

Data Dissemination in Opportunistic Networks

Radu-Ioan Ciobanu
Ciprian Dobre

University Politehnica of Bucharest
Faculty of Automatic Control and Computers
Bucharest, Romania

May 25, 2011

Layout

- 1 Introduction
- 2 Taxonomy
- 3 Analysis
- 4 Conclusions

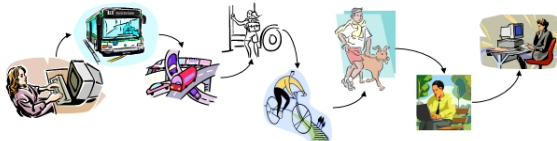
Layout

- 1 Introduction
- 2 Taxonomy
- 3 Analysis
- 4 Conclusions

Introduction

Opportunistic networks

- networks composed of mobile nodes that may not have a direct connection between them
- routes are build dynamically as topologies are unstable
- nodes act according to the store-carry-and-forward paradigm
- data dissemination is usually based on a publish/subscribe model



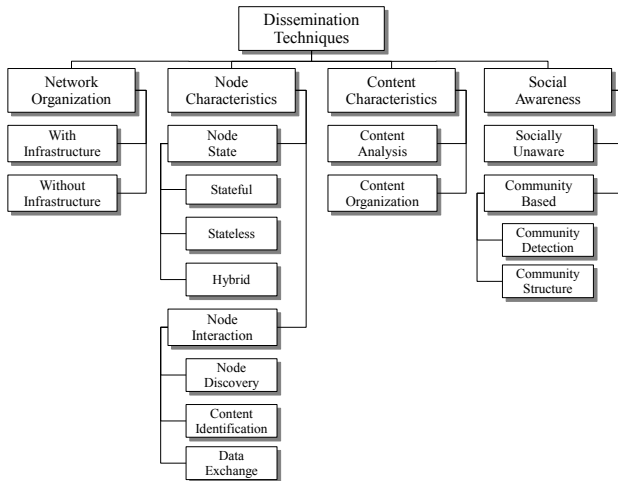
Paper goals

- present the categories of a proposed taxonomy that captures the capabilities of data dissemination techniques in opportunistic networks
- survey relevant data dissemination algorithms and analyze them using the proposed taxonomy

Layout

- 1 Introduction
- 2 Taxonomy
- 3 Analysis
- 4 Conclusions

Taxonomy



Categories

• Network organization

- *with infrastructure*
 - exploit nodes with high centrality (hubs) and build an overlay network between them
- *without infrastructure*
 - assume no infrastructure (costly to maintain and highly unstable)

• Node characteristics

- *node state*
 - signifies if and how a node stores information about the nodes encountered so far
 - three approaches: *stateful*, *stateless*, *hybrid*
- *node interaction*
 - must be efficient, because contact duration can be extremely low
 - *node discovery* - depends on the type of mobile devices being used
 - *content identification* - the way nodes represent the data internally and how they “declare” it
 - *data exchange* - how nodes transfer data to and from each other

Categories (2)

- **Content characteristics**

- use case for opportunistic networks is the sharing of content available on mobile users' devices
- content producers and consumers might not be connected
- *content organization*
 - the way content is organized
 - dissemination usually based on pub/sub, so content usually organized in channels
- *content analysis*
 - the way in which the algorithm analyzes a content object and decides if it will fetch it or not
 - advanced methods assign priorities (utilities) to content objects, based on various parameters (hop count, subscribers, communities)

Categories (3)

- **Social awareness**

- nodes represented by devices that belong to humans
- user movements are conditioned by social relationships
- *socially-unaware*
 - do not assume the existence of a social structure that governs the movement or interaction of nodes
 - simple dissemination methods
- *community-based*
 - assumes users are grouped into communities, based on social relationships
 - most used social model is the “caveman model”
 - utilities are computed taking into account communities
 - security improvement (implicit trust relationships)
 - two aspects: *community detection* and *community structure*

Layout

- 1 Introduction
- 2 Taxonomy
- 3 Analysis**
- 4 Conclusions

Dissemination Techniques

• **Socio-Aware Overlay**

- a publish/subscribe data dissemination solution that uses an overlay created over detected communities
- overlay composed of nodes with high closeness centrality values (hubs or brokers)
- subscriptions in a community are propagated towards brokers, who then send them to other brokers
- dynamically performs decentralized community detection
- nodes classified as community nodes, familiar strangers, strangers, friend nodes

• **Wireless Ad Hoc Podcasting**

- publish/subscribe approach, with content organized into channels, episodes, chunks and pieces
- queries used when nodes are in range: random/new episodes
- solicitation strategies used when two nodes do not have content for each other (Most Solicited, Least Solicited, Uniform, Inverse Proportional)

Dissemination Techniques (2)

• DTN Pub/Sub Protocol (DPSP)

- nodes split into sources, sinks, forwarders
- nodes exchange subscription lists when they meet and use a set of filters to build queues of bundles to forward to the peer (Known Subscription, Hop Count, Duplicate)
- queues sorted by priorities using four heuristics (Short Delay, Long Delay, Subscription Hop Count, Popularity)

• ContentPlace

- publish/subscribe technique that exploits learned information about users' social relationships to decide where to place user data
- socially-aware algorithm, based on the caveman model
- utility function used to associate values to data objects (computed as weighted sum of one component for each community a node has relationships with)
- five policies for computing the utility function (Most Frequently Visited, Most Likely Next, Future, Present, Uniform Social)

Analysis of Four Dissemination Techniques

- an approach without an infrastructure should be considered for a more general case
- a hybrid approach doesn't suffer under frequent topology changes and doesn't require large amount of control traffic
- data exchange performed using data units as small as possible
- publish/subscribe pattern used for content organization
- social-based dissemination algorithms have better results
- there is no single best approach

Data Dissemination Technique	Network Organization	Node Characteristics				Content Characteristics		Social Awareness	
		Node State	Node Interaction			Content Analysis	Content Organization	Community Detection	Community Structure
			Node Discovery	Content Identification	Data Exchange				
Socio-Aware Overlay	Overlay Infrastructure	Hybrid	Bluetooth and WiFi	Encountered nodes and cont. duration	Subscriptions and list of centralities	N/A	Publish Subscribe	Simple and K-clique algorithms	Contact duration and no. of contacts
Ad Hoc Podcasting	No Infrastructure	N/A	Broadcast beacons	Bloom filter hash index	Episodes or chunks	Solicitation strategies	Publish Subscribe	N/A	N/A
DPSP	No Infrastructure	N/A	N/A	Subscription lists	Selection of bundles	Filters and priority heuristics	Publish Subscribe	N/A	N/A
ContentPlace	No Infrastructure	Stateless	Bluetooth and WiFi	Set of channels the node is subscribed to	Data objects	Utility function	Publish Subscribe	N/A	Caveman model

Layout

- 1 Introduction
- 2 Taxonomy
- 3 Analysis
- 4 Conclusions**

Conclusions

- **Conclusions**

- proposed a taxonomy for data dissemination techniques in opportunistic networks
- analyzed four relevant dissemination algorithms using the proposed taxonomy
- concluded that the future of opportunistic networking lies in the social property of mobile networks

- **Future work**

- propose and implement a socially-aware opportunistic mobile wireless solution for communication based on the conclusions of our analysis (Social Dissemination)

Thank You!

