Exploiting self-reported social networks for routing in delay tolerant networks

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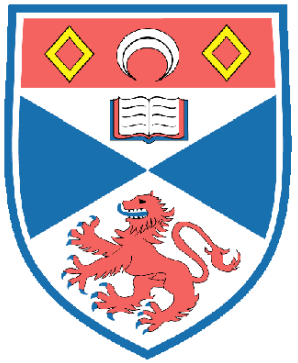


Social Networks

- Delay Tolerant Networks: episodic connectivity
- Self-Reported Social Networks: declared social contacts
- Detected Social Networks: built from encounter trace
- Understanding how human contacts affect DTNs:
  - Can we use social networks to improve DTN routing?
  - How does a self-reported social network differ from a detected one?
  - In what ways can social networks give us indicators of how a DTN will behave?

Obtaining Social Networks

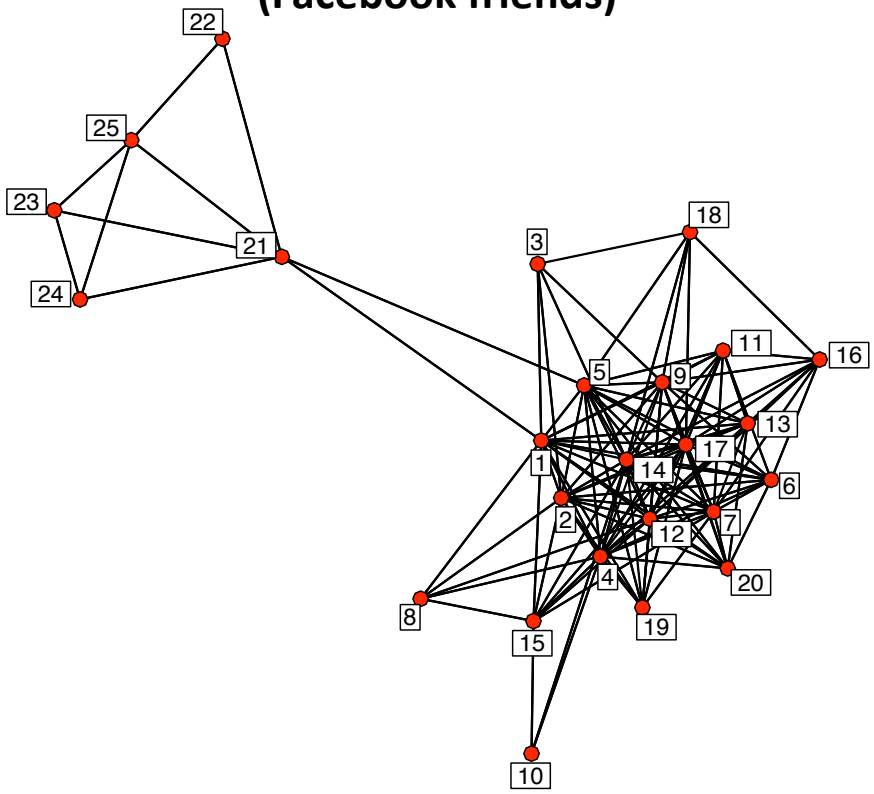
- Detected Social Network (DSN):
  - Mobility tracking experiment
  - 27 participants carrying Tmote invent devices
  - 79 days of encounter tracking
  - Upload via ZigBee basestations
- DSN ties are encounters

- Self-Reported Social Network (SRSN):
  - Facebook
- SRSN ties are Facebook "friends"

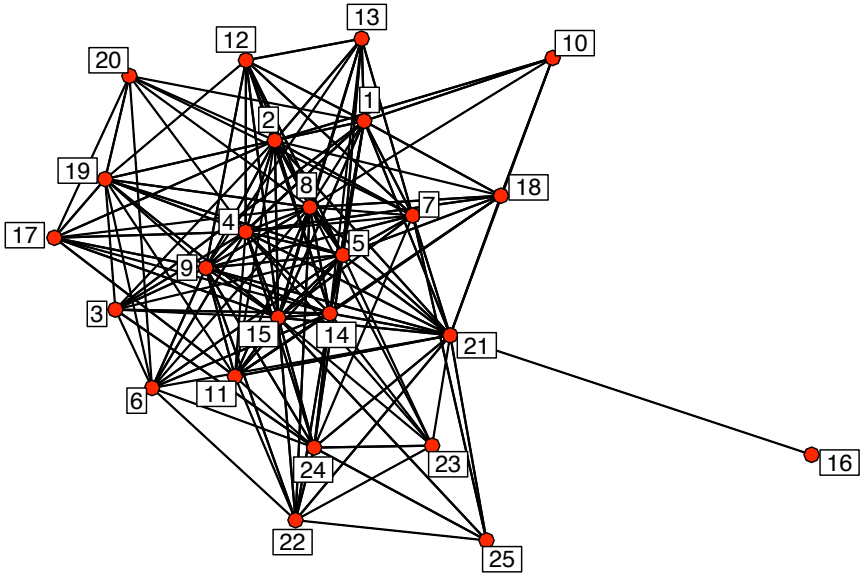
Network Topology

Nodes are more reachable in the DSN

SRSN
(Facebook friends)

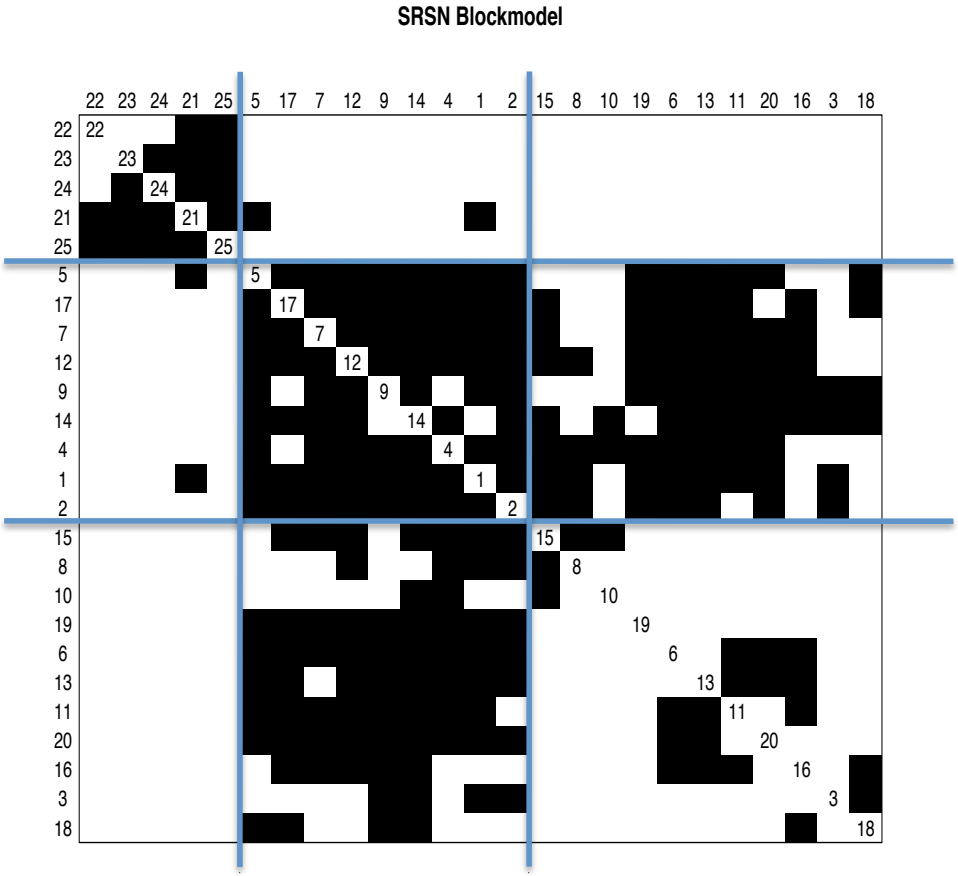


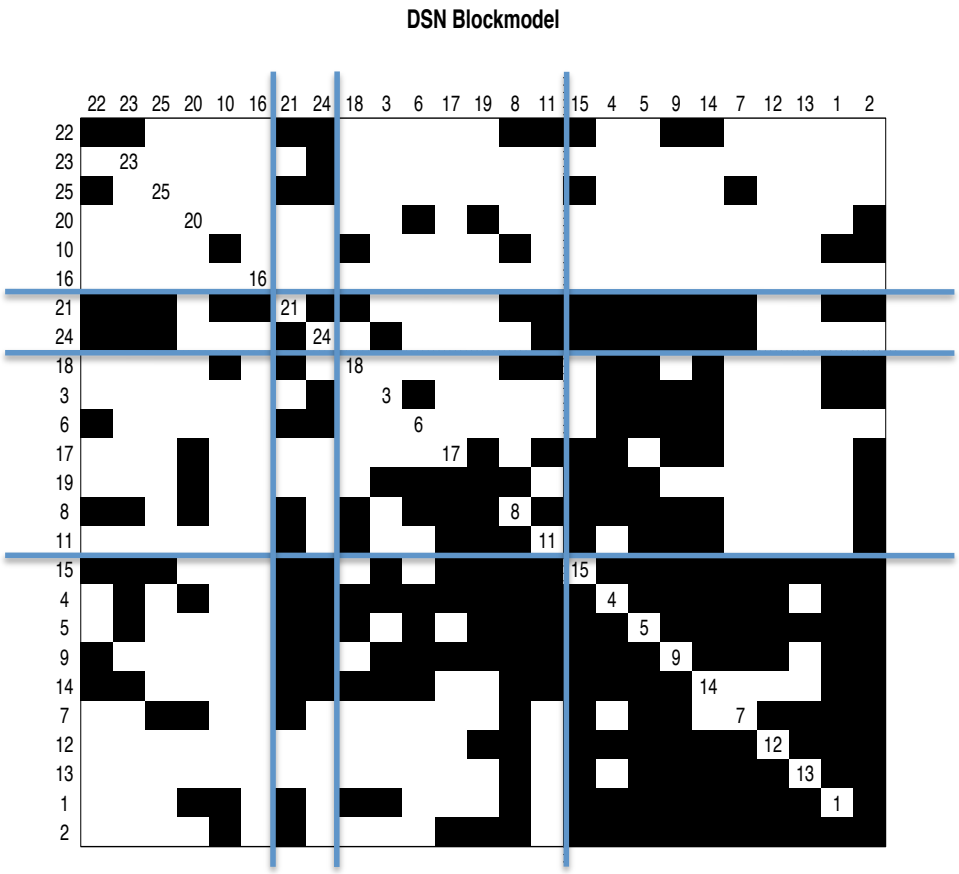
DSN
(Encounters)



Social Network Comparison- Role Equivalence

Roles are more clearly defined in SRSN





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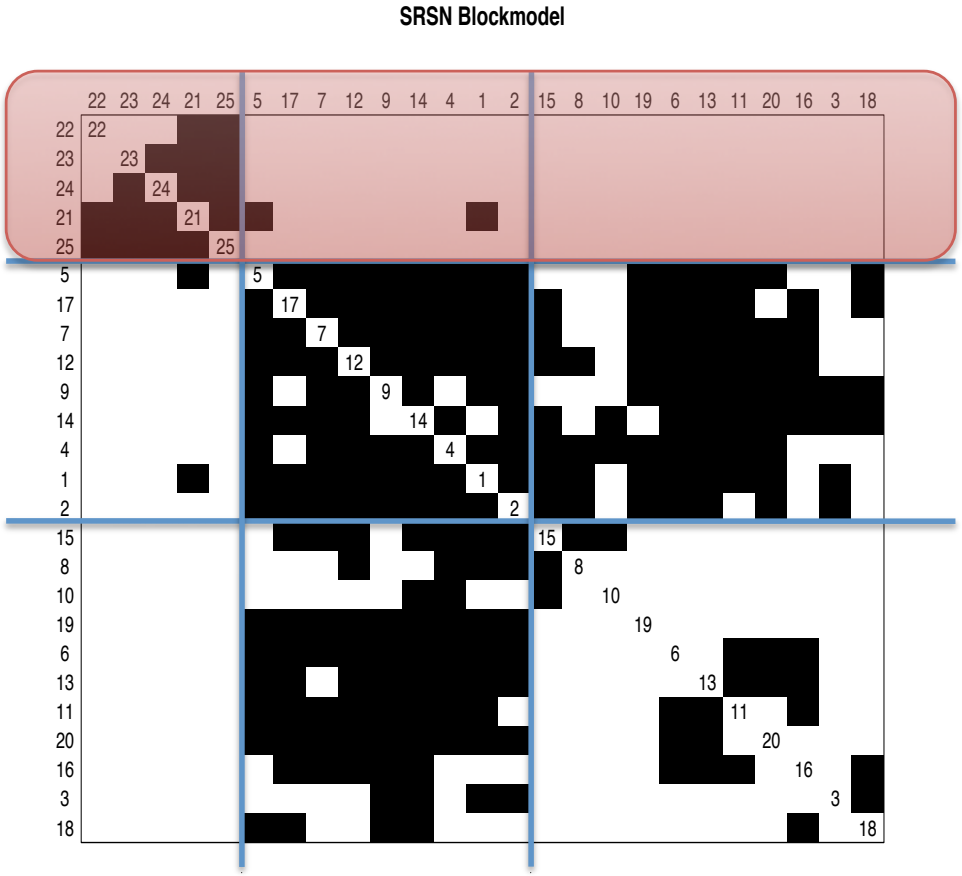

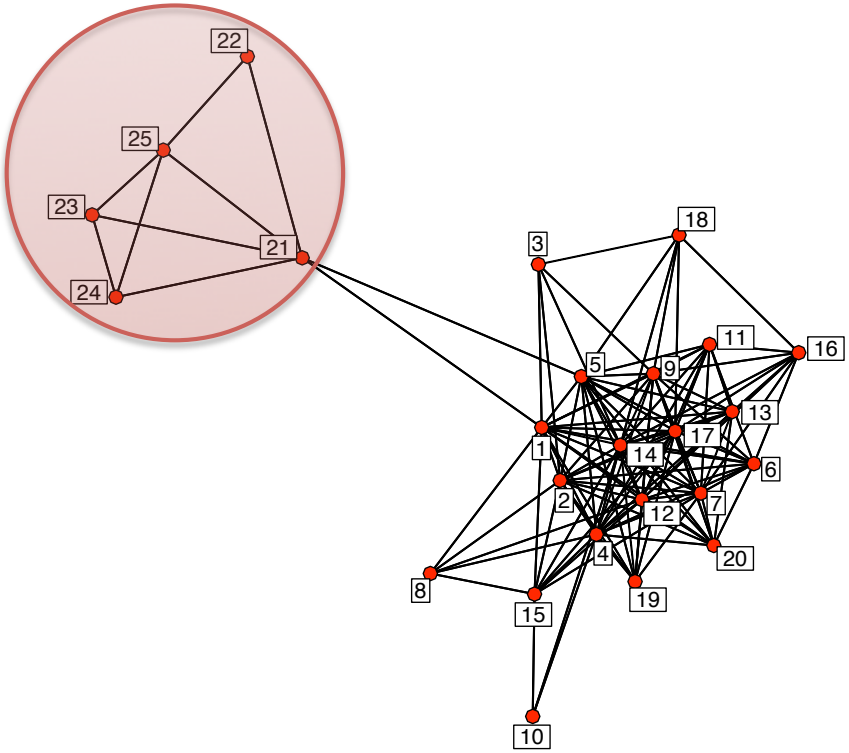

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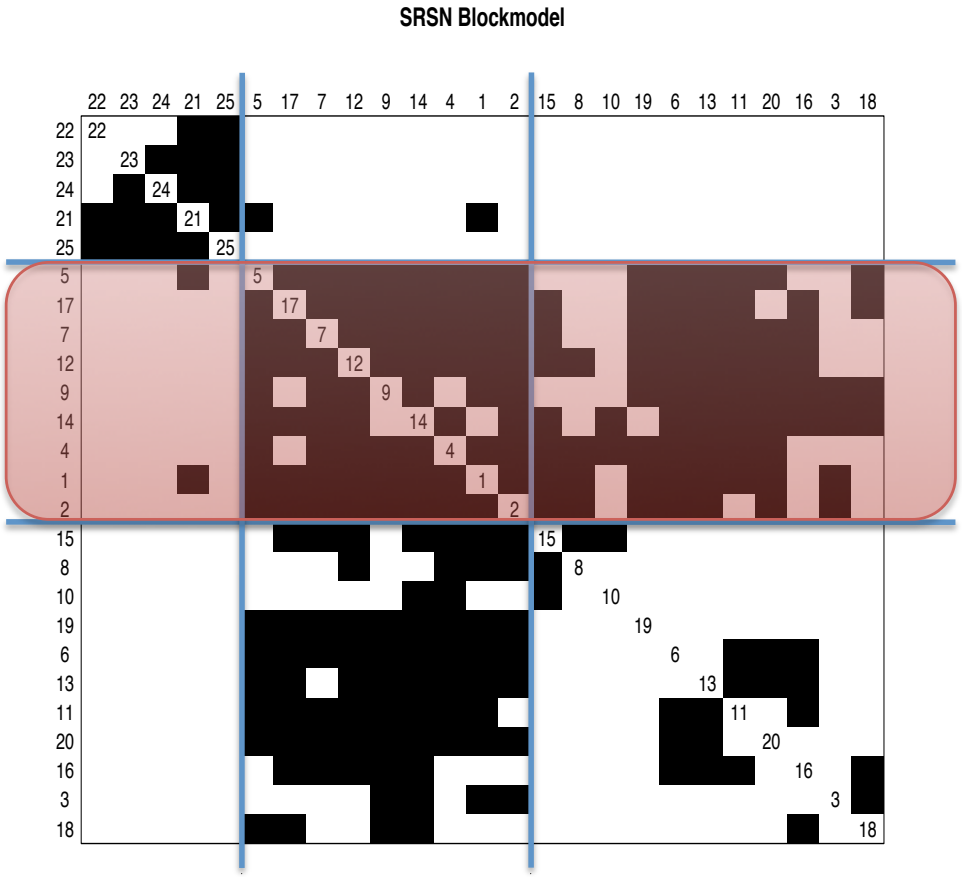

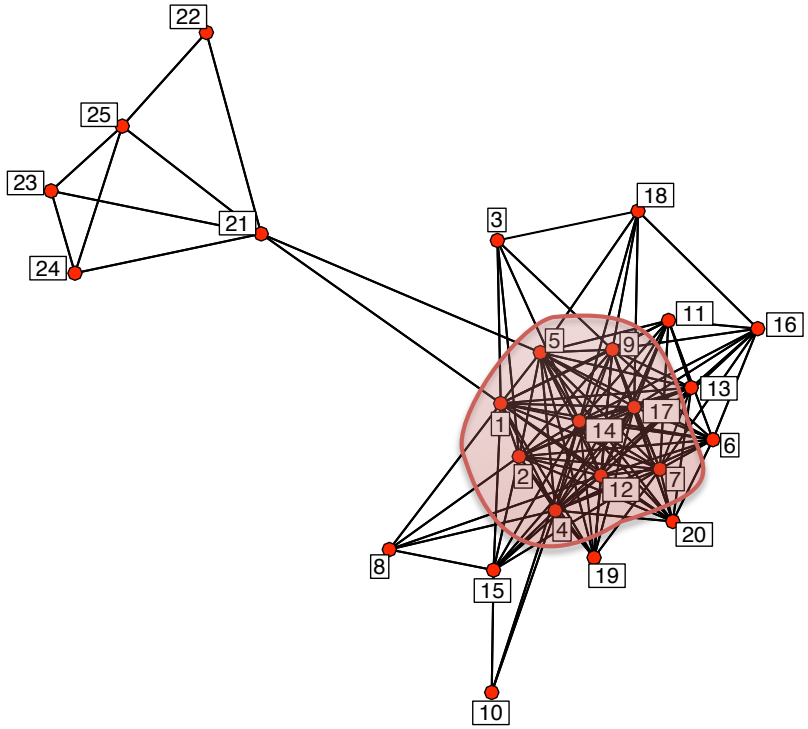

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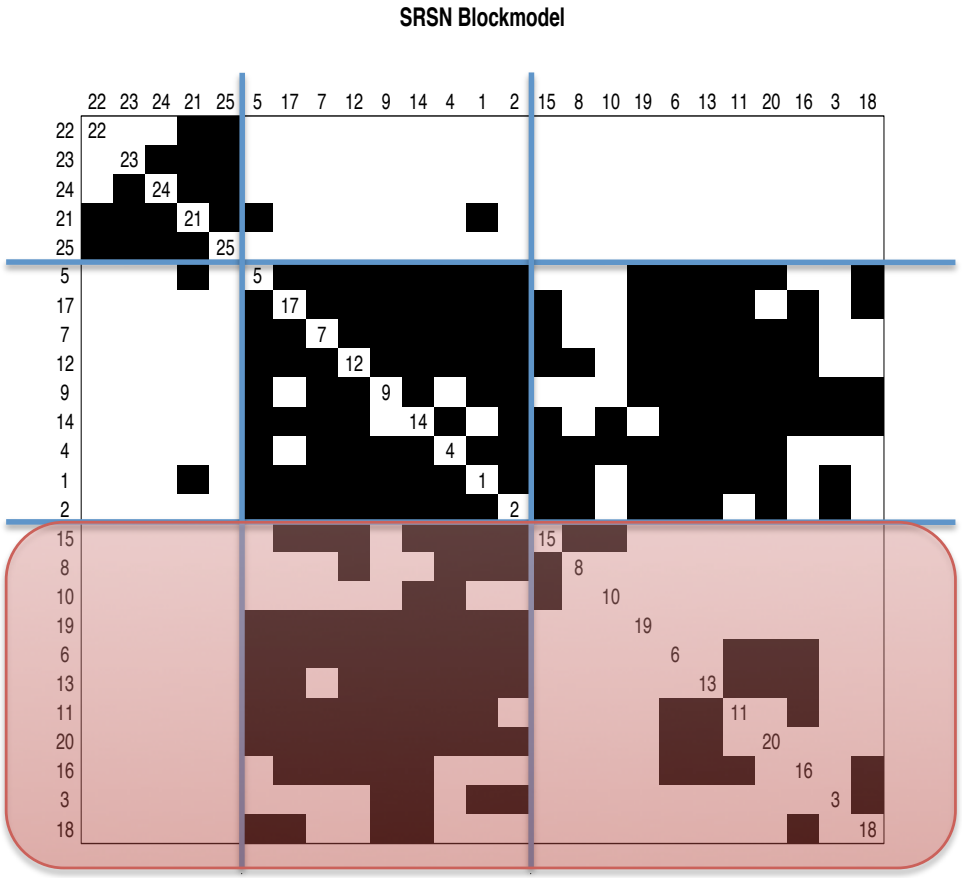

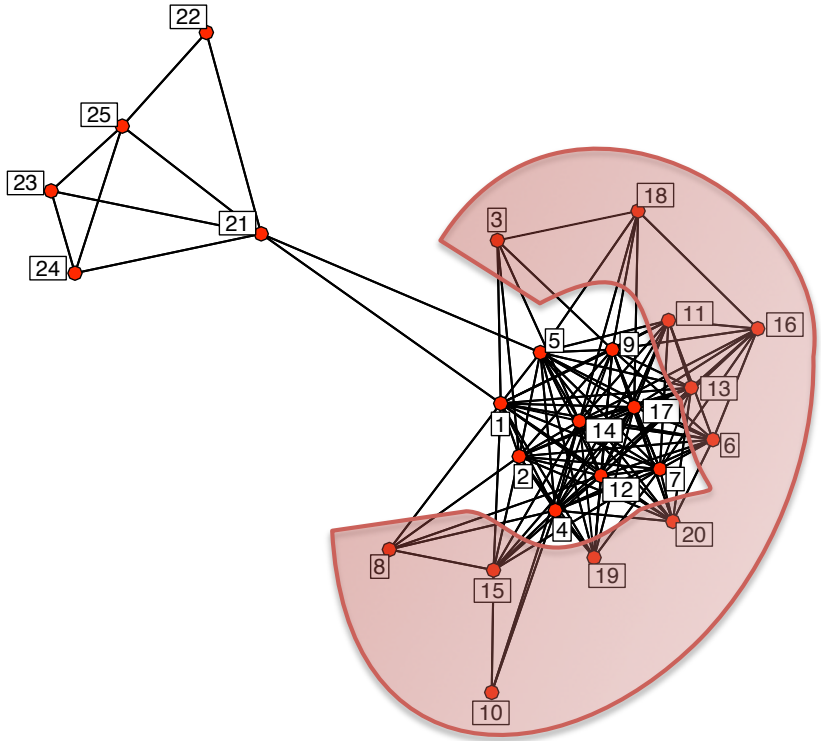

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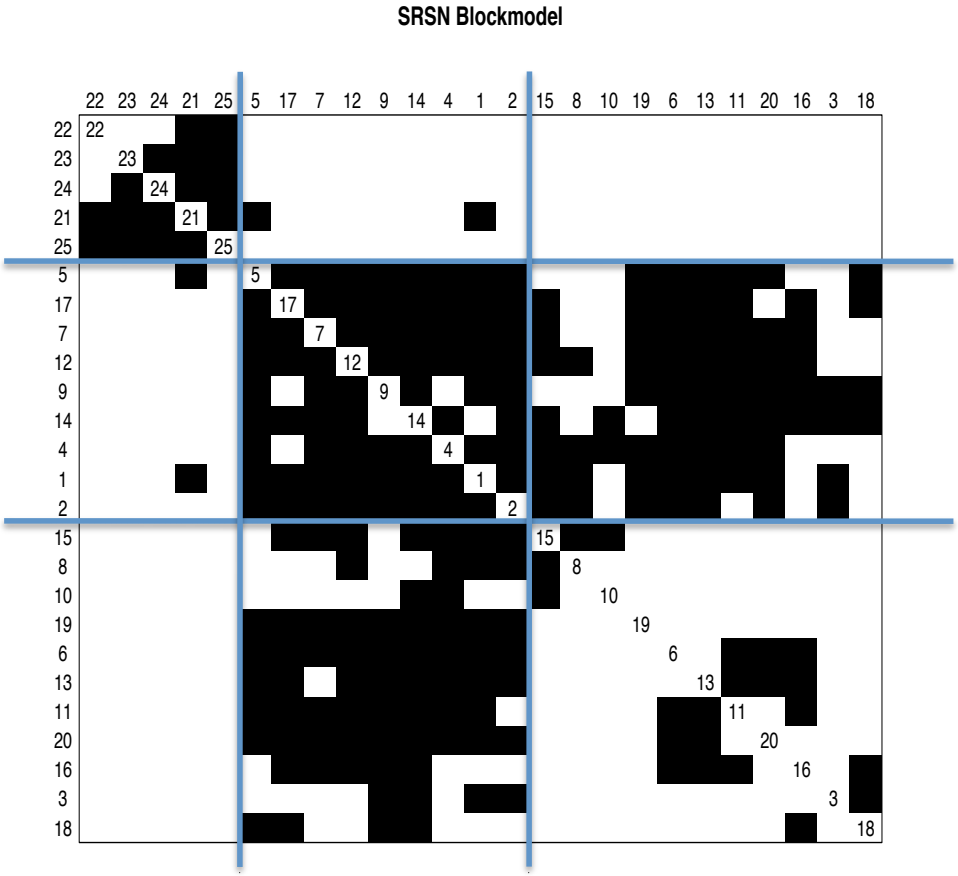

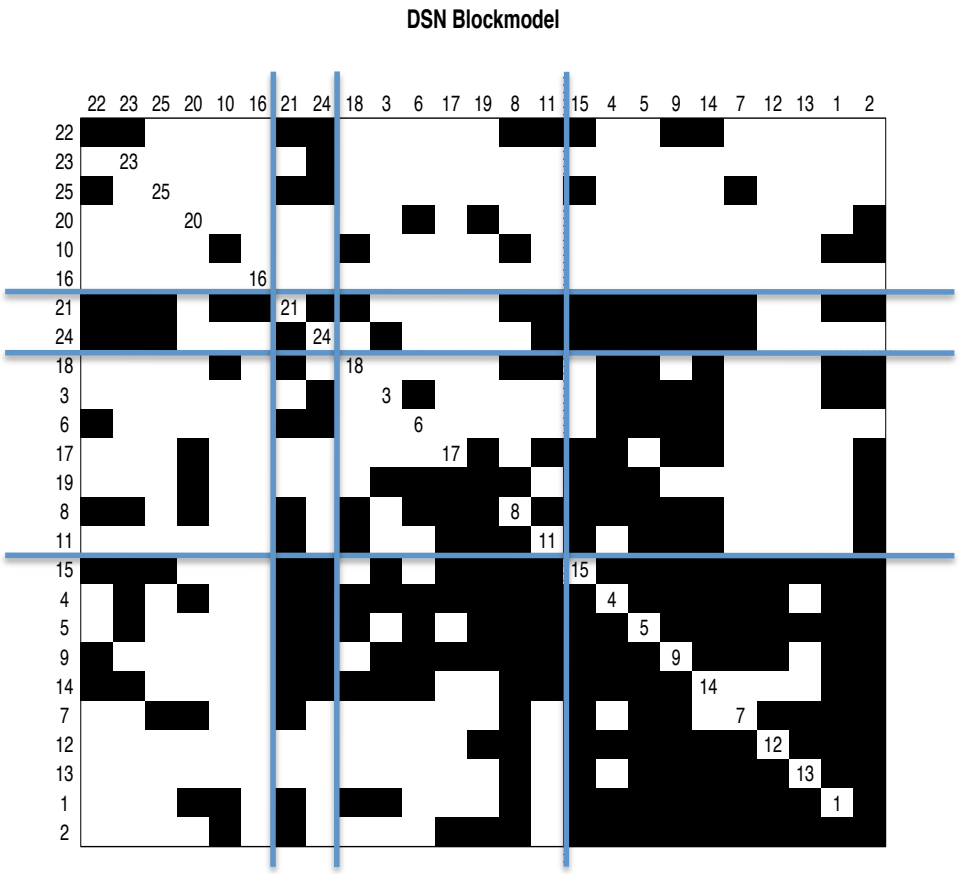

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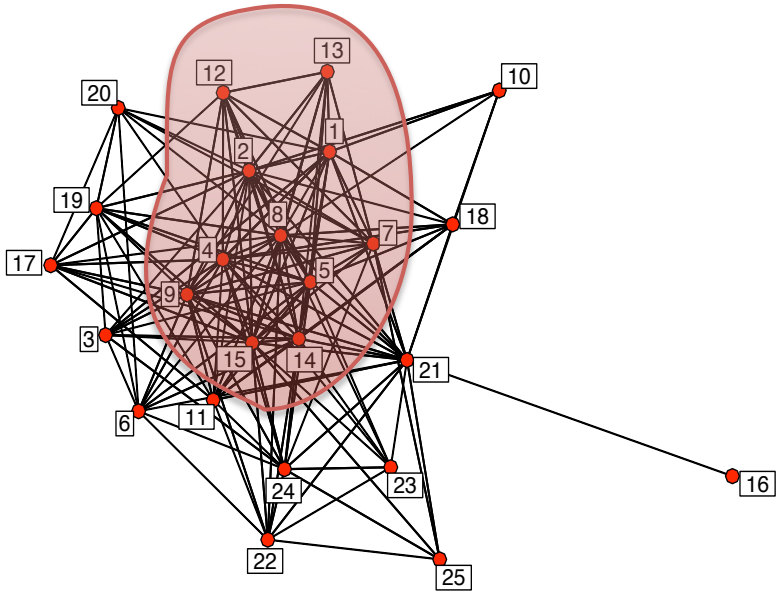
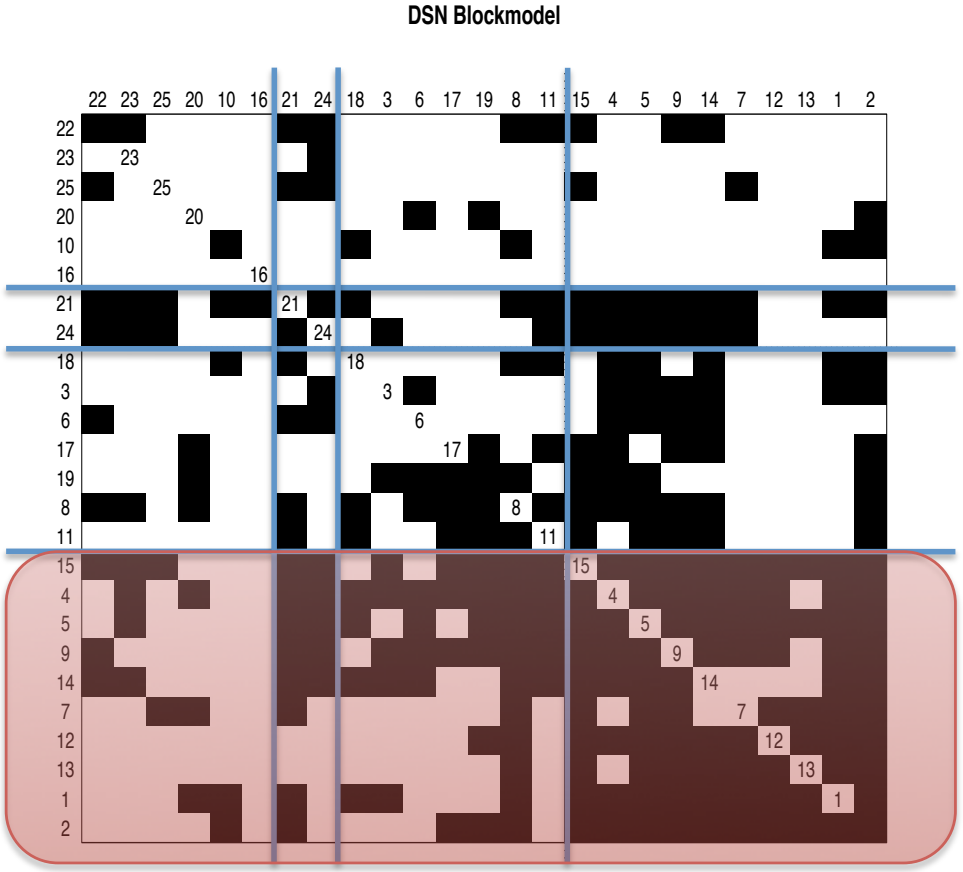




Experiments

Hypotheses

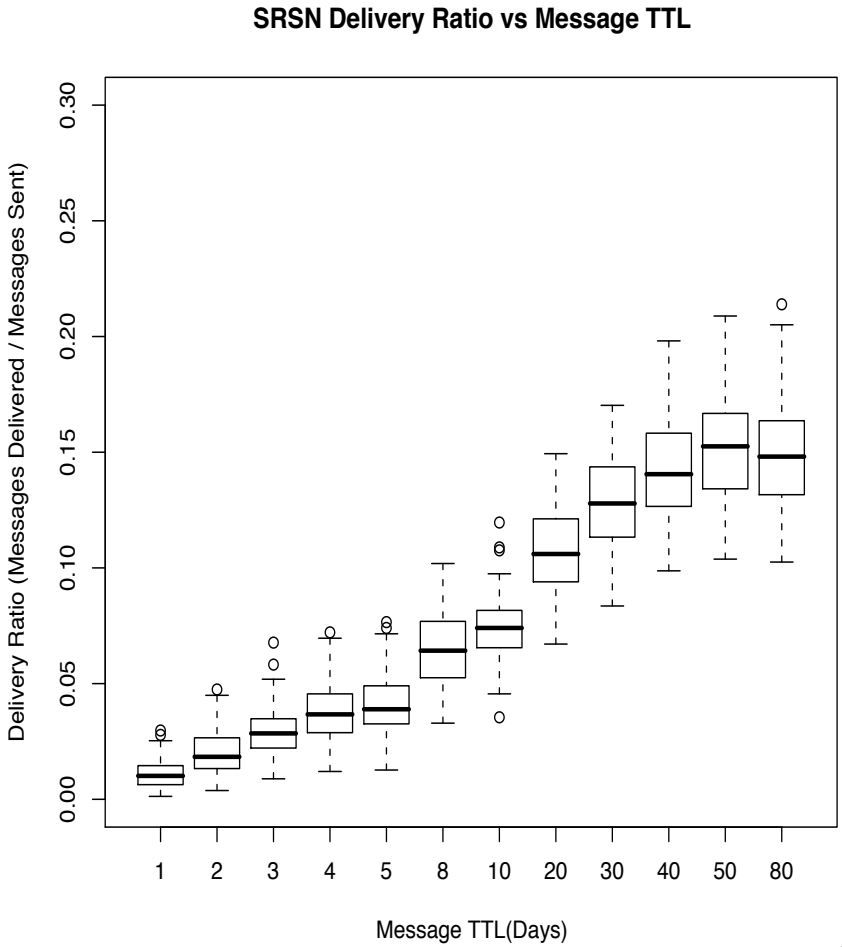
- More messages to be delivered in DSN
  - Higher delivery ratio (messages delivered/ messages sent)
- Less message duplication in SRSN
  - Lower delivery cost (medium accesses/ messages sent)

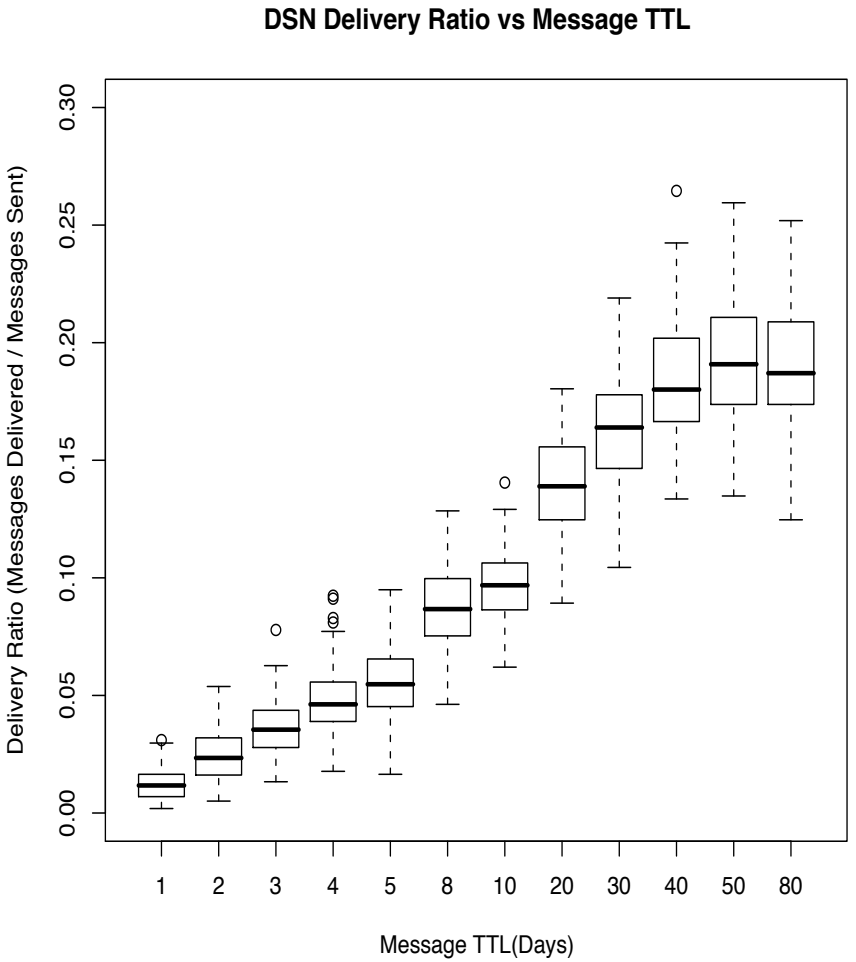
Configuration

- Simulate message passing application
- Source passes SN with message
- 20 messages per day over whole 79 day trace
- 100 runs
- Analyse (against TTL):
  - Delivery ratio
  - Delivery cost

DTN Delivery Ratio

DSN has only a slightly higher delivery ratio



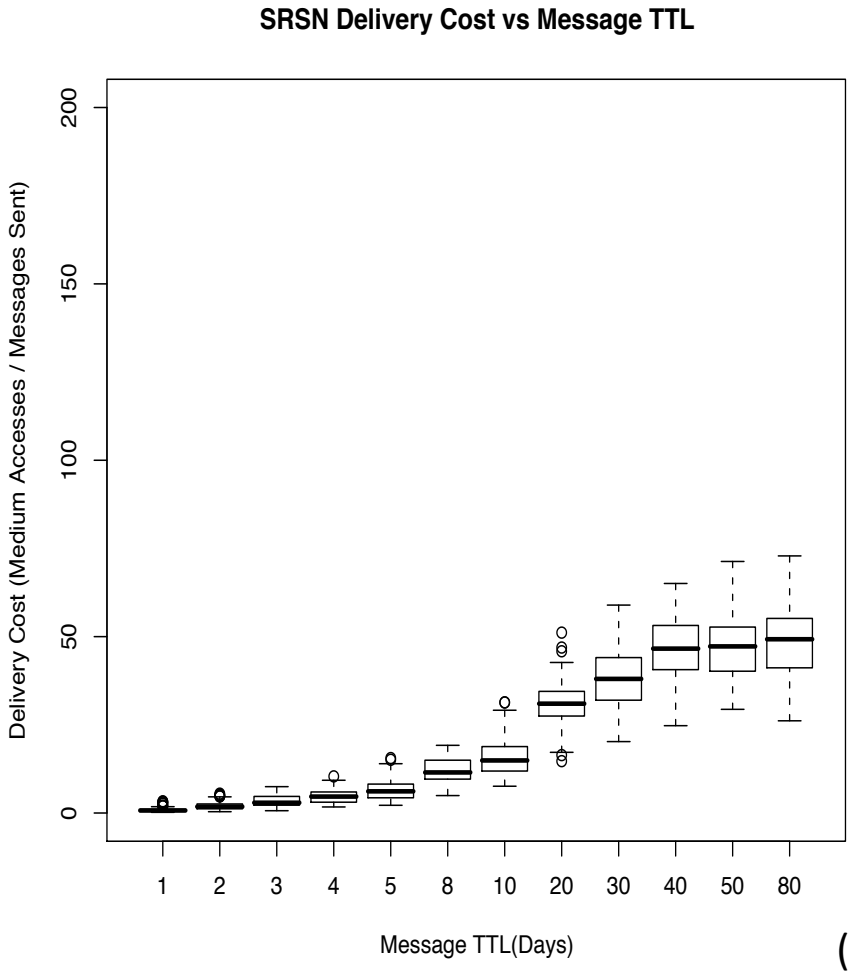


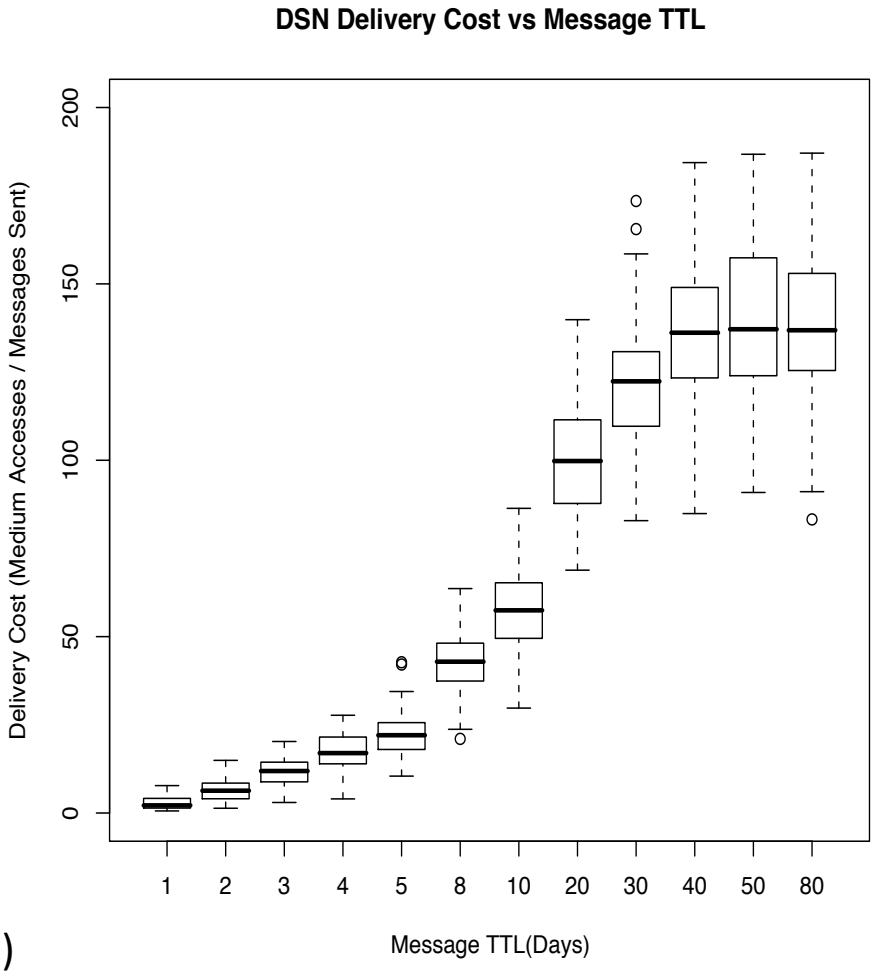
($p < 0.01$)

Mean diff in range: 0.023%

DTN Delivery Cost

SRSN has a much lower delivery cost





($p < 0.01$)

Mean diff in range: 46.9

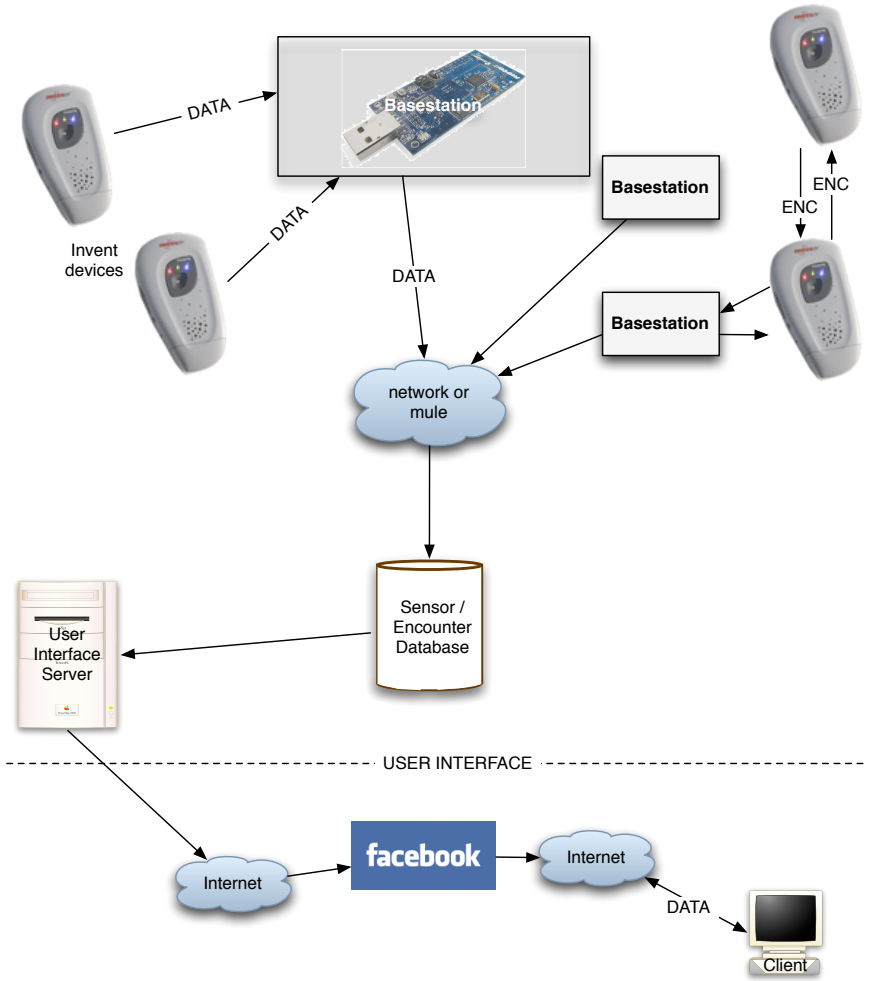
Future work

- How can we bootstrap DTN networks using a mixture of SRSNs and DSNs?
- How can we exploit role equivalence for DTN routing?
- How can applications use social network information?
- What additional experiments do we need to conduct?

Summary

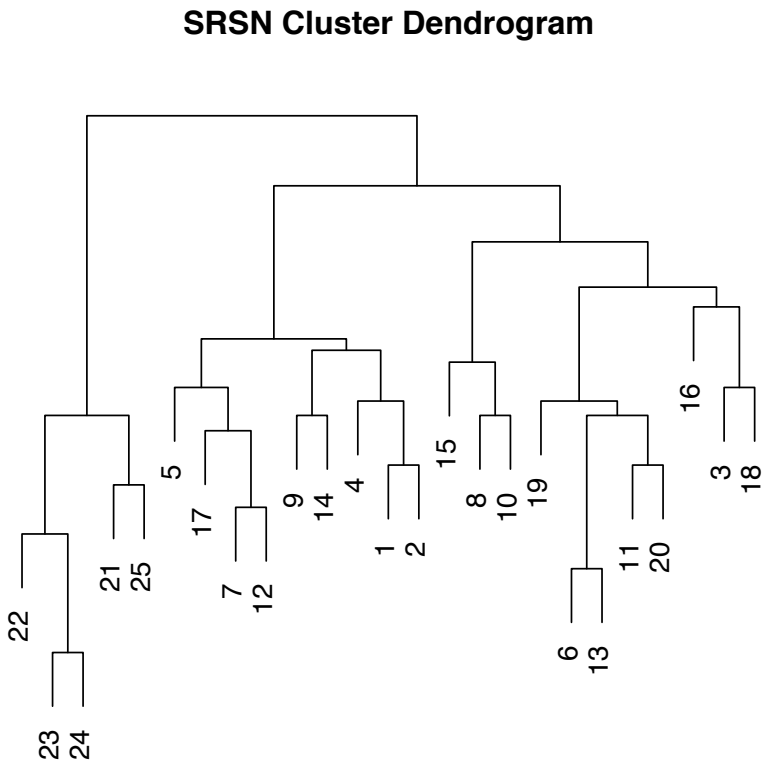
- Social networking analysis techniques can provide us with insights into DTN performance.
- Self-reported and detected social networks are different in terms of structure and role equivalence.
- SRSNs and DSNs have similar performance when used for DTNs, but SRSNs have a much lower cost.

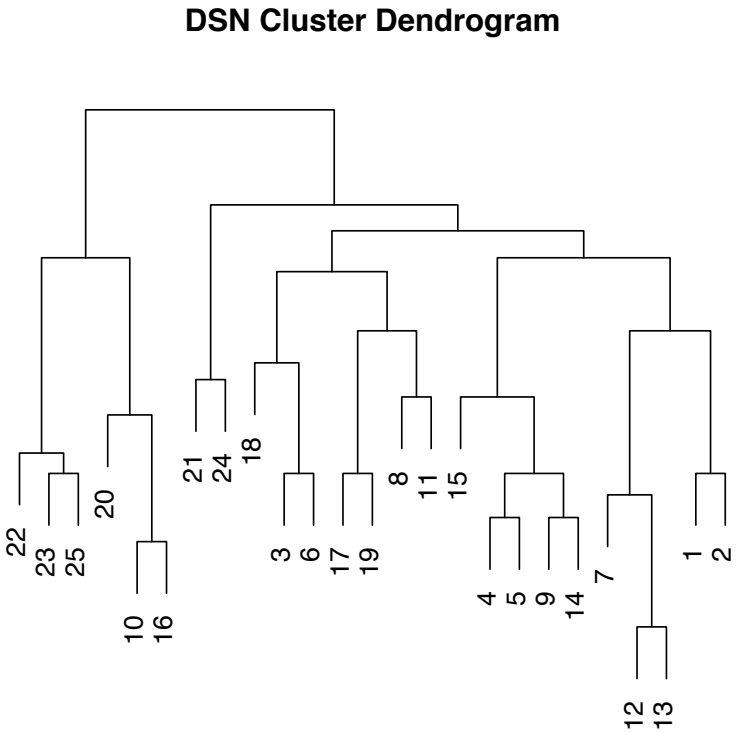
Architecture



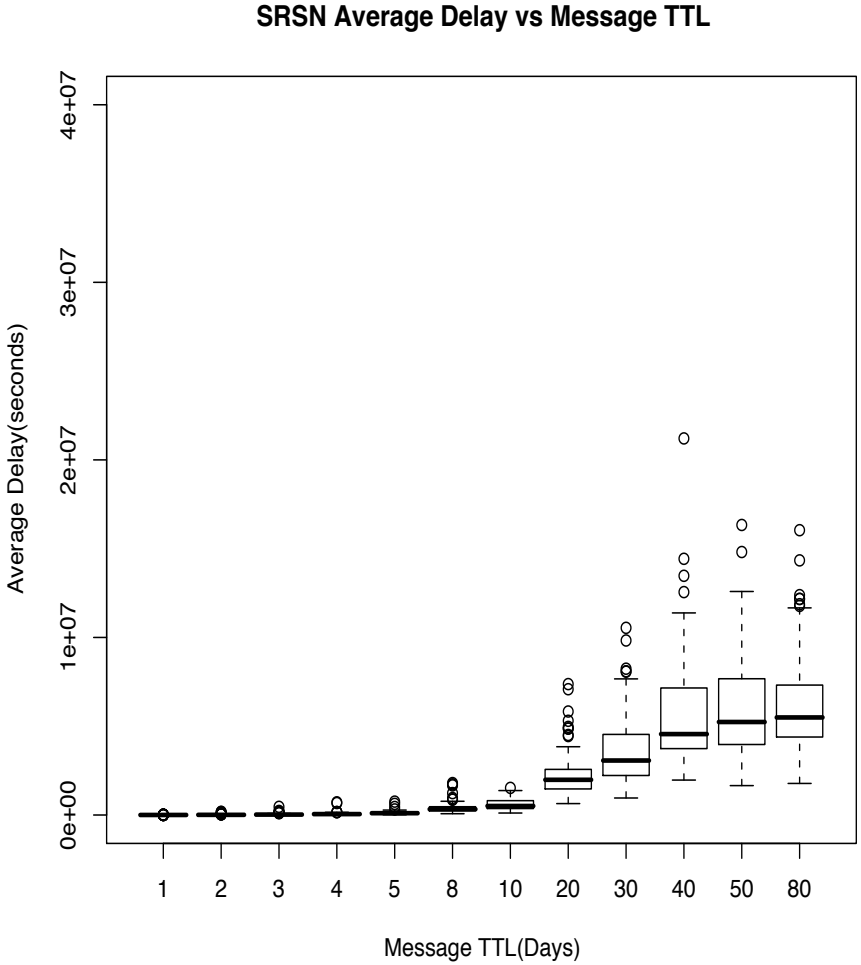
Do social networks differ? Structural equivalence

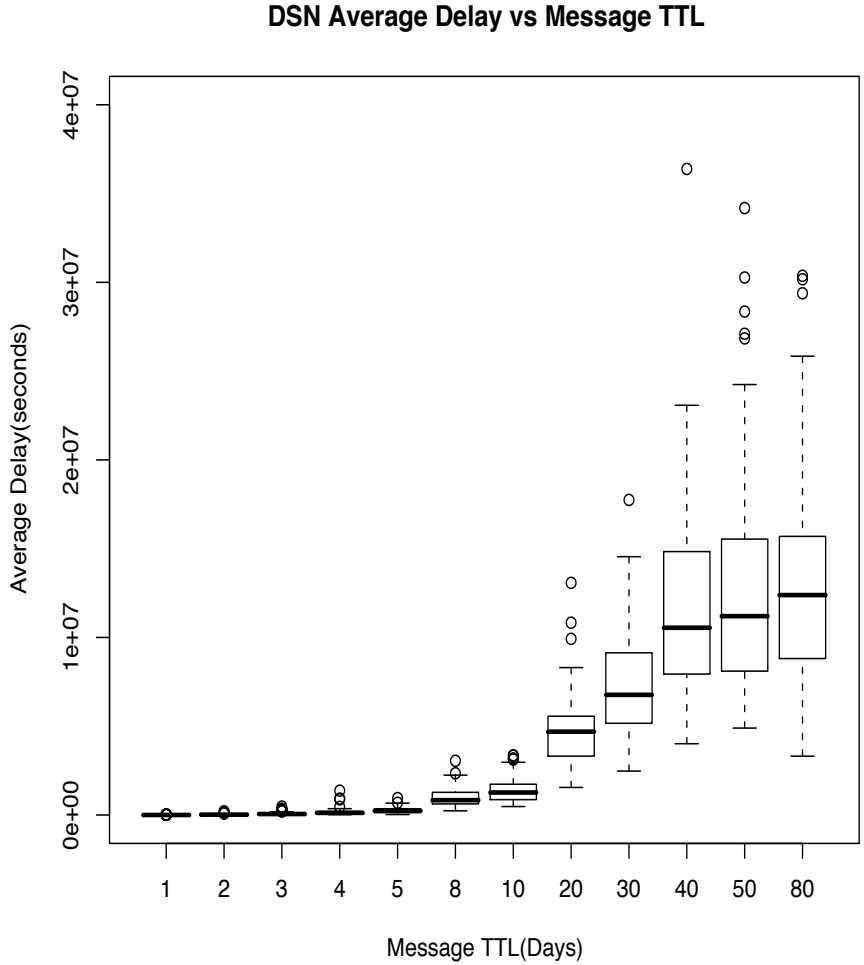
Clusters are more clearly defined in the SRSN





Delivery Delay





($p < 0.01$)

Mean diff in range: 25 days

Social network analysis

- In order to understand if the detected and self-reported are similar.
- Structural equivalence
  - Nodes with identical ties are structurally equivalent.
- Role equivalence
  - Nodes are role equivalent if the ways in which they relate to the other nodes is the same.