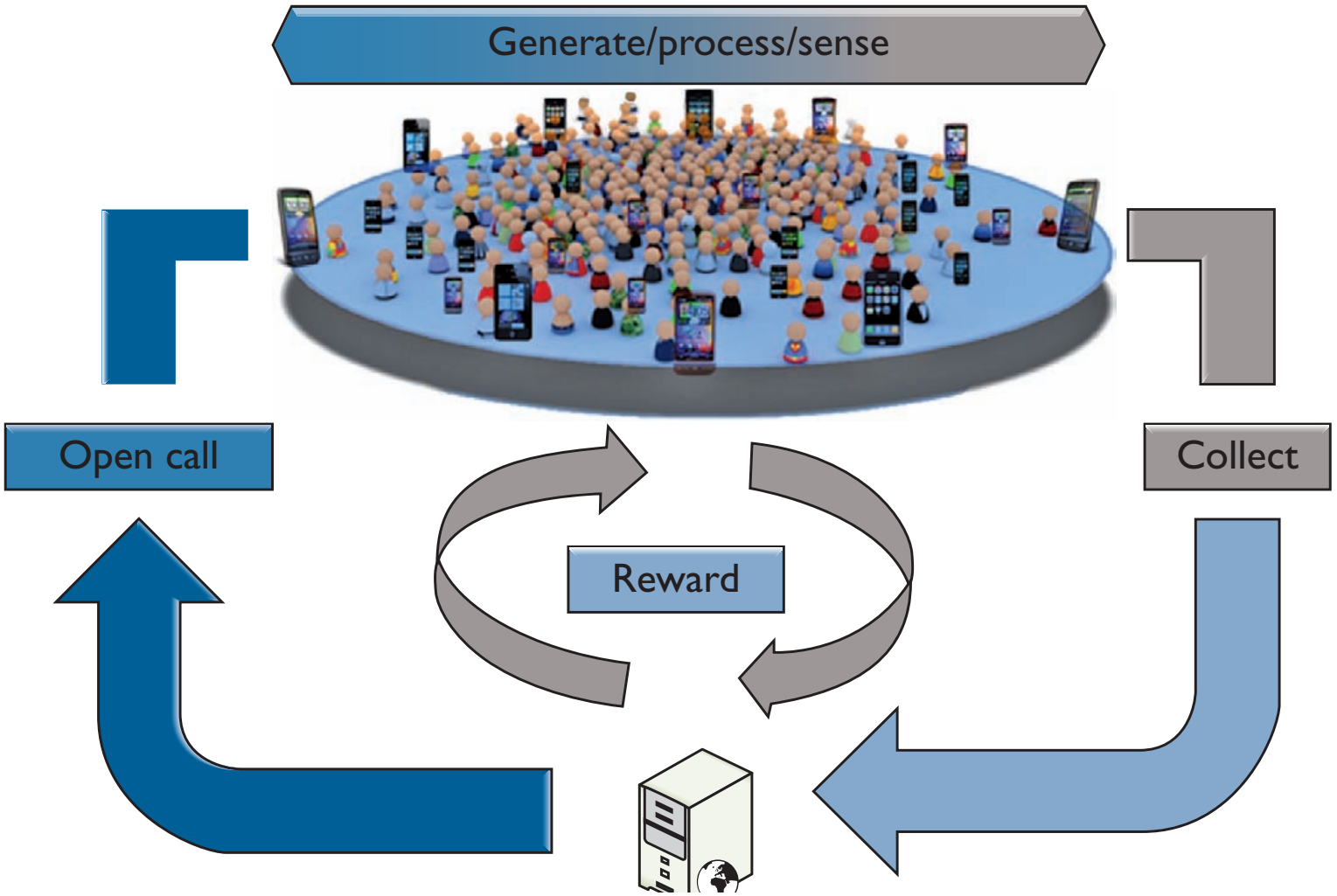
BLM5134 - CROWDSOURCING

WEEK – 10

What is Crowdsourcing ?

- “the act of taking a job traditionally performed by a designated agent (usually an employee) and outsourcing it to an undefined, generally large group of people in the form of an open call”

CROWDSOURCING



TWO APPROACHES

- Participatory
- Opportunistic

Example: Disaster relief efforts, mining operations, health campaigns
In emergency situations, entities with any sensing capabilities such as cellphones with GPS or desktops equipped with surveillance cameras, can be especially valuable for the OppNet.

Participatory vs Opportunistic

- Typically, users perform computations or generate data as input for participatory crowdsourcing;
- The input for opportunistic crowdsourcing is data generated from sensors and computations that are automatically performed by the crowd's devices

4 Categories of Crowdsourcing Apps

- (1) Collective intelligence (or wisdom of the crowd). People (in a crowd) solving problems and providing new insights and ideas leading to product, process, or service innovations .
- (2) Crowd creation (or user-generated content). People creating various types of content and sharing it with others for free or for a small fee.
- (3) Crowd voting. People giving their opinion and ratings on ideas, products, or services, as well as parsing, evaluating, and filtering information presented to them.
- (4) Crowdfunding. This is a special model in which people can raise money for investment, donations, or for micro-lending of funds.

Roles of a Crowd

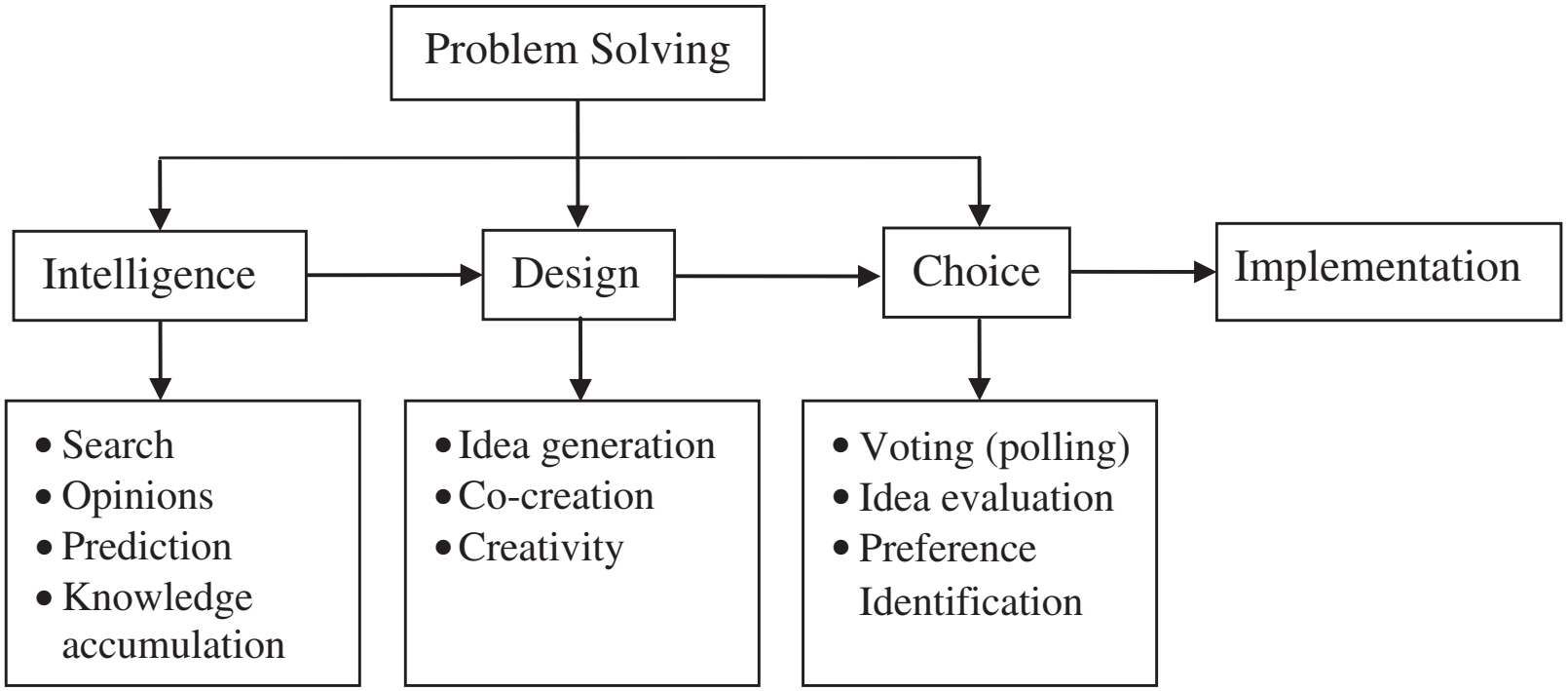


Fig. 1. Roles of a crowd in different decision making phases.

Crowdsourcing Process

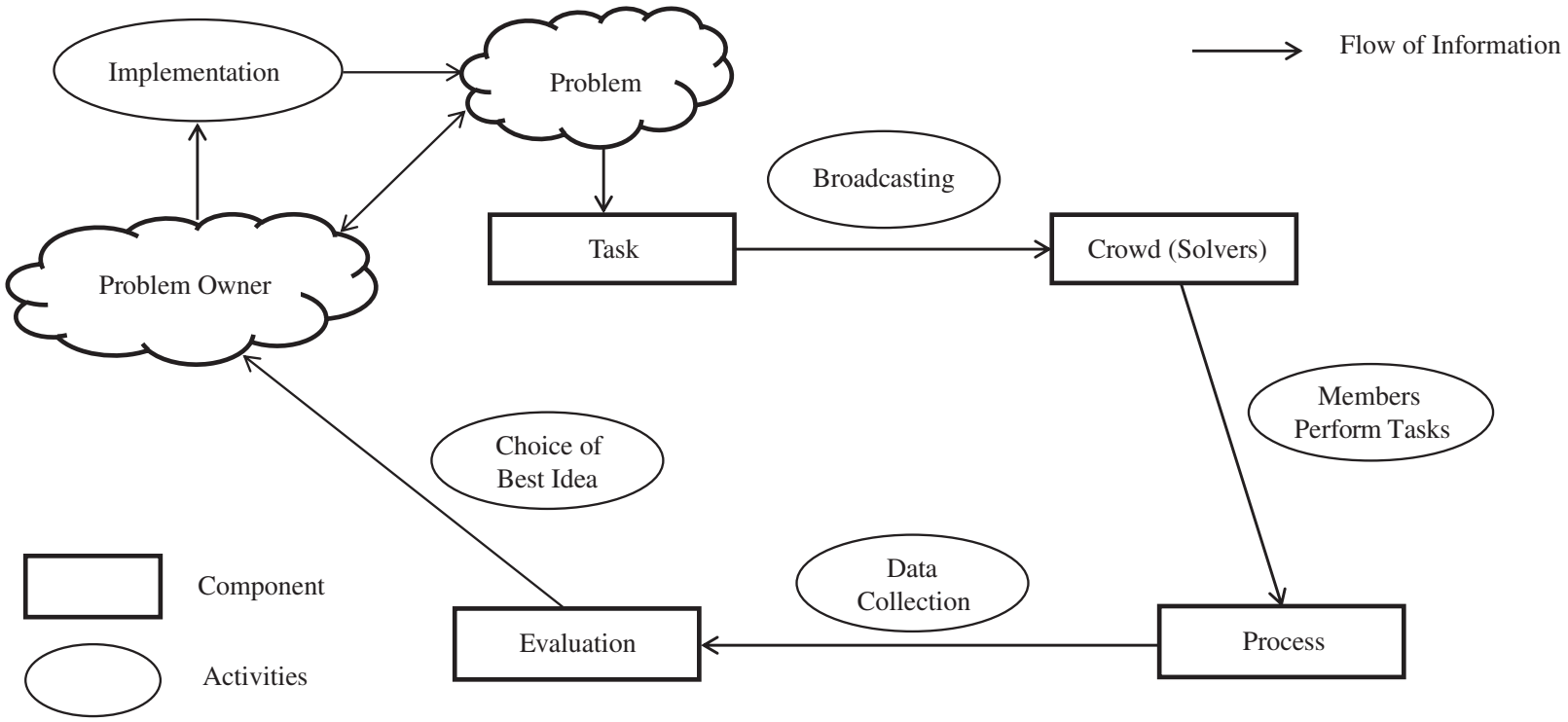


Fig. 2. The crowdsourcing process for decision making.

A Framework for Organizing Crowdsourcing Research

Table 1
A framework for organizing crowdsourcing research.

Component / Levels of concern	Task	Crowd	Process	Evaluation
Managerial	➢ Task suitability ➢ Task feasibility ➢ Task presentation ➢ Key capabilities involved ➢ Task variety ➢ Task complexity ➢ Task decomposition	➢ Incentive mechanisms ➢ Crowd selection ➢ Determination of proper crowd size ➢ Diversity of the crowd	➢ Crowdsourcing mechanism ➢ Feedback on the crowdsourcing process ➢ Accessibility of peer contributions ➢ Legal issues ➢ Infrastructure	➢ Evaluator selection ➢ Evaluation metrics ➢ Quality measurement
Behavioral	➢ Impact of crowdsourcing on employees ➢ Employees' attitudes toward crowdsourcing ➢ Impact of task features on participants' outputs	➢ Crowd's task selection behavior ➢ Crowd motives ➢ Trust ➢ Crowd's attitude toward participation ➢ Participation intention and behavior	➢ Groupthink ➢ Human biases ➢ Cheating in crowdsourcing	➢ User participation in evaluation ➢ User attitude toward rating scale
Technology and Systems	➢ Platform selection ➢ System functionalities	➢ Use of collaboration tools ➢ Participants' reaction to system functions	➢ Process monitoring ➢ System architecture design ➢ Collecting process data ➢ Use of social network ➢ Use of collaboration tools ➢ Use of artificial intelligence ➢ Platform usage profile	➢ Outcome evaluation method ➢ Use of idea evaluation tools

Crowdsourcing Applications

- Crowdsourced traffic monitoring, with Waze (www.waze.com);
- Road-traffic delay estimation, as in VTrack2;
- The construction of fine-grained noise maps using uploaded data captured by users' smartphone microphones (Ear-Phone3 and NoiseTube4);
- The identification of holes in streets by letting users share vibration and location data their smartphones capture (PotHole5);
- Location-based games aimed at collecting geo-spatial data (such as City- Explorer6); collaborative traffic signal schedule advisories (SignalGuru7);
- Real-time, fine- grained indoor localization services that exploit the radio signal strength of Wi-Fi access points (Airplace8).

Crowdsourcing with Smartphones

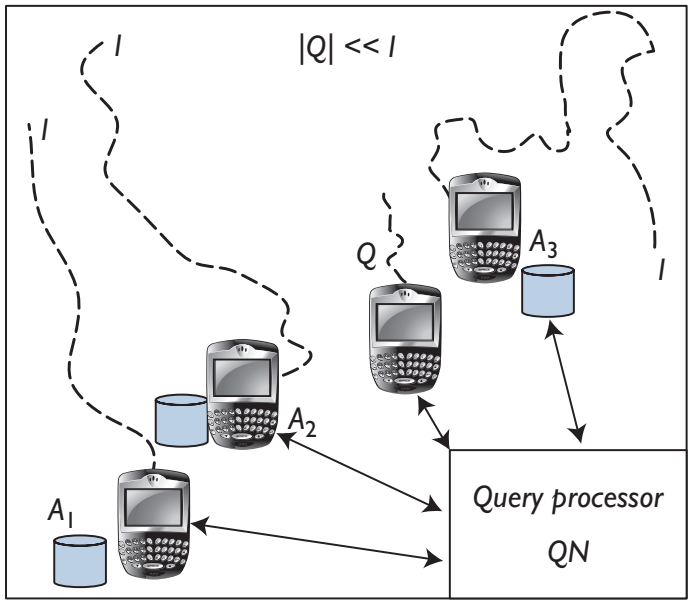
Table 1. Taxonomy of mobile crowdsourcing applications.

Applications	Web-extend	Involvement	Data wisdom	Contribution quality	Incentives	Human skill	Sensors	Location
Gigwalk.com	Y	Participatory	Individual	Heterogeneous	Monetary	Labor	Camera	Y
Jana.com	Y	Participatory	Individual	Heterogeneous	Monetary	Visual	X	Y
Crowd Translator[1]	Y	Participatory	Collective	Homogeneous	Service	Visual	X	X
Waze.com	X	Both	Collective	Homogeneous	Ethical/service	Visual	Camera	Y
CityExplorer[6]	X	Participatory	Collective	Homogeneous	Entertainment	Visual	Camera	Y
VTrack[2]	X	Opportunistic	Collective	Homogeneous	Ethical/service	X	X	Y
SignalGuru[7]	X	Opportunistic	Collective	Homogeneous	Ethical/service	X	Camera	Y
Ear-Phone[3]	X	Opportunistic	Collective	Homogeneous	Ethical	X	Audio	Y
NoiseTube[4]	X	Opportunistic	Collective	Homogeneous	Ethical	X	Audio	Y
PotHole[5]	X	Opportunistic	Collective	Homogeneous	Ethical	X	Vibration	Y
AirPlace[8]	X	Opportunistic	Collective	Homogeneous	Service	X	X	Y
SmartTrace[11]	X	Opportunistic	Collective	Homogeneous	Service	X	X	Y
Crowdcast[12]	X	Opportunistic	Collective	Homogeneous	Service	X	X	Y
SmartP2P[13]	X	Opportunistic	Collective	Homogeneous	Service	X	X	Y

Centralized vs Decenteralized Methods

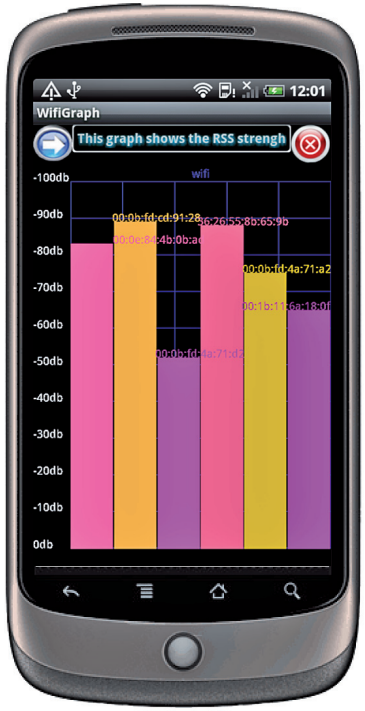
Table 2. Energy profiling of a typical smartphone.	
Basic smartphone operation	**Megawatts of power (mW = mJ/s)**
CPU minimal use (just OS running)	35
CPU standard use (light processing)	175
CPU peak (heavy processing)	469
Wi-Fi idle (connected)	34
Wi-Fi localization (avg/minute)	125
Wi-Fi peak (Uplink 123Kbps, -58dBm)	400
3G localization (avg/minute)	300
3G busy	900
GPS on (steady)	275
OLED economy mode	300
OLED full brightness	676

SmartTrace+



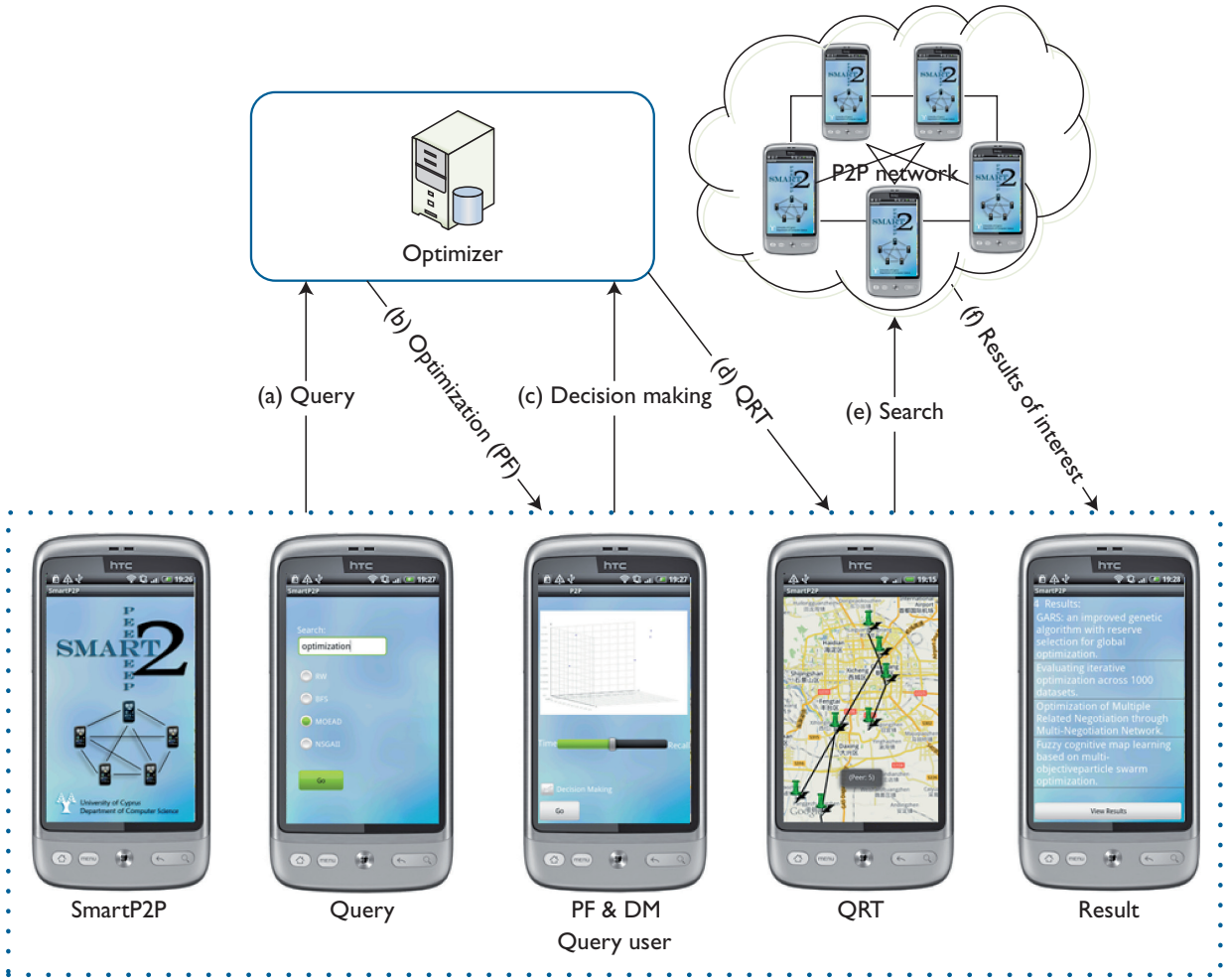
(a)

(b)



(c)

SmartP2P


Optimizer
P2P network
(a) Query
(b) Optimization (PF)
(c) Decision making
(d) QRT
(e) Search
(f) Results of interest
SmartP2P
Query
PF & DM
QRT
Result
Query user

SmartP2P

- minimize energy consumption during search,
- minimize the query response time in conducting the search, and
- maximize the user query's recall rate.

Mobile Crowdsensing

- Mobile crowd sensing [3] requires large amounts of participants (e.g., normal smartphone users) to sense the surrounding environment via rich built-in sensors of mobile devices, including accelerometer, gyroscope, compass, microphone, camera, GPS, and wireless network interfaces.

- These sensors are able to record various information about the participants (e.g., mobilities and locations) and the environment (e.g., images and sounds).

Incentives for Crowdsensing

- Entertainment
- Service
- Money

- Altruism,
- Enjoyment,
- Reputation,
- Service,
- Payment.

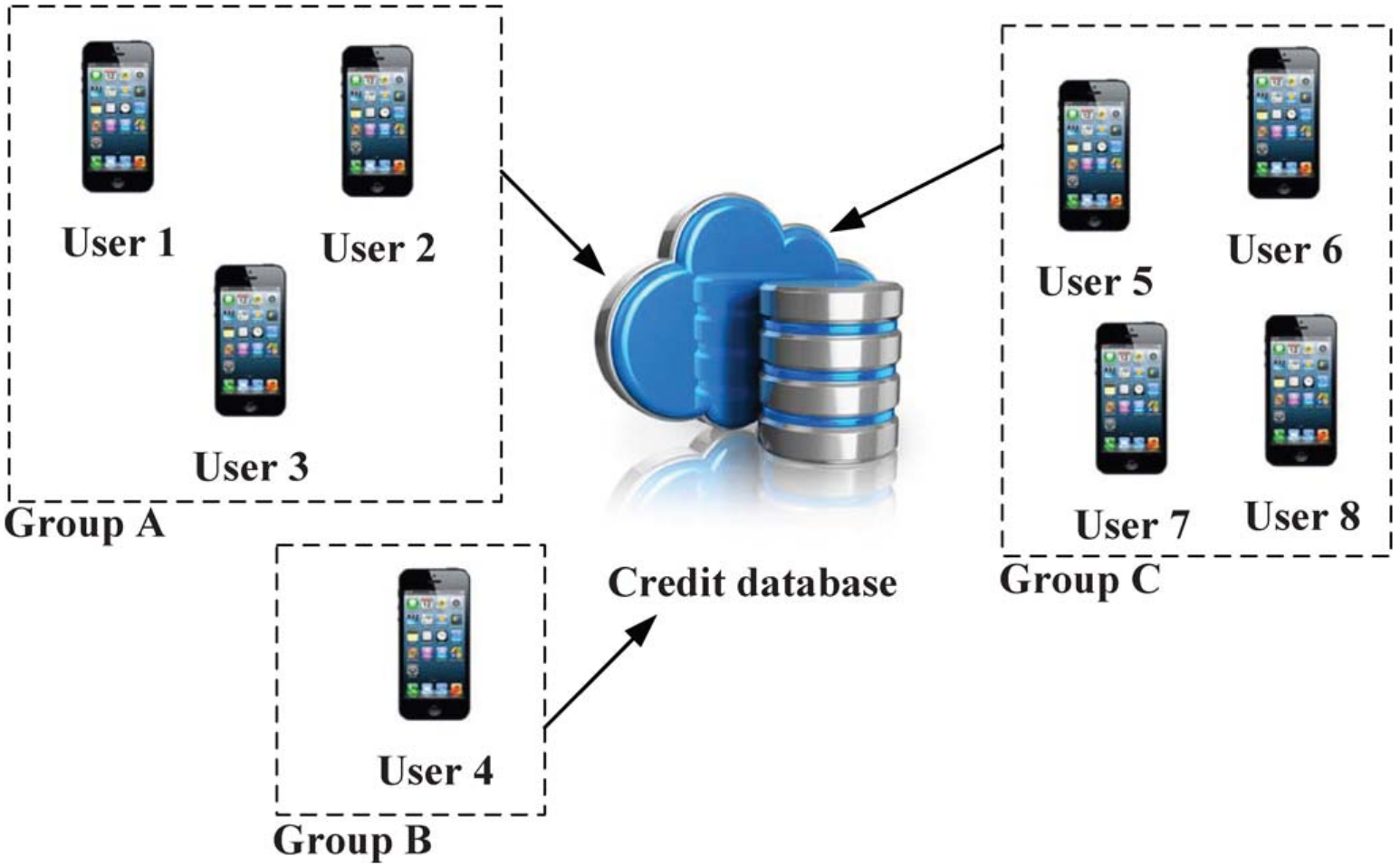
Crowdsensing Problems

- Imbalanced data
- Unreliable data
- Malicious data
- Unbalanced crowd
- Lack of crowd

Sensing Games

Authors	Ref	Game	Sensing Task	Technology/Sensor	Collected Data
Barkhuus *et al.*	[20]	Treasure	study WiFi coverage of specific areas	WiFi, GPS	maps with signal strength
Bell *et al.*	[21]	Feeding Yoshi	study WiFi coverage of specific areas	WiFi	manually annotated maps
Broll and Benford	[22]	Tycoon	evaluate the coverage of GSM cells	GSM, GPS	travel trajectories with cell-ids and GPS readings
Drozd *et al.*	[23]	Hitchers	evaluate the coverage of GSM cells	GSM	travel trajectories with cell-ids
Schlieder *et al.*	[24]	GeoTicTacToe	collect GPS traces (and other sensor readings) for predefined areas	GPS, other sensors	GPS traces (and other sensor readings)
Schlieder *et al.*	[25, 26]	CityPoker	collect GPS traces (and other sensor readings) for predefined areas	GPS, other sensors	GPS traces (and other sensor readings)
Jordan *et al.*	[27]	Ostereiersuche	identify structural landmarks	GPS	GPS traces
Matyas *et al.*	[10]	CityExplorer	produce geospatial data for location-based service	GPS, camera	GPS traces, photos, manual annotations
Han *et al.*	[28]	BudBurst Mobile	facilitate climate change education and data collection	accelerometer, GPS, compass	GPS traces, manual annotations
Bell *et al.*	[29]	EyeSpy	produce information about recognizable and findable locations	WiFi, camera	WiFi fingerprints, photos, manual annotations

GROUP-LEVEL INCENTIVE



Service Incentives

TABLE II
SENSING TASKS WITH SERVICE INCENTIVES

Authors	Ref	Type of Sensor	Sensing Service Description
Luo and Tham	[31]	general	provides two general incentive mechanisms: one considers user fairness and the other pursues social welfare maximization
Hoh *et al.*	[33]	GPS	provides available parking information (when and where) to drivers
Lan *et al.*	[34, 35]	video camera	provides mobile surveillance videos and data forwarding service
Gupta *et al.*	[36]	none	digitizes local-language text
Deng and Cox	[37]	camera	provides product price sharing service
Reddy *et al.*	[38]	camera, GPS, microphone	provides eating habit comparison and suggestion service
Cheng *et al.*	[39]	general	collects different types of data in wireless sensor networks

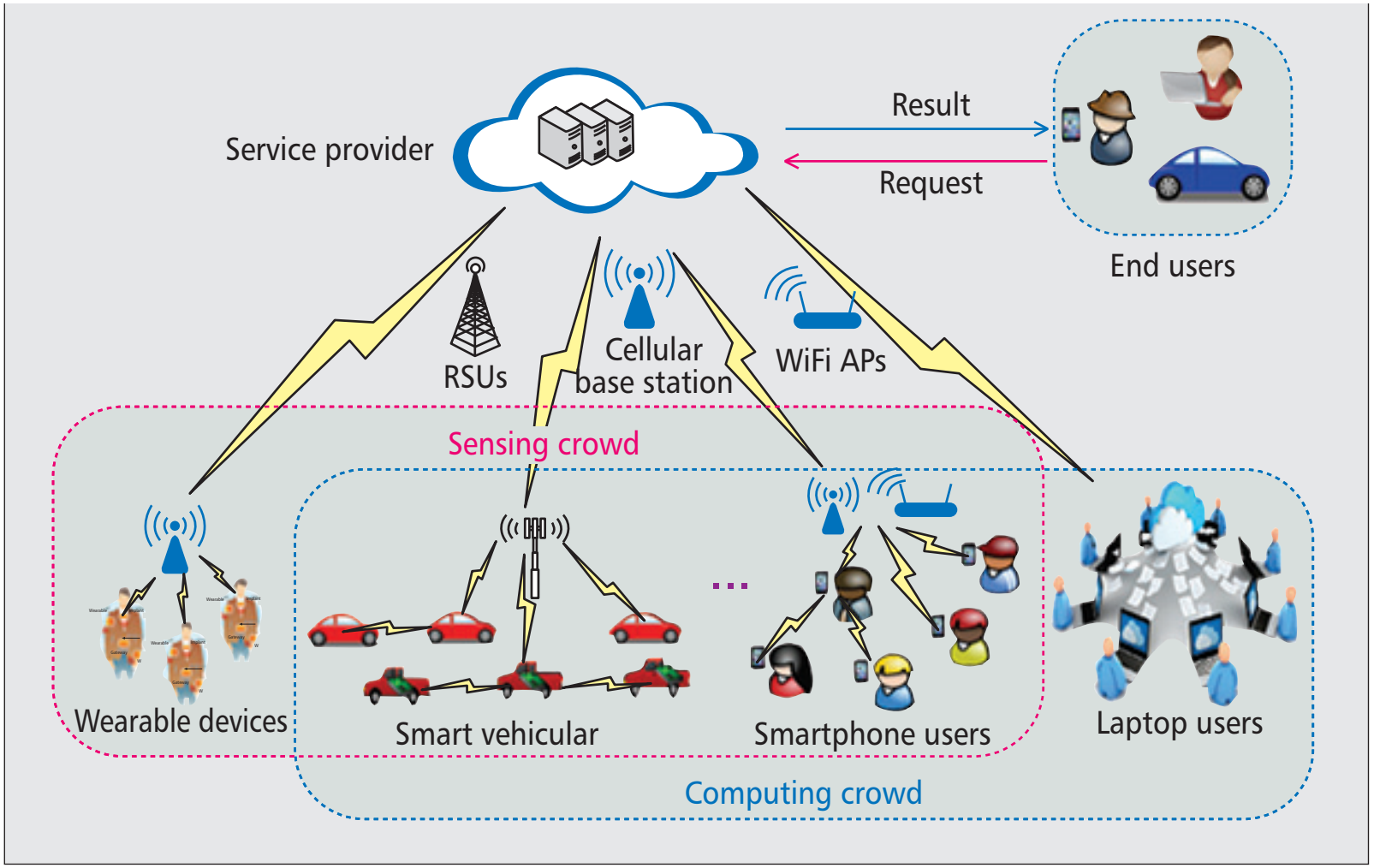
Different Payment Incentives

- UNIFORM. Participants are paid a fixed amount of 4 cents for each completed question.
- VARIABLE. Participants are paid a variable amount in the range 2 to 12 cents per question. The amount changes with questionnaire according to some distribution.
- HIDDEN. This scheme is the same as VARIABLE, except that participants are not told the amount of each question until they complete an entire questionnaire.

Future Directions

- Entertainment-Based Incentives
  - Hybrid Networks
  - Integrating Equipments
  - Heterogeneous Sensing Systems
- Service-Based Incentives
  - Dynamic Models
  - Group-Level Models
- Monetary Incentives
  - Online Mechanism Design
  - Task Assignment
  - Quality Control
  - Privacy Tradeoff

General Architecture of MCN



Components of each Entity in MCN

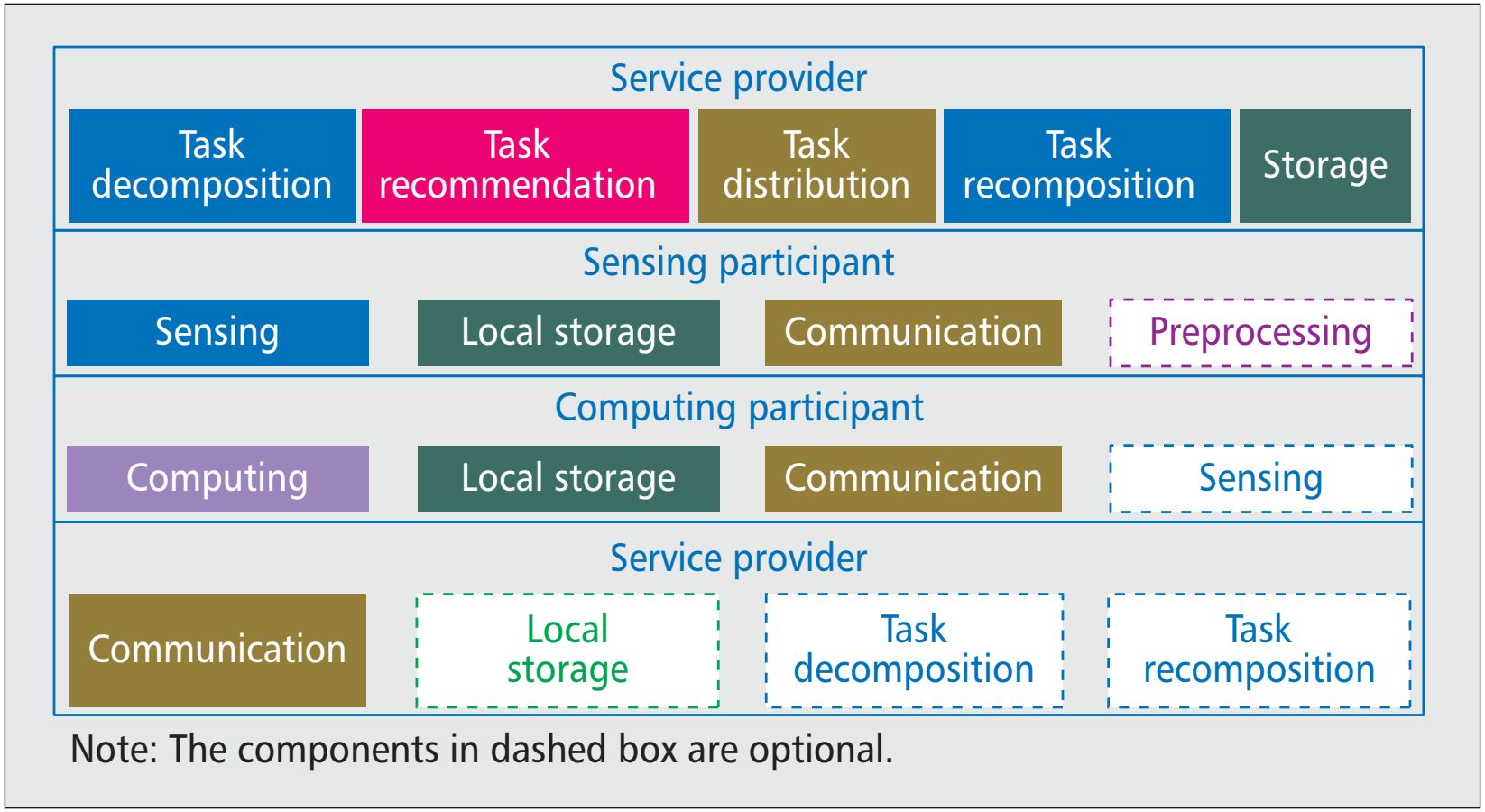


Figure 2. Components of each entity in mobile crowdsourcing networks.

Critical and Challenging Issues

- Human Involvement
- Task Crowdsourcing
- Dynamic Topology
- Heterogeneity

Application Examples

Application examples	Descriptions
Air pollution	Detect air pollution emitted by factories, cars, and farms.
Water quality	Monitor the water quality and study its eligibility for drinking.
Levels	Measurement of the energy radiated by cell stations and WiFi routers.
Smart navigation	Plan route according to weather conditions, accidents, and traffic jams.
Smart parking	Monitor parking space availability in the city and recommend with charges.
Smart traffic light	Control traffic lights according to traffic load and emerging events.
Health monitoring	Monitor health status from heart rate, electrocardiography, blood pressure, etc.
Disease diagnosis	Diagnose the disease from personal health parameters, and other cases.
Food recommendation	Recommend food or drinks according to personal health conditions.

Table 1. Application examples of mobile crowdsourcing networks.

Security and Privacy Challanges

- Privacy Threats
- Reliability Threats

Security and Privacy Threats in MCNs

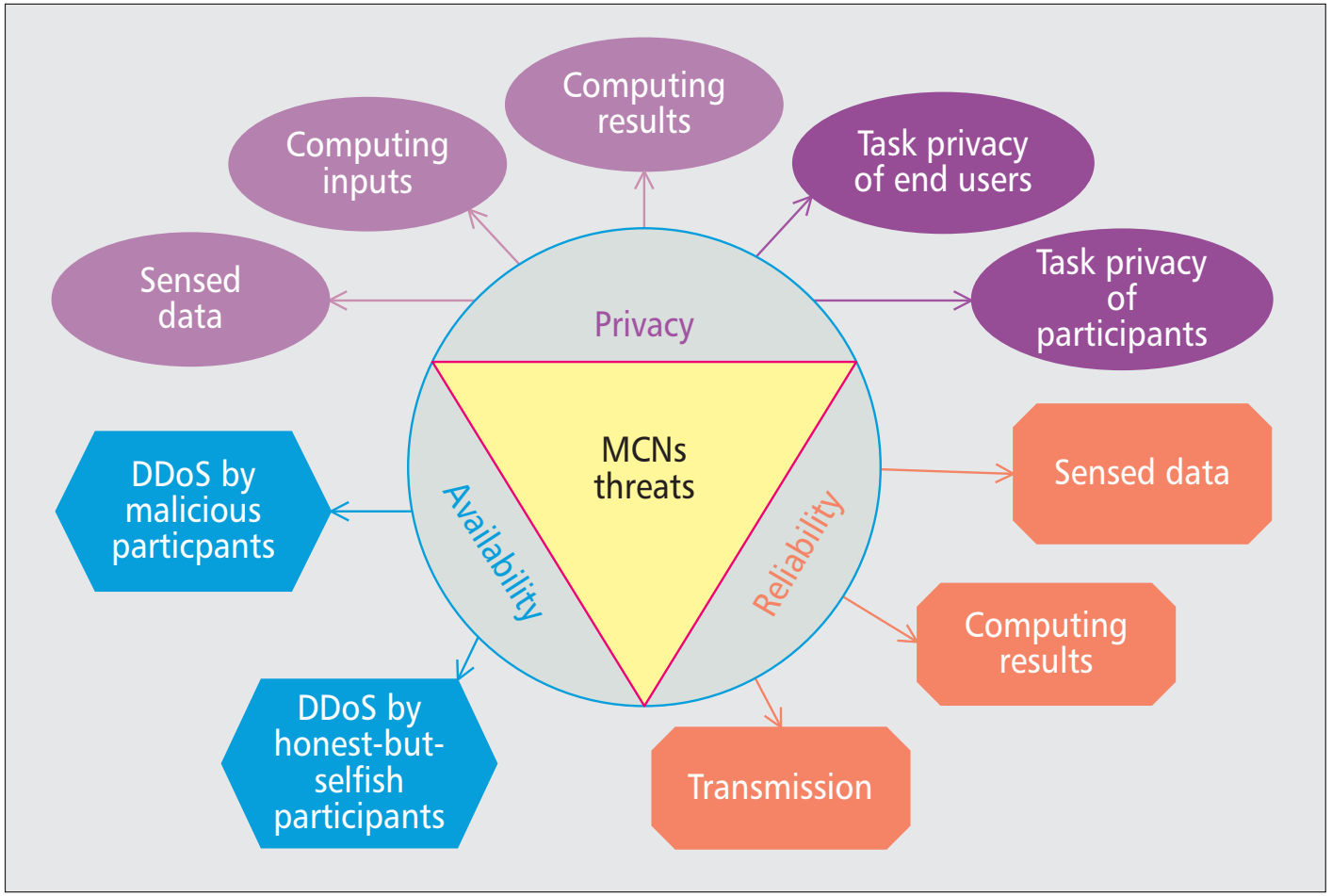


Figure 4. Security and privacy threats in MCNs.