Applications, Architectures, and Protocol Design Issues for Mobile Social Networks: A Survey


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This talk presents an overview of mobile social networks, applications, architectures and protocol design issues.
A Mobile Social Network (MSN) provides data delivery services exploring the social relationship among mobile users.
A social network is a structure of entities that are connected to each other through interdependencies.

**Interdependencies**

- Shared values,
- Physical contacts,
- Financial exchanges,
- Commodity trades,
- Group participations

Knowledge about the structures and ties among the users of a social network $\leftrightarrow$ efficiency and effectiveness of network services.
MSNs is an emerging, cross-disciplinary field, that combines the concepts from the social networks and mobile communication.
A MSN is a mobile communications system which involves the social relationship of the users

The knowledge of social behavior and structure can be used for designing and providing efficient and effective data communications services

Routing and data dissemination
Bandwidth and computing capacity allocation
Storage and power consumption

.....

Content publishing
Data exchange
Sharing
Delivery services

.....
Mobility aspect is the major difference between the MSN service and a classical social network service.

Mobile users not only transmit data but also provide constant feedback to improve the services.

This feedback is basically the social relationship among mobile users.

Mobility can be used as additional information to analyze the social relationship among mobile users.
Mobile Social Network:
Types and Components
Types of MSNs

**Communication with web-based applications through internet**

Eg., iPhone facebook app, Whozthat, Google latitude, …..

**Use simple wireless protocols to transfer users’ identity and bind it with contextual information**

Centralized communications structure

**Web based MSN**

**Decentralized MSN**

**Communication is based on opportunistic contacts**

Eg. EyeVibe

**Wireless technologies such as Bluetooth, WiFi, are used to exchange and share information**

Connection to a centralized server is not needed
Components of MSNs

Content providers (CPs)
- fixed dedicated server
- injects contents/data to users

Mobile users/devices
- mobile devices
- have different wireless interfaces

Network infrastructure
- used for data transfer
- centralized and opportunistic network architectures
Mobile Social Network : Applications
Applications of Mobile Social Networks (1)

Online Social Networking to Mobile Social Networking Services

Key motivation
Knowing people and making friends through online social networks

MSNs add freedom of movement
⇒ ease of use and seamless connection

Advanced services in mobile phones such as GPS, accelerometers, touch technology etc. are the key facilitators

Issues
Usability, availability, privacy and security
Applications of Mobile Social Networks (2)

**Healthcare services**

Key motivation
Helping people with various physical and mental illness

Free web-based social networking applications: PatientsLikeMe, CaringBridge, mCare,…

MSNs can provide easy access to required data during emergencies

Special and strong support to people with severe mental illness and life altering diseases - eg., to locate them when they are lost or confused about their locations (GPS, LBS)
Applications of Mobile Social Networks (3)

**Location-Based Services**

Provides information specific to a location using GPS or signal triangulation of cellular towers

Location based information + social network ➔ contextual services, eg., locating friends, the nearest ATM, ..... 

Some popular MSN-ing applications: Google latitude, Loopt, Gypsii, Whrrl, Mobiluck, Foursquare,.....

**Issues: privacy**
Applications of Mobile Social Networks (4)

**Wearable services**

A wearable network consists of mobile devices which can be used for
- behavioral modeling
- health monitoring
- entertainment

Can augment real and virtual world social interactions

**Applications:** Hug Shirt, Patches, iBand, ...

Anything that can be worn on body and that provides a sense of closeness, is a mobile device
Mobile Social Network: Architectures
MSN: Architectures (1)

**Centralized**
- A centralized server is used to exchange data between CP and mobile users

**Distributed**
- Mobile users communicate directly
  - opportunistic contacts
  - based on common interests, mobility patterns

**Hybrid**
- Mobile users contact the CP when the centralized network structure is available, and data can be exchanged/shared/delivered based on (re)encounters
Almost all web based Applications, which depend on CPs’ updates. Eg., Facebook

Typical middlewares: MobiSoc, Roadspeak (virtual chat groups for vehicular social networks)

Advantages:
- simplicity of implementation,
- high efficiency

Issues:
- a single point of failure
- congestion (bottleneck)
MSN: Architectures (3) : Distributed Architecture

Dedicated middlewares provide functionalities such as
- storing the interests
- identifying other users
- sharing data

Typical middleware: Mobiclique

Advantages:
- No need of a central server
- scalability

Issues:
- Community detection
- routing
- content distribution
- delivery delays
Multimode devices facilitate hybrid architecture
- cellular network can guarantee the performance of data delivery
- ad hoc network can reduce the cost

Typical eg.,: A hybrid middleware platform based on Jini Surrogate Architecture (JSA)
- uses lookup service to register different services - centralized
- upon registration, interaction with device service: decentralized

Advantages:
- Benefits of both architectures

Issues:
- Network switching
Access Infrastructure for Mobile Social Networks
Communications and Networking, the key components, can be achieved using different network infrastructures:

1. **Cellular and WiFi N/w**
   - Seamless connection
   - Most popular for web-based MSN
   - History of call records <-> identifying social relationship to build the MSN

2. **Access Infrastructure**
   - Low cost, flexibility,
   - User-centric <-> collect user behavior
   - Contextual information
   - Actuators
   - eg., wearable services
   - Issue: data interpretation

3. **Opportunistic N/w**
   - Prolonged disconnection, partitions and unpredictable and unstable topologies
   - Mapping to human characteristics
   - Issue: packet routing and forwarding

4. **Wireless Sensor and Actuator N/w**
   - Seemless connection
   - Most popular for web-based MSN
Protocol Design for Mobile Social Networks: Issues and Related Approaches
The traditional networking protocols can be modified by exploiting the mobility pattern and social relationship to improve the performance of data delivery services in MSNs.
Protocol Design for MSNs (1)

Community detection discovers unknown clusters or groups sharing the same social behavior or interests

Content Distribution: Find appropriate forwarding nodes/links to reduce delay and increase delivery efficiency

Important factors
- bandwidth utilization
- mobility
- time
- duration of encounter
- message duplication,

Approaches based on
- Social Measures
- Mobility pattern and control
- Optimization

Metrics
- Degree centrality
- Betweenness centrality
- Closeness centrality

Algorithms based on
- Heuristic Measures
- Influence maximization

![Graph showing centrality metrics: Degree, Betweenness, Closeness.]

- Degree Centrality: Node 1 has the most direct connections.
- Betweenness Centrality: Node 8 connects all other nodes to nodes 6 and 10.
- Closeness Centrality: Nodes 4 and 5 have the shortest path to all the nodes.
Protocol Design for MSNs (2)

**Context awareness** means having the knowledge of the situation in which a device is being used.

Provides intelligent reasoning and understanding, which are helpful for user discovery, managing processing, routing, privacy protection...

Eg., whozthat, CenceMe,...

**Privacy** implementation in MSN-ing applications is very challenging
- context aware privacy protection
  - real mobility models
- Context aware algorithms in social routing: further research needed
  - LBS – most security sensitive
- Proximity detection algorithms without disclosing exact locations

Realistic **mobility models** that represent every-day movements and behavior, are required
- Mobility models for ad hoc networks
- real scenario traces
  ➔ Data training for simulations to develop effective routing and dissemination protocols

Virtual Social Simulated Environment is the closest state driven simulation model that uses **Second Life**
Open Issues and Future Research Directions

Usage and Estimation of Social Network Metrics


Resource Efficient Protocols

Cross-layer Design of Protocols

Cognitive Radio Techniques

Mobile Peer-to-Peer Networks

Standard Interface

Applications
Summary

The applications of mobile social networks are beyond playing games and listening to favourite music.

MSNs can help elderlies and sick people, can ease life with services such LBS 😊

The mobility of users adds challenges to the design of appropriate architectures, protocols and efficient algorithm 😐

However, many existing mobility models can be utilized 😊

The MSN can be built on top of most of the existing heterogeneous wireless networks 😊