

S-38.3455 Challenged Networks

Introduction

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Overview

- ▶ Seminar (5-10 ETCS points)
- ▶ Introduction (today)
- ▶ Mid-term presentations: initial review + feedback
- ▶ Seminar presentations, extended afternoon seminar
 - 30 – 45min Presentation and discussion per topic
 - One opponent per topic
- ▶ Overview and assignments: today
- ▶ Dates and venue: according to course webpage

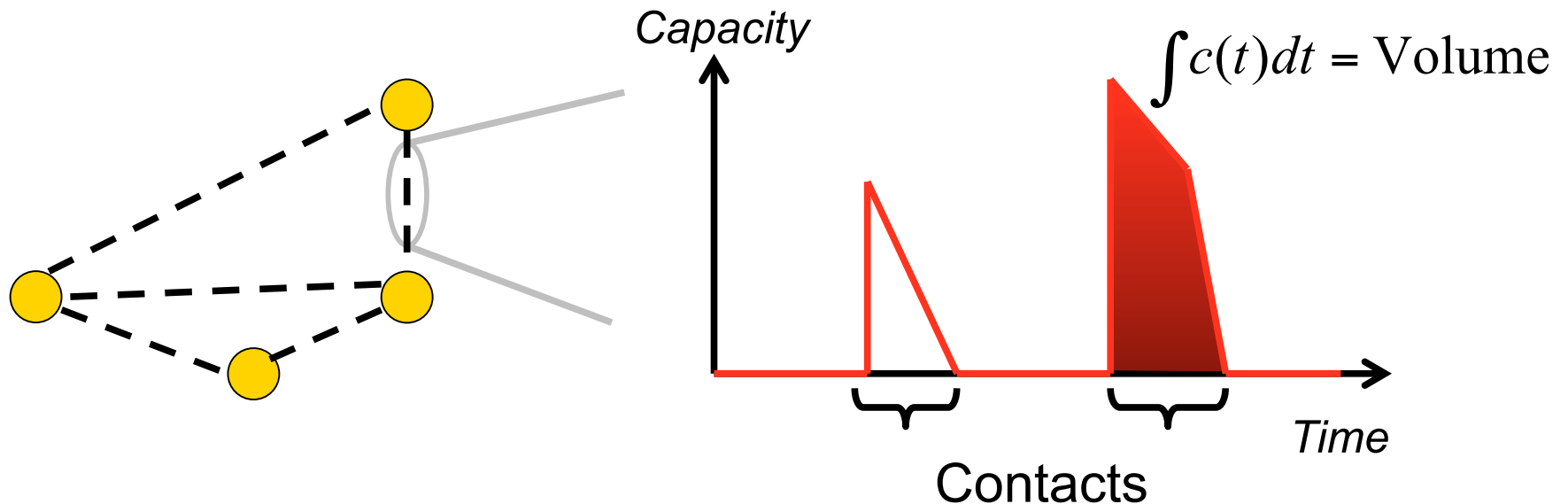
Motivation to DTN Scenarios

- ▶ Several large photographs about extreme environments (space, rural) and urban environments (commuting in subway, mall) were removed from this part to enable sharing in Web
- ▶ Main purpose of this was to motivate the wide array of application scenarios

Routing in Challenged Networks

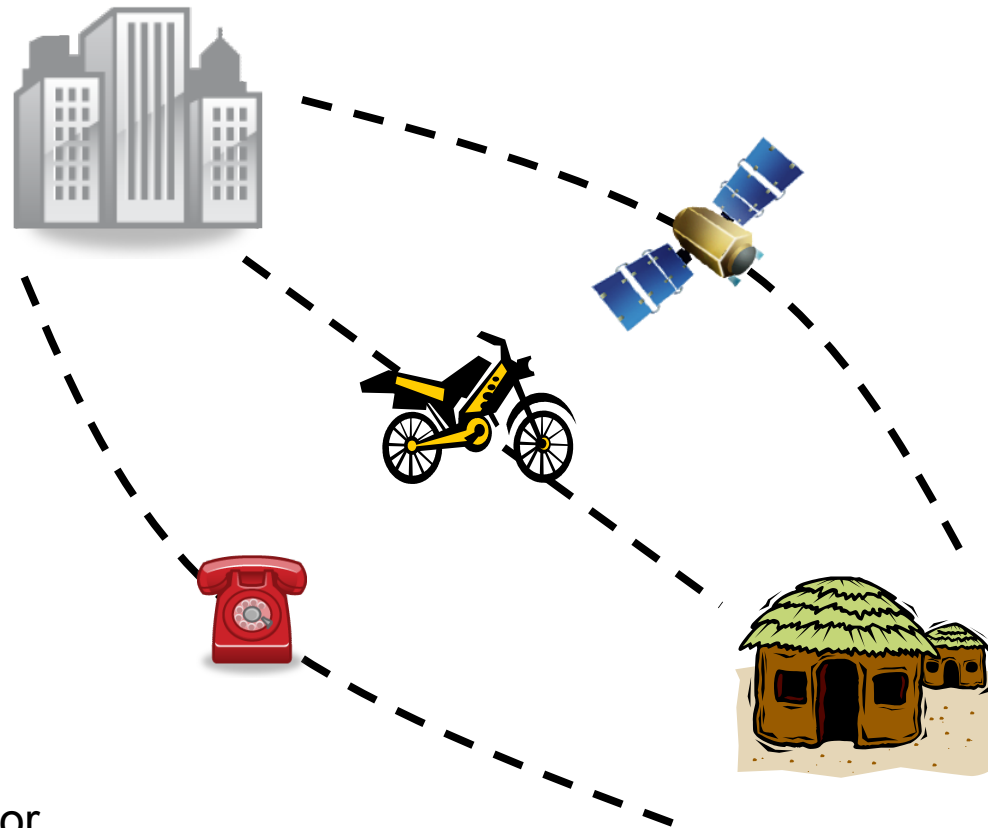
Contacts

- ▶ In the Internet addressable entities are online all the time
 - Disruptions are treated as transient failures => time invariant cost
- ▶ In DTNs we expect communication to be possible only intermittently
 - Links have time varying delay and capacity => time varying cost

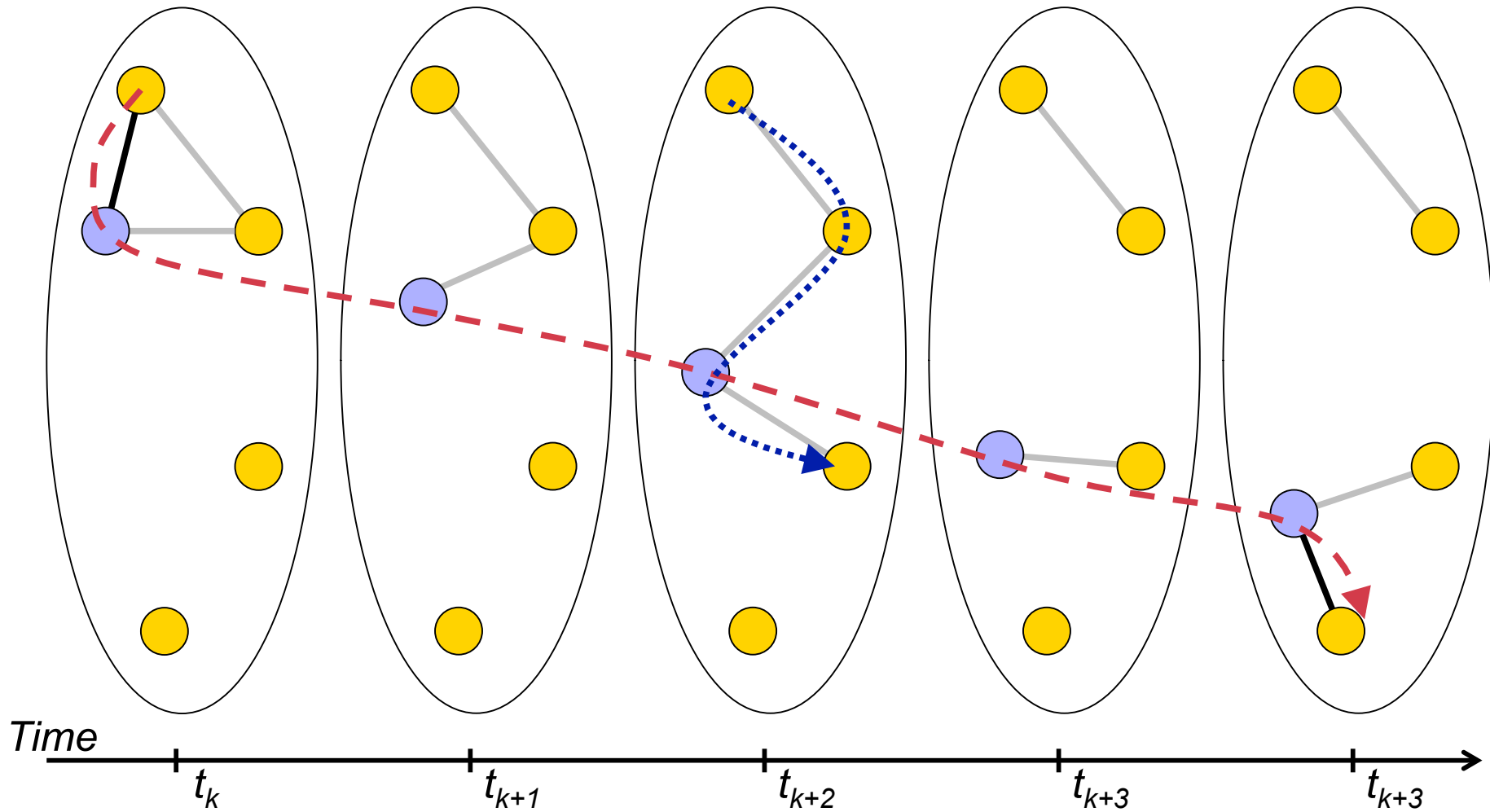


Contact Types

- ▶ Persistent
 - DSL
- ▶ On-demand
 - Dial-up connection
- ▶ Scheduled
 - Deep-space applications
- ▶ Opportunistic
 - Ad-hoc connections
- ▶ Predicted
 - Based on past observations or other information



Space Paths vs. Space-Time Paths



Challenges of Routing in DTNs

- ▶ The scope of applicability of the DTN architecture is very large
 - In deep-space missions topology and contacts are known ahead of time
 - In rural networks topology is known, but connectivity outages unpredictable
 - In mobile ad-hoc networks all contacts are opportunistic
- ▶ A single, grand routing algorithm might not be realistic
 - Need to understand the different classes of DTNs
 - Informal classification by Borrel, Ammar and Zegura [1]
 - Formal classification by Ramanathan, Baus and Krishnan [2]
 - Need to understand the different classes of routing approaches
 - Classification by Zhang [3]

[1] V. Borrel, M. Ammar, E. Zegura, "Understanding the Wireless and Mobile Network Space: A Routing-Centered Classification," CHANTS'07

[2] R. Ramanathan, P. Basu, R. Krishnan, "Towards a Formalism for Routing in Challenged Networks," CHANTS'07

[3] Z. Zhang, "Routing in Intermittently Connected Mobile Ad Hoc Networks and Delay Tolerant Networks: Overview and Challenges," *IEEE Communications Surveys and Tutorials*, 8(1), 2006

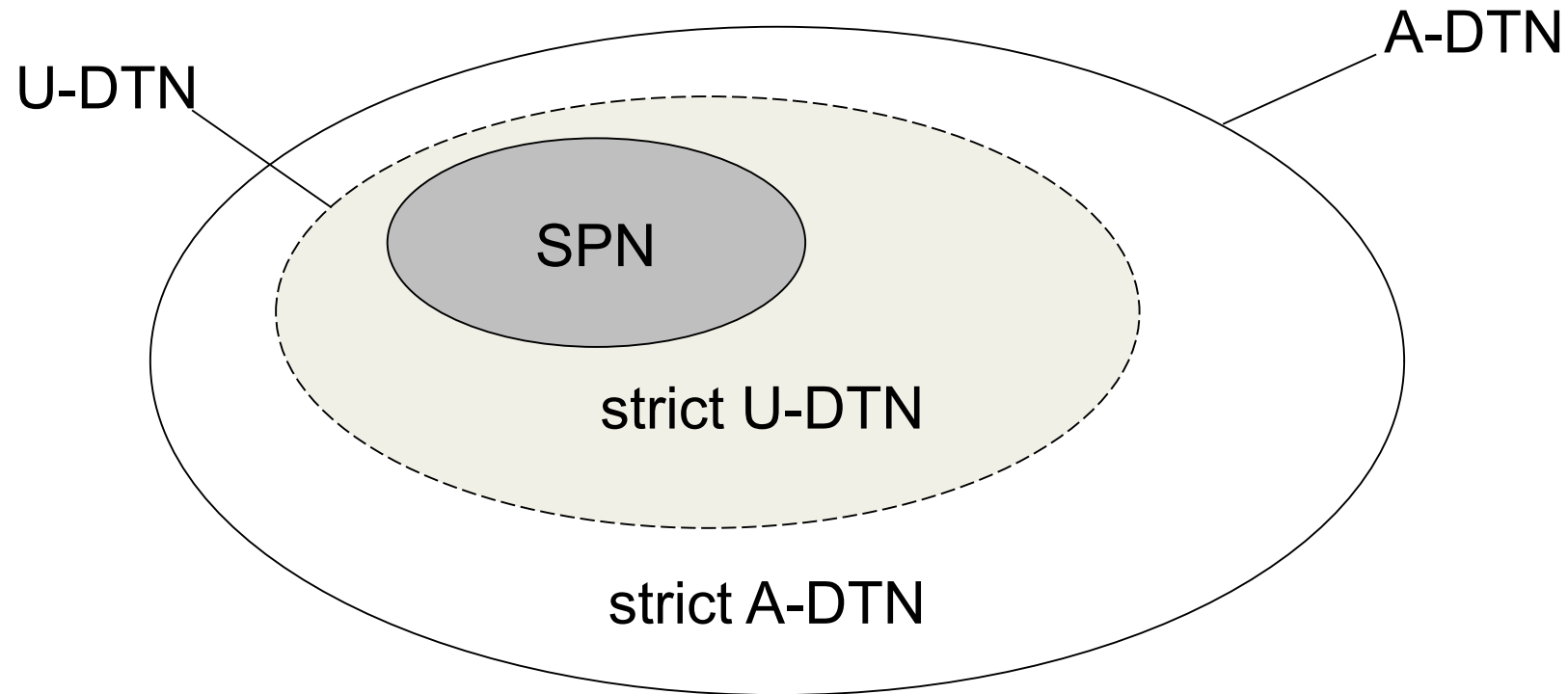
Informal Network Classification

- ▶ Space-Path Network (SPN)
 - Space-paths exist between all the nodes
 - The typical “MANET” network

- ▶ Unassisted DTN (U-DTN)
 - Space-Time paths exist between all the nodes
 - The typical DTN network

- ▶ Assistance-needed DTN (A-DTN)
 - No paths exist between some nodes
 - Separated network islands, needs “assistance” to connect

Informal Network Classification



SPN = Space-Path Network

U-DTN = Unassisted DTN

A-DTN = Assistance-needed DTN

Classification of Routing Approaches

- ▶ Classification based on knowledge of schedule
 - Deterministic: Future topology and contacts well known in advance
 - e.g., deep-space networks
 - Stochastic: Future topology and contacts not known in advance
 - e.g., (sparse) mobile ad-hoc networks

- ▶ Formal classifications exist as well
 - Borrel, Ammar and Zegura
 - Routing centered network classification based on evolving graphs
 - Ramanathan, Baus and Krishnan
 - Classification based on three attributes: 1) end-to-end path required, 2) single copy (no replication), 3) unavailable schedule.

Routing Approaches

Deterministic

Space time routing

Tree approach

Modified SPF

Stochastic

Epidemic /
Random Spray

Prediction-based

Model-based

Control movement

Coding-based

Numerous Challenges

- ▶ Getting a message from A to B
 - With sufficiently high probability to make it worthwhile (70% is not enough)
 - Within an acceptable delay (a week may be way too long)

- ▶ Distributing/sharing contents among groups/all nodes
 - Achieving effective and efficient replication
 - Not bothering non-interested nodes (too much)

- ▶ Limiting network resource utilization
 - Buffer overflows lead to messages being dropped
 - Full buffers may overwhelm transmission capacity during contacts
 - Mobile devices are subject to battery and processing constraints

- ▶ Utilizing infrastructure in DTNs

Seminar Organization

Requirements

- ▶ Contents
 - Summarize and interpret the contents of at least 3 papers
 - Initial contents provided; further search welcome
 - Synthesize / interpret: go beyond the plain summary
- ▶ Seminar presentation
 - 30 minutes
 - Slides (digital: PS, PDF, or PPT)
 - Will be provided on the course web page after the seminar
 - Preparation meeting by individual appointment to discuss contents
- ▶ Written summary: 5–8 pages
 - Double column style of IEEE journal / conference proceedings
 - Should be sent one week prior to the seminar (14.2.)
 - Also to the opponent
 - Will be published on the course web page

Background Reading

- ▶ A Delay-Tolerant Network Architecture for Challenged Internets
- ▶ Routing in intermittently connected mobile ad hoc networks and delay tolerant networks: overview and challenges
- ▶ Efficient Routing in Intermittently Connected Mobile Networks: The Single-copy Case Efficient
- ▶ Routing in Intermittently Connected Mobile Networks: The Multi-copy Case
- ▶ DTN: An Architectural Retrospective
- ▶ RFC 4838 - Delay-Tolerant Networking Architecture

Finding Topical Material

- ▶ Several conferences and workshops cover related topics
 - Infocom, Sigcomm, MobiSys, IMC, Co-next, Mobicomm, WWW, etc...
- ▶ Journals
 - often for more mature results, but e.g. ACM CCR contains timely material
- ▶ Search also other relevant keywords than just DTN
 - opportunistic networking, challenged networks, mobile social networks, disrupted communications, vehicular communications
- ▶ Support your story with timely data
 - market reports, newspaper articles, etc.

Topics (1)

1. Resource Management

- Max-Contribution: On Optimal Resource Allocation in Delay Tolerant Networks
- Retiring Replicants: Congestion Control for Intermittently-Connected Networks
- Congestion Aware Forwarding in Delay Tolerant and Social Opportunistic Networks

2. Mobility

- Estimating and Sampling Graphs with Multidimensional Random Walks
- Measuring serendipity: connecting people, locations and interests in a mobile 3G network
- Habit: Leveraging Human Mobility and Social Network for Efficient Content Dissemination in DTN

3. Wireless Offloading

- Mobile Data Offloading: How Much Can WiFi Deliver?
- Opportunistic Web Access via WLAN Hotspots
- Cellular Traffic Offloading through Opportunistic Communications: A Case Study

Topics (2)

1. Vehicular Communications and DTN

- SPRING: A Social-based Privacy-preserving Packet Forwarding Protocol for Vehicular Delay Tolerant Networks
- Performance Comparison of 3G and Metro-Scale WiFi for Vehicular Network
- Maximizing the Contact Opportunity for Vehicular Internet Access

2. Social Aspects (I)

- MobiCent: a Credit-Based Incentive System for Disruption Tolerant Network
- Know Thy Neighbor: Towards Optimal Mapping of Contacts to Social Graphs for DTN Routing
- Routing in Socially Selfish Delay Tolerant Networks

3. Social Aspects (II)

- Listen to Me if You can: Tracking User Experience of Mobile Network on Social Media
- Exploiting Locality of Interest in Online Social Networks
- Social similarity as a driver for selfish, cooperative and altruistic behavior

Topic Assignment

Topic	Presenter	Opponent
Resource Management	Philip	Kari
Mobility		
Security I		
Wireless Offloading	Masham	
Vehicular Communications and DTN	Aashish	
Social Aspects (I)	Evgeniy	
Social Aspects (II)		
Own Topic	Kari	Philip
Own Topic	Anssi	