Opportunistic Content Distribution in an Urban Setting

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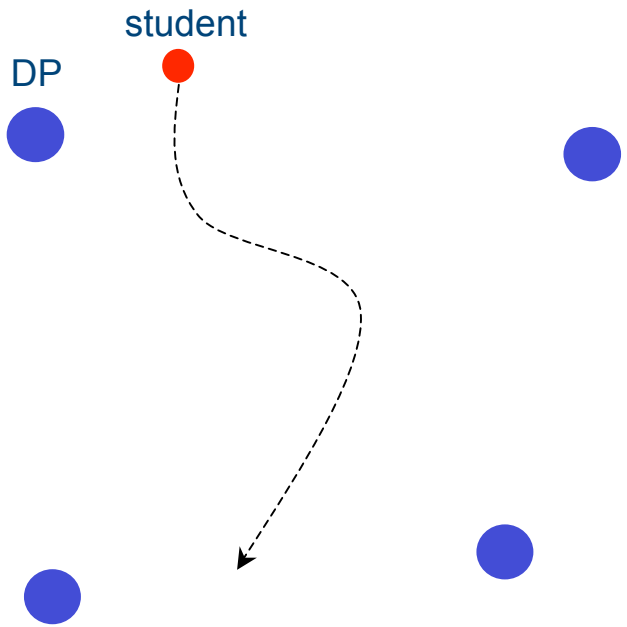
Outline

- Main Contribution
  - Study a real DTN scenario: mobility trace collection
  - Shows how to improve data distribution by relaying via selected strangers

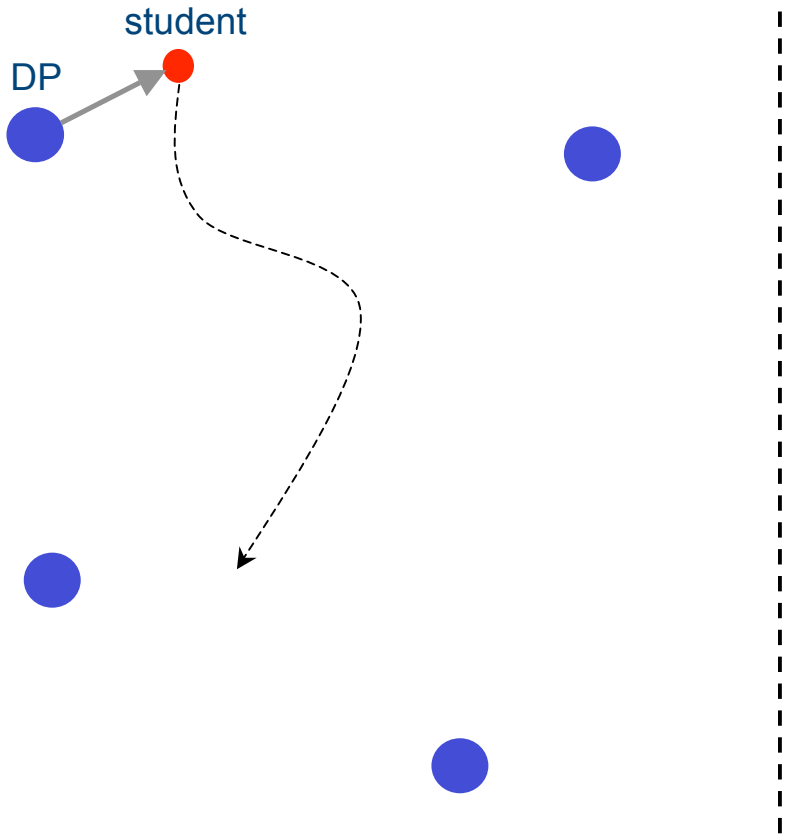
- Outline
  - Scenario
  - Data collected
  - Simulation results

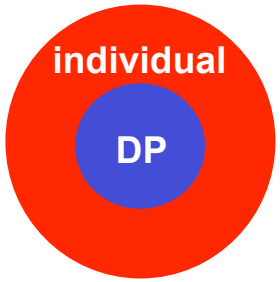
- The electronic daily paper arrives at a distribution point (DP) at 7 am every morning



DPs could be at popular locations (metro stations, crossroads, shopping centres, streets…) or in public transportation

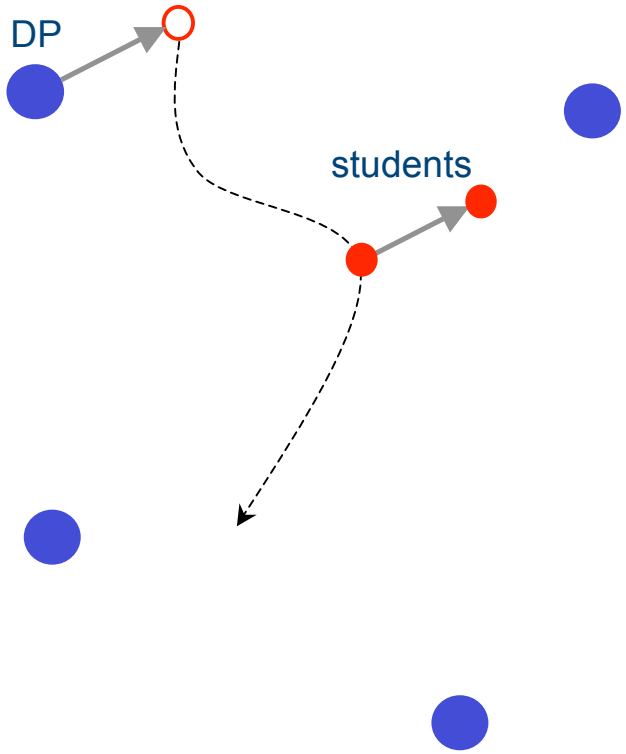
- One possibility for distribution: give the paper to students who pass the DP

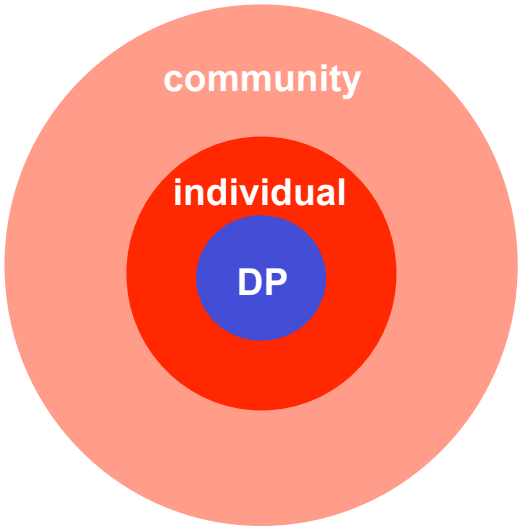




circles involved

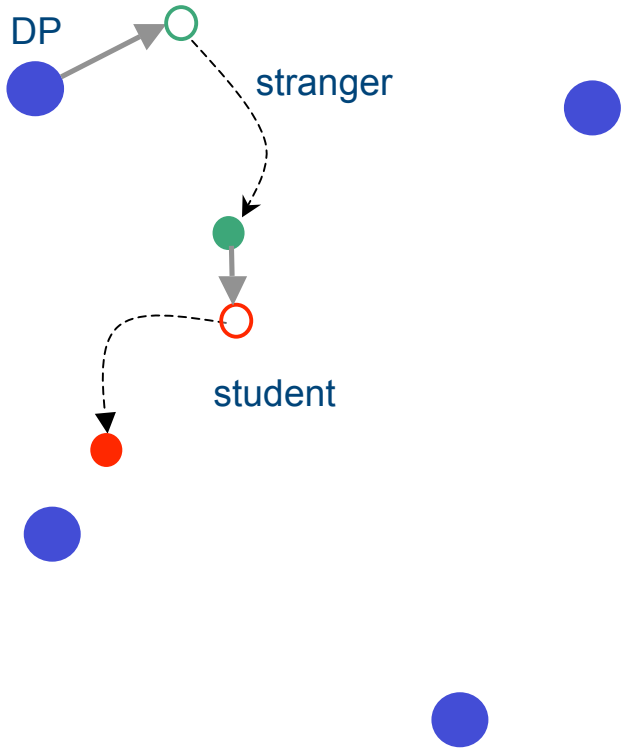
- But, distribution will be more effective if we can use peers as relays

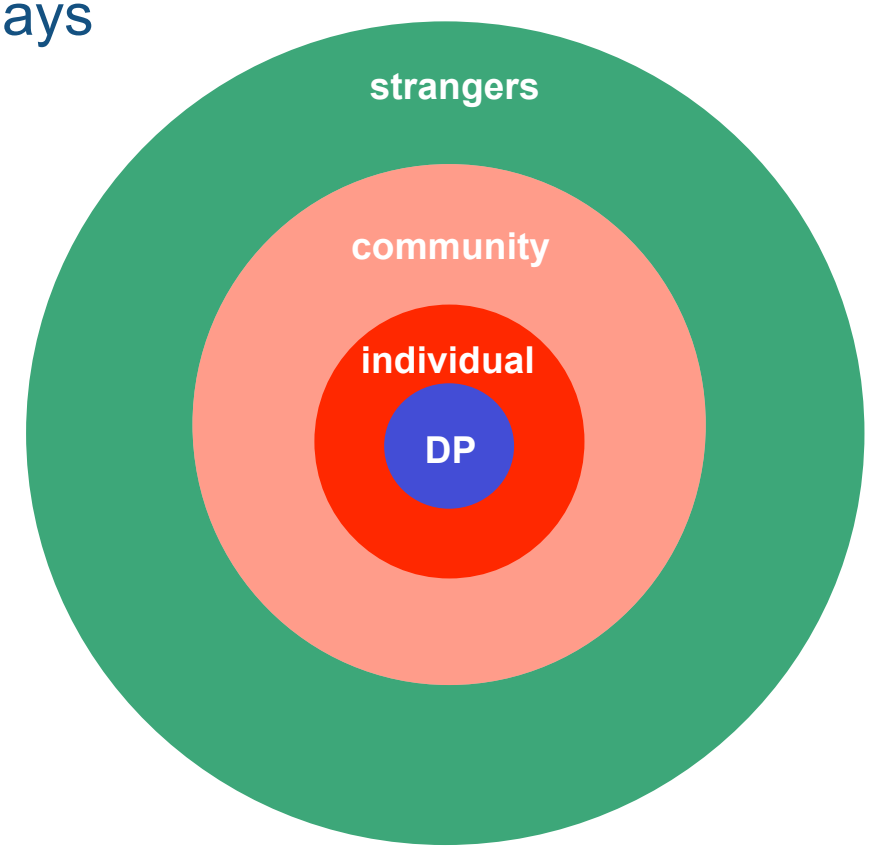




circles involved

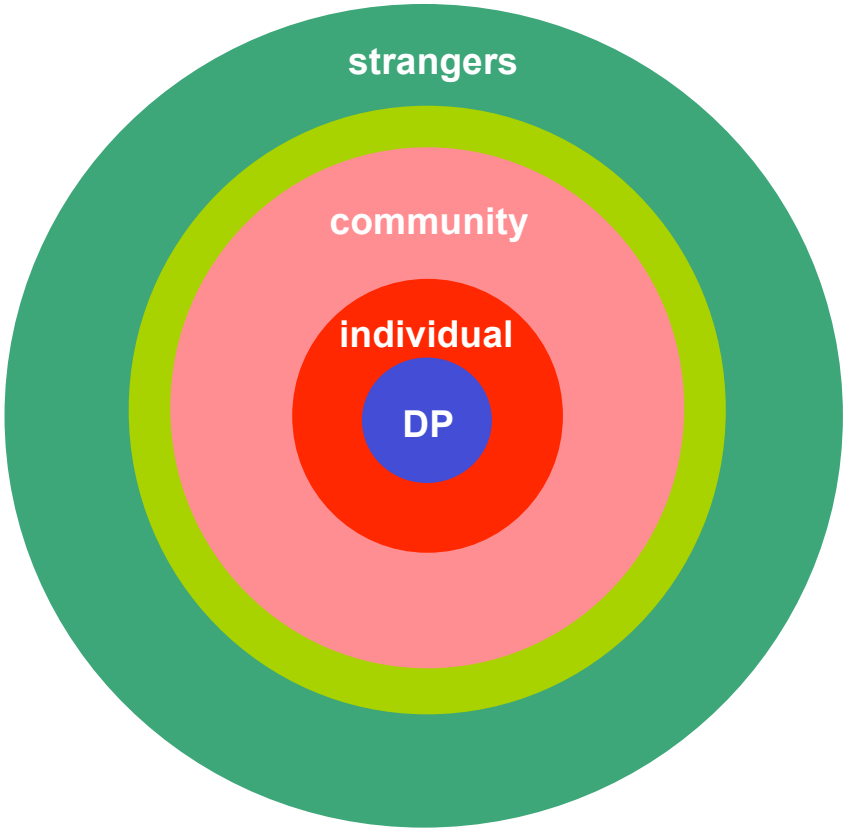
- Distribution is even more effective if third parties (strangers) can serve as relays





circles involved

- Choosing random relays is inefficient. We want to chose a subset: how?

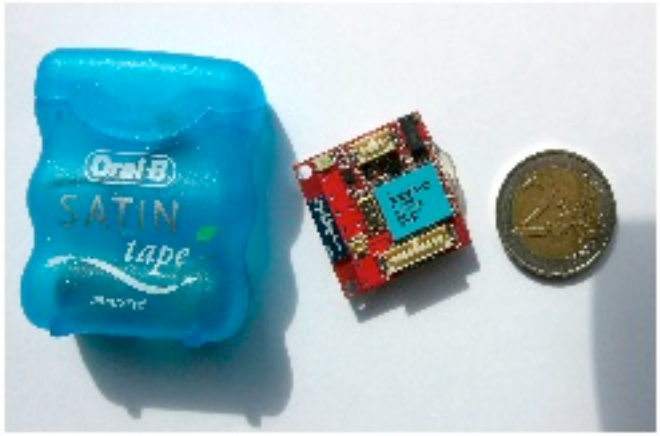


circles involved

Experiment

- Contact loggers
  - Intel iMotes (Bluetooth)
  - Deployed at fixed locations and on students
  - Record all Bluetooth contacts including cell phones, printers, etc…
- Fixed locations represent DPs
  - Popular locations in Cambridge, UK: pubs, shops, colleges' porter lodges, shopping centres, super markets, computer lab.
- Target population
  - Students in 3rd year at Cambridge University
  - Asked to keep the iMotes in their pockets at all times
- 25 days
  - Distribution date: Friday, October 28th 2005
  - Collection date: Wednesday, November 21th 2005
  - Some iMotes stopped before the end
- Privacy
  - Traces are anonymized

- Mobile devices
  - Regular iMotes
    - Inquiry interval: 10 min
    - Inquiry length: 5 s
    - 950 mAh
    - **40 students**



- Fixed devices
  - Regular iMotes
    - 950 mAh
    - Inquiry interval: 10 min
    - **15 locations**
  - High battery capacity iMotes
    - 2200 mAh
    - Inquiry interval: 6 min
    - **2 locations**
  - Extra high battery capacity iMotes with antennas
    - 6600 mAh
    - Inquiry interval: 2 min
    - **4 locations**

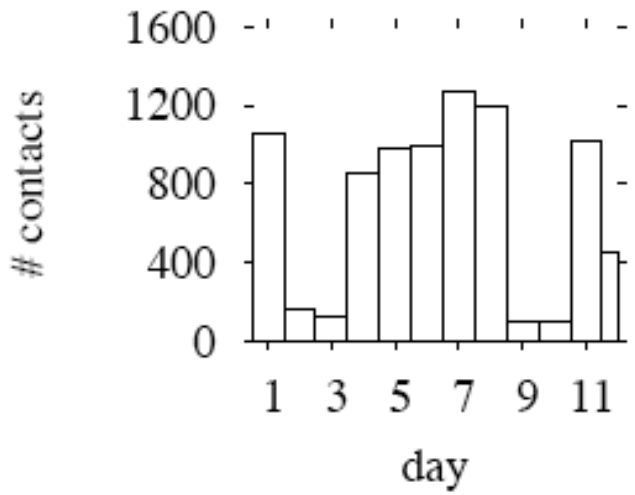
Data collected

- Overall figures
  - By iMote type

	Mobile	Fixed		
Capacity (mAh)	950	950	2200	6600
Inq. interval (min)	10	10	6	2
Nb. iMotes	36	12	2	4
Lifetime (days)	10.7±0.8	11.0±0.6	14.5±0.5	15.7±8.3
Contacts	19,014	8,270	1,082	11,119

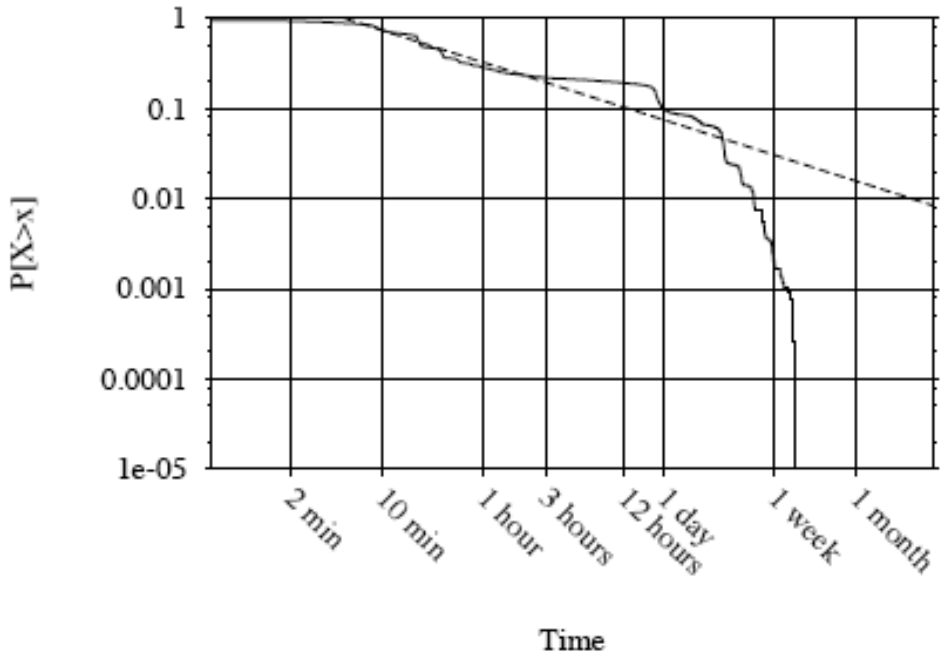
  - **About** 10,000 external devices seen in total

- Inter-students contacts
  - Weekly pattern



Contacts per day

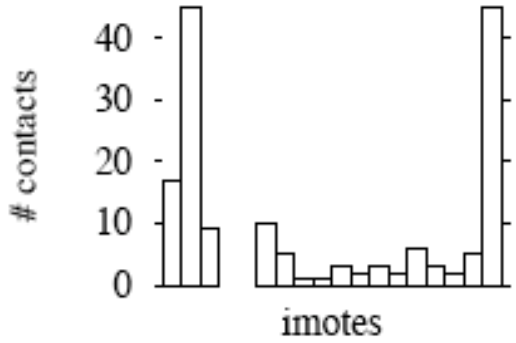
- Inter-students contacts
  - 90 % of inter-contacts are shorter than one day



Inter-contact time distribution

Data collected

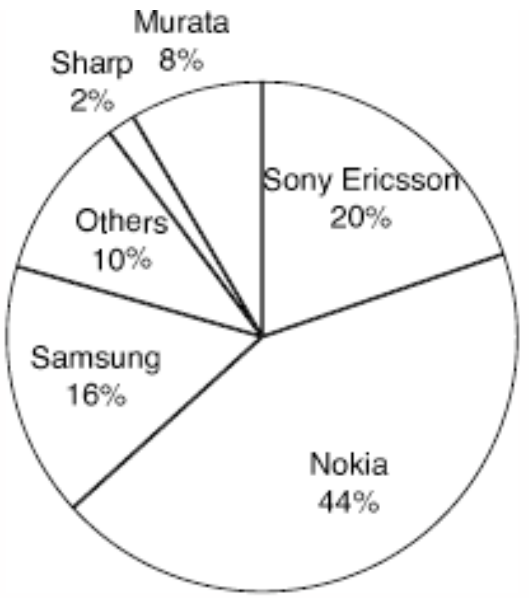
- Contacts between mobile and fixed iMotes
  - Few such contacts were observed



Contacts per iMote

  - If people were going to DPs to receive content, there would be more contacts

- External contacts (strangers)
  - Almost all seem to be mobile phones
    - MAC resolution with the database of Organizationally Unique Identifiers (OUI)



Manufacturer repartition

Content distribution

- Schemes
  - **No relays**
    - nodes are selfish and never pass content to other nodes.
  - **Student relays**
    - Students share content within their community.
  - **Student and stranger relays**
    - Students and strangers relay the content.

Evaluation

- Simulation scenario
  - 5 days of data replayed: from Monday to Friday
  - Access points distribute the daily paper starting at 7 am every day
  - Goal
    - Deliver the paper to all students before 7 am the next day
  - Data removed
    - The fixed iMote at the computer lab (avoid triviality)
    - Two extra high battery capacity fixed iMotes (no data)
  - We assume infinite buffers and bandwidth

- Results:

	Delivery ratio (%)	Delay (hours)	Efficiency (transfers/delivery)
No relays	20.5	7.47	1.00
Student relays	90.2	5.29	1.00
Student and stranger relays	97.1	4.10	36.4

- Lessons:
  - Collaboration within the community has a great impact on delivery ratio
  - Delivery ratios can be further improved by relying upon strangers, but at great cost in efficiency.

Evaluation

- What if only a subset of strangers are relays? How can we select them efficiently?
  - **Top N bridges:**
    - Definition: A mobile bridge is a node covering at least one pair (DP, student)
    - Mobile bridges with the highest coverage

- Results:

	Delivery ratio (%)	Delay (hours)	Efficiency (transfers/delivery)
No relays	20.5	7.47	1.00
Student relays	90.2	5.29	1.00
Top 50 bridges	94.2	4.59	2.86
Student and stranger relays	97.1	4.10	36.4

- Lessons:
  - Choosing good subsets of strangers as relays increases performance

Conclusion

- Contributions
  - Highlight collaborations that make content distribution works
    - We expect better performance in a real deployment due to DPs attraction
  - Original data set
    - Sent to Crawdad
- Future work
  - Larger scale community of interest
  - Community detection / management
  - Incentive mechanisms (tit for tat, virtual money, etc…)
- Acknowledgements
  - Pan Hui for his support with the iMotes