# On the Analysis of Periodic Mobility Behaviour

Zhiyu Wang
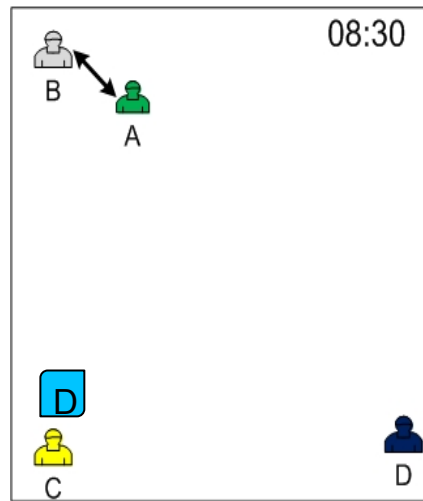**Mario A. Nascimento**
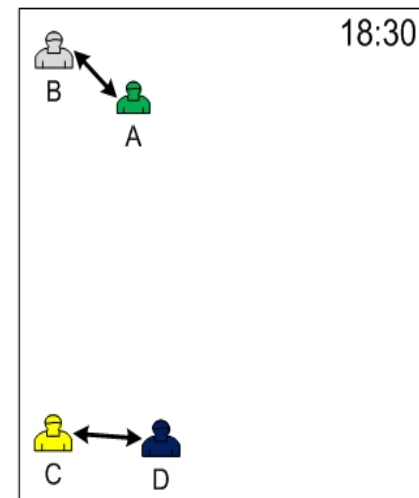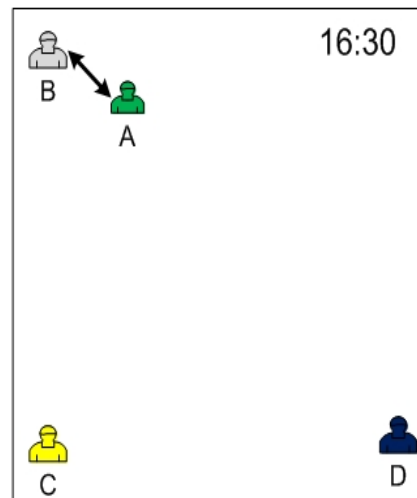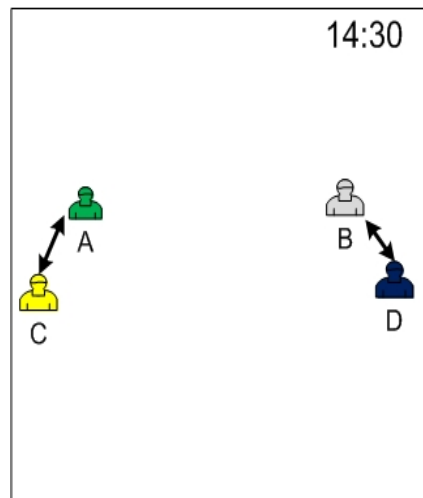**Mike H. MacGregor**

FROM SUN MICROSYSTEMS

Motivation

- **Routing in delay tolerant mobile networks (DTMNs) is very challenging**

  – One solution is to explore user mobility

- **Previous studies investigate:**

  – Encounter probabilities

  – Social connectivity

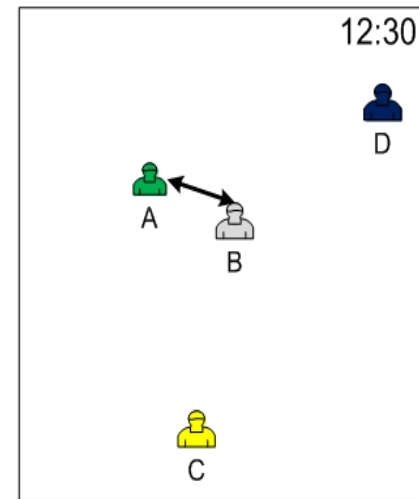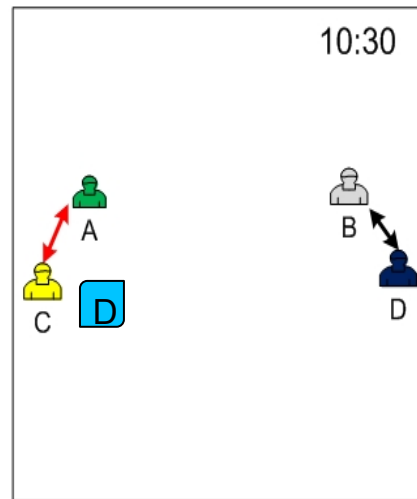- **We focus on periodic encounter behaviours**

Routing in DTMNs
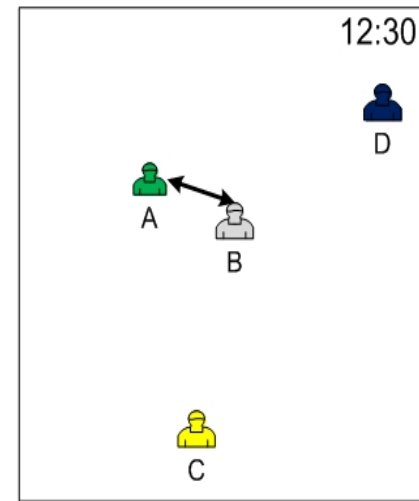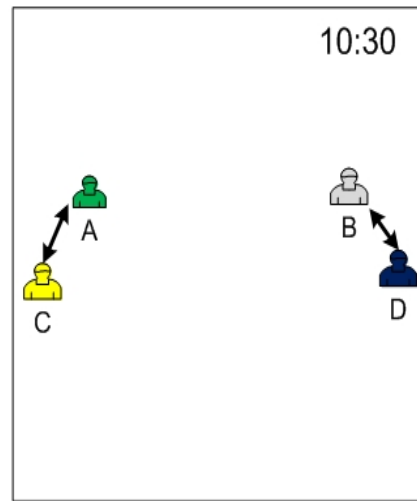
C Source

D Destination

Routing in DTMNs

C Source

D Destination
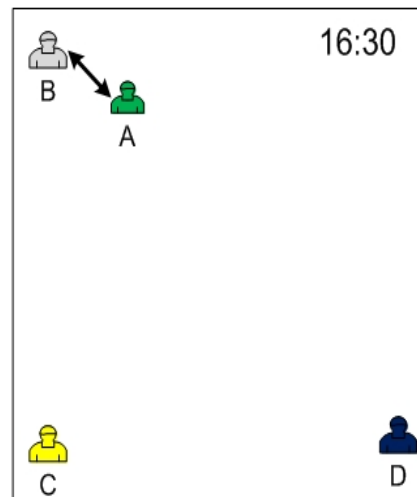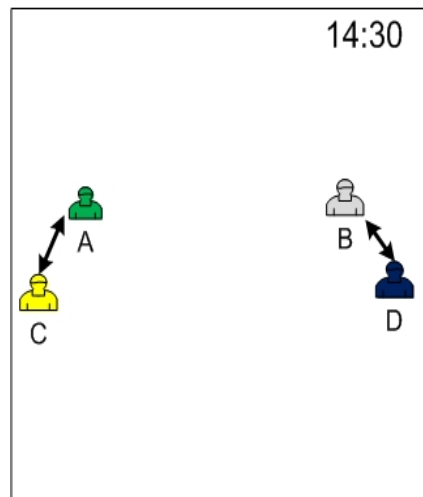
A Relay

Routing in DTMNs
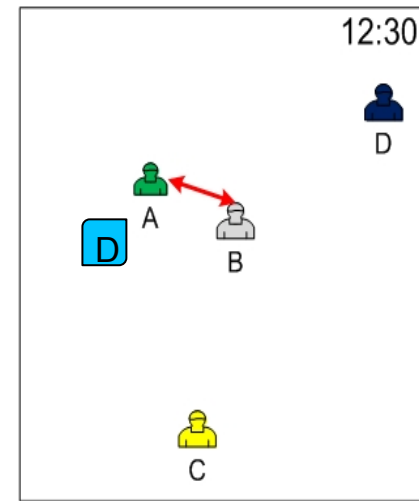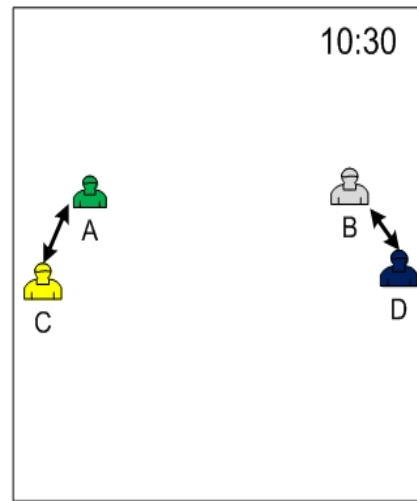
C   Source

D   Destination

A   Relay

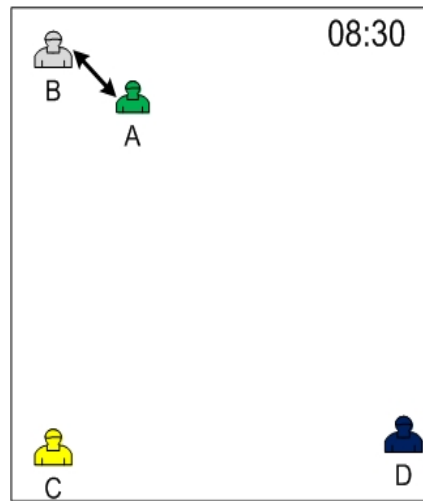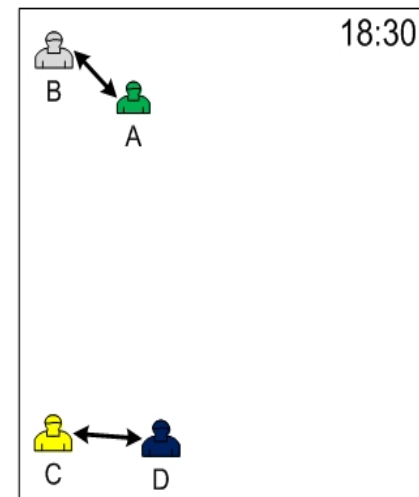B   Relay

Routing in DTMNs
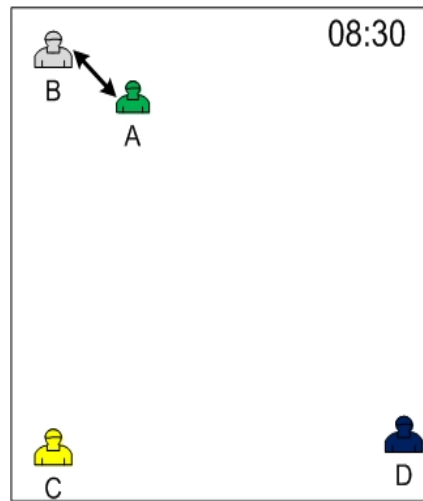
C Source

D Destination

A Relay

B Relay

Indirect Delivery
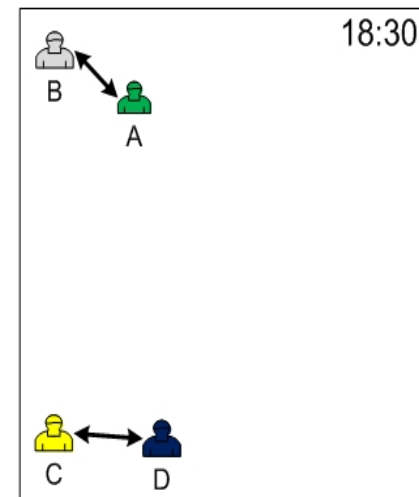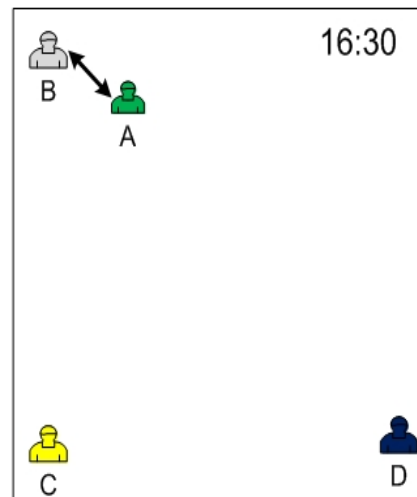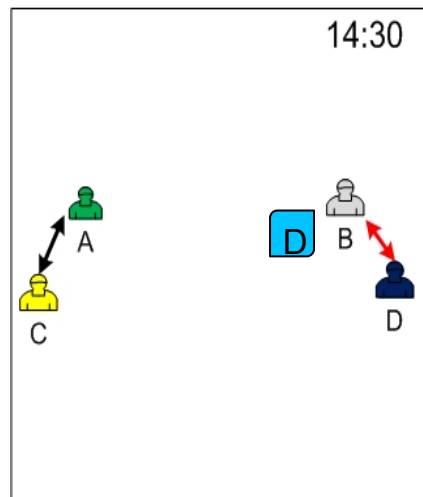
Periodic Encounter

-Time & +Cost

Routing in DTMNs
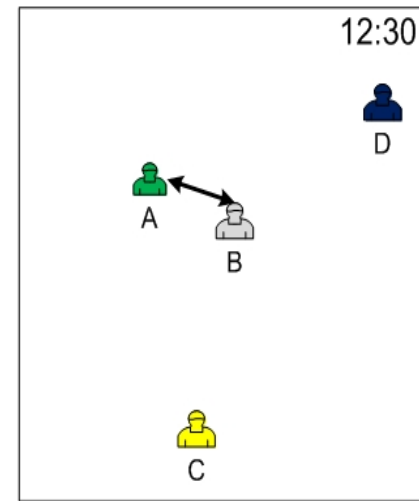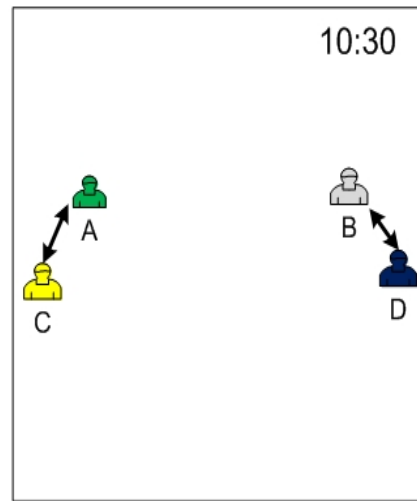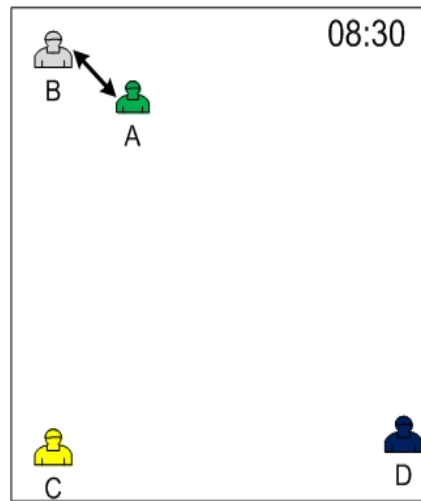
C Source
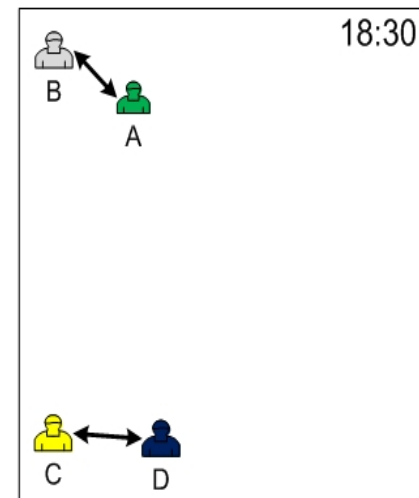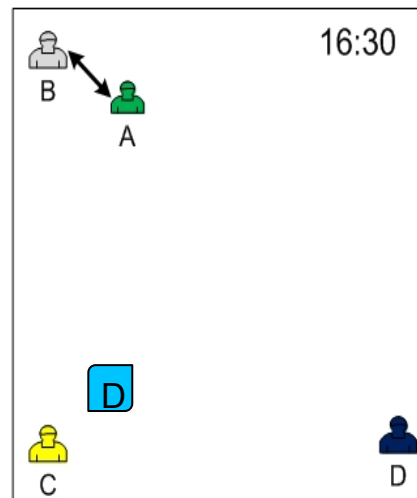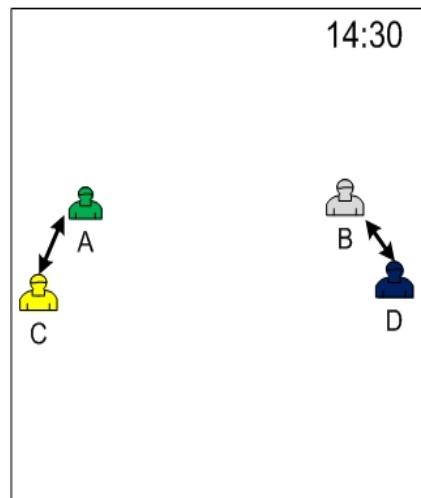
D Destination

Routing in DTMNs
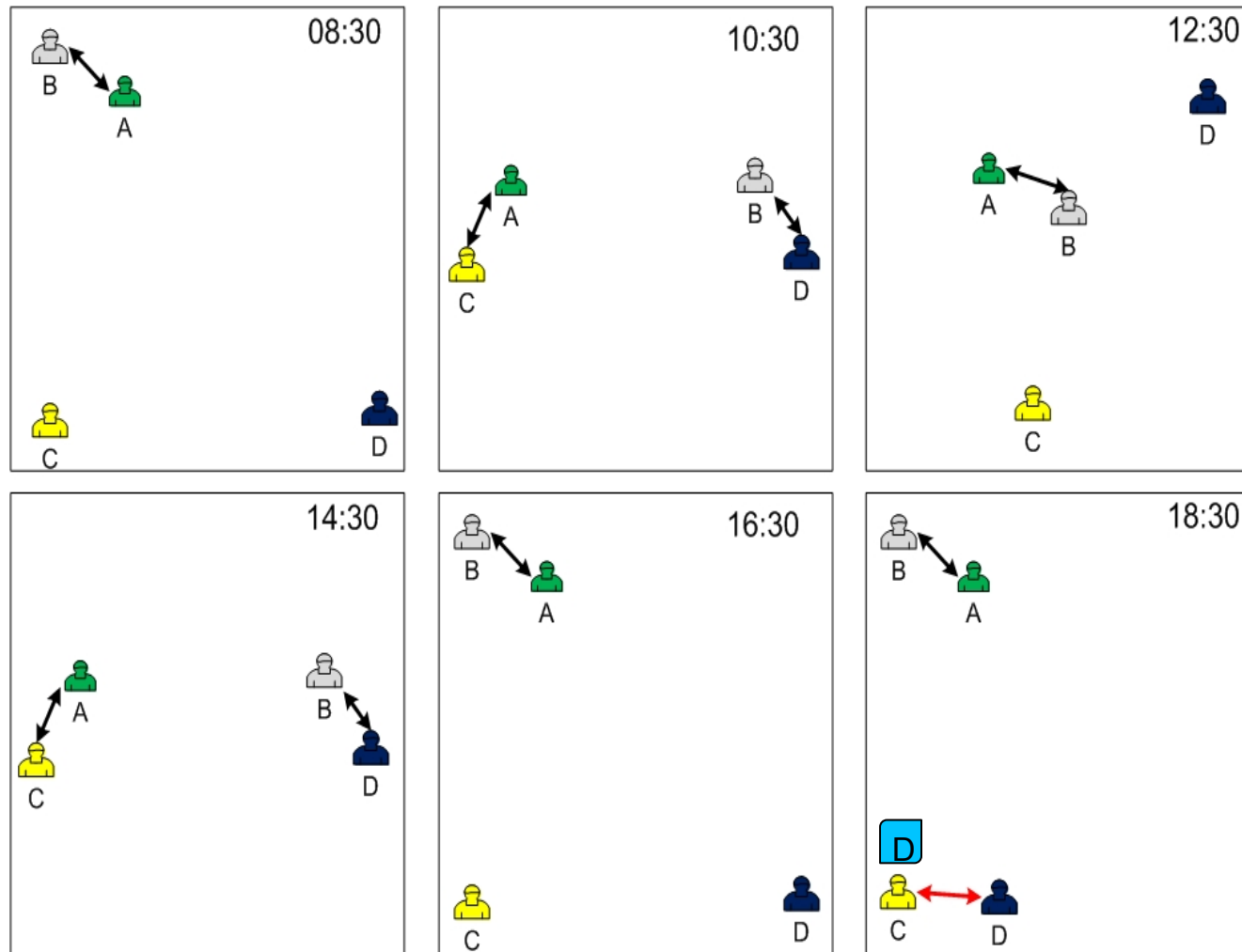
C   Source

D   Destination

Direct Delivery

Low probability
Encounter

+Time & -Cost

Encounter Series

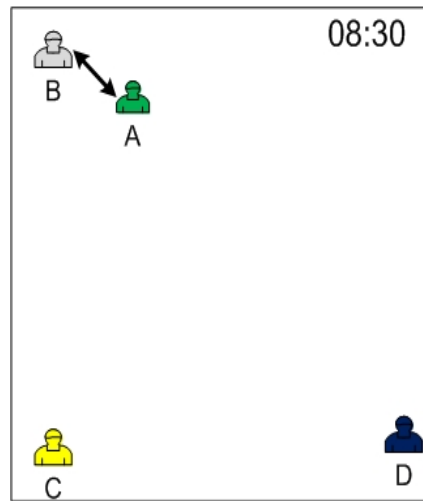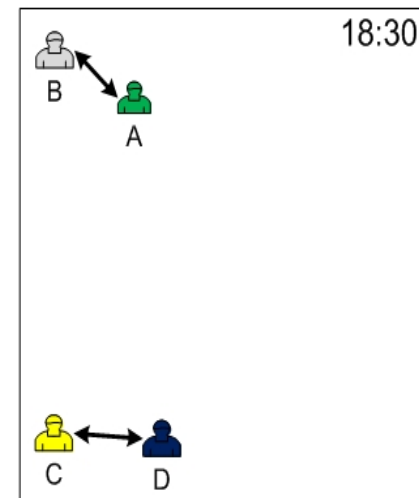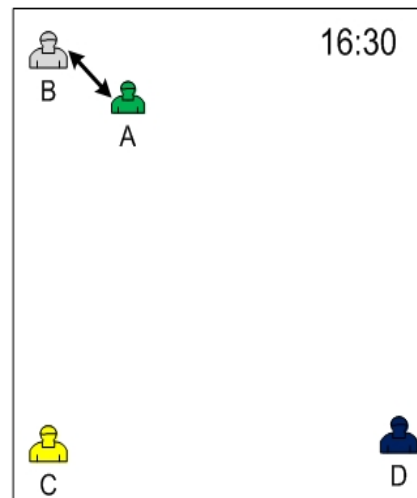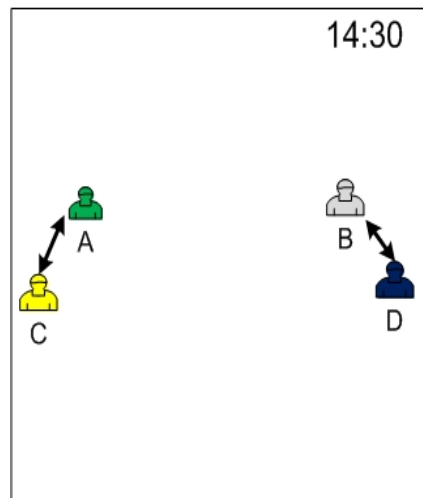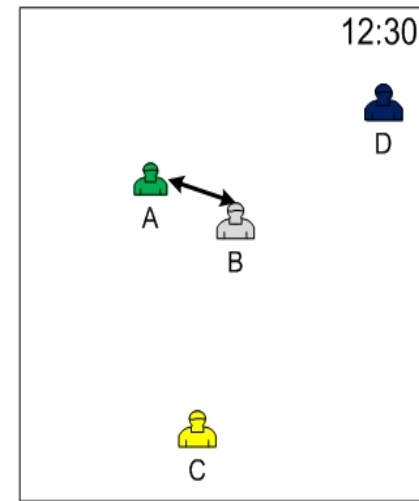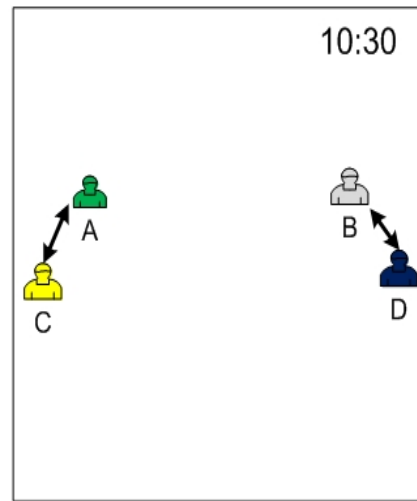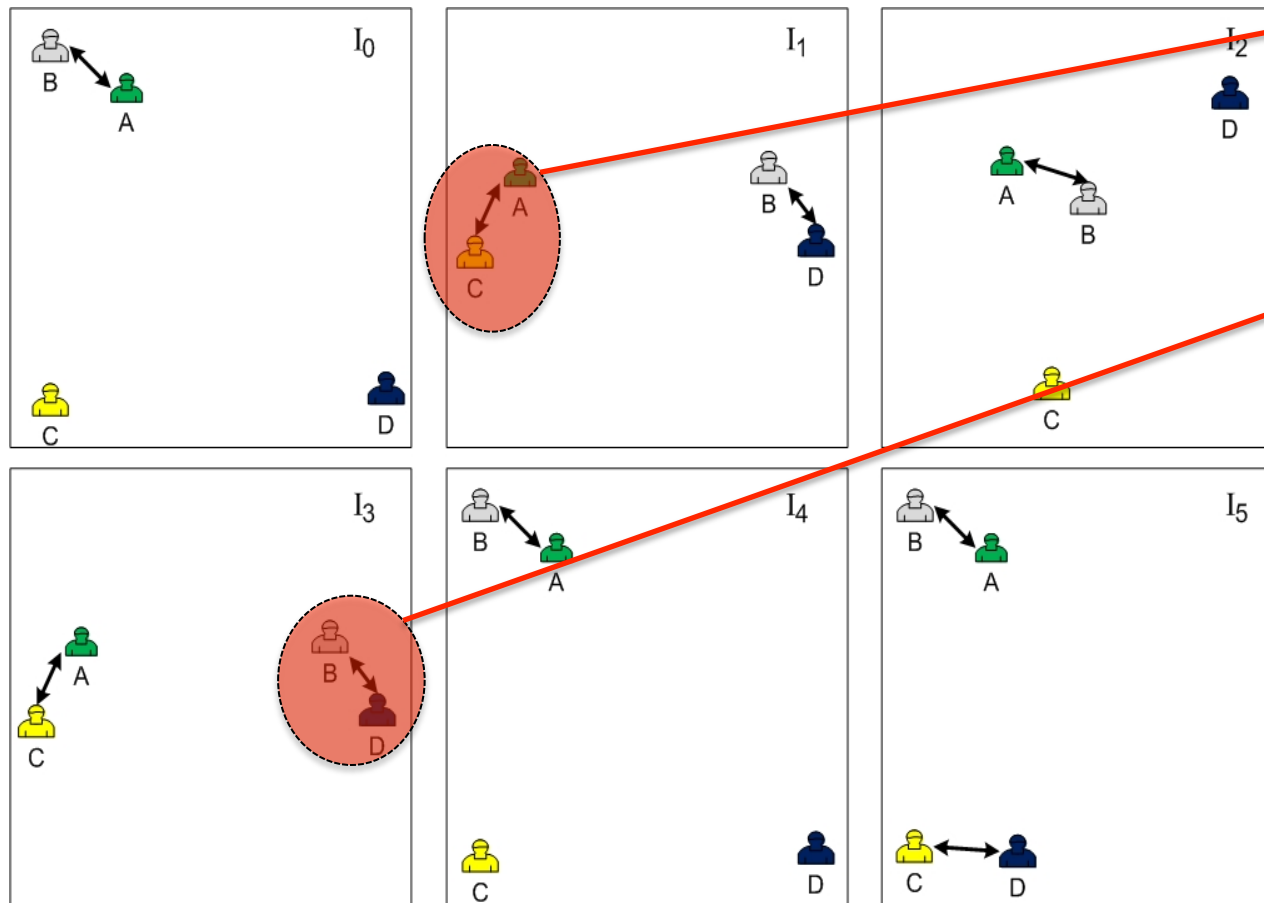| Nodes	I_0	I_1	I_2	I_3	I_4	I_5
A⟺B	1	0	1	0	1	0
A⟺C	0	1	0	1	0	0
A⟺D	0	0	0	0	0	0
B⟺C	0	0	0	0	0	0
B⟺D	0	1	0	1	0	0
C⟺D	0	0	0	0	0	1

- **Encounter series are binary time series**

- **The objective is to find periodic encounter patterns**

Periodicity recognition

- **APG examines conditional probabilities of encounters at different lags in encounter series.**

  - Peaks are formed by underlying periodic encounters at corresponding phases

- **If an encounter series has periodic behaviour with length p, then it also has periodic behaviour with length $2p$, $3p$ and so on.**
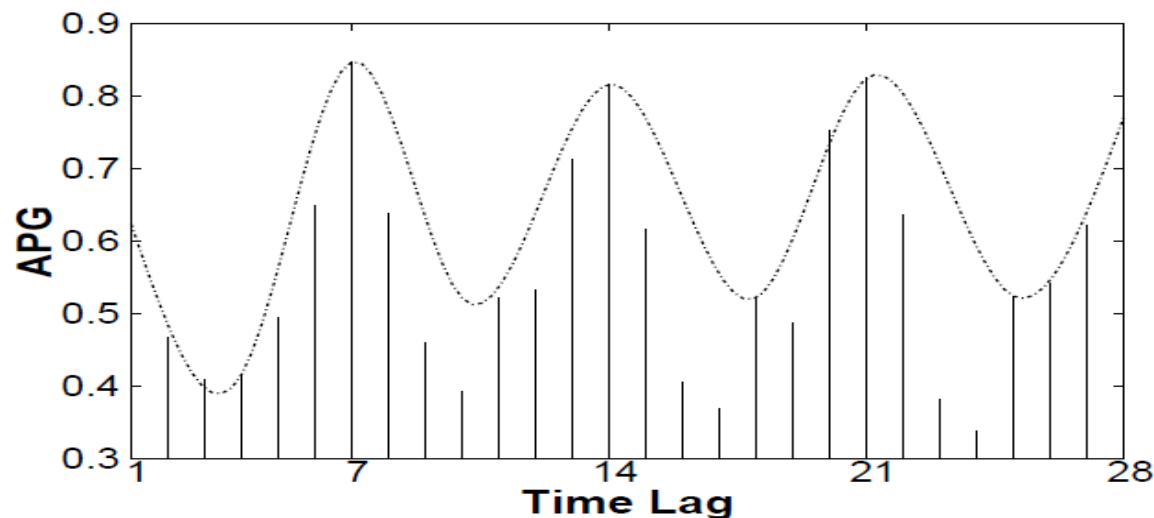
Periodicity recognition

Periodic encounters detected
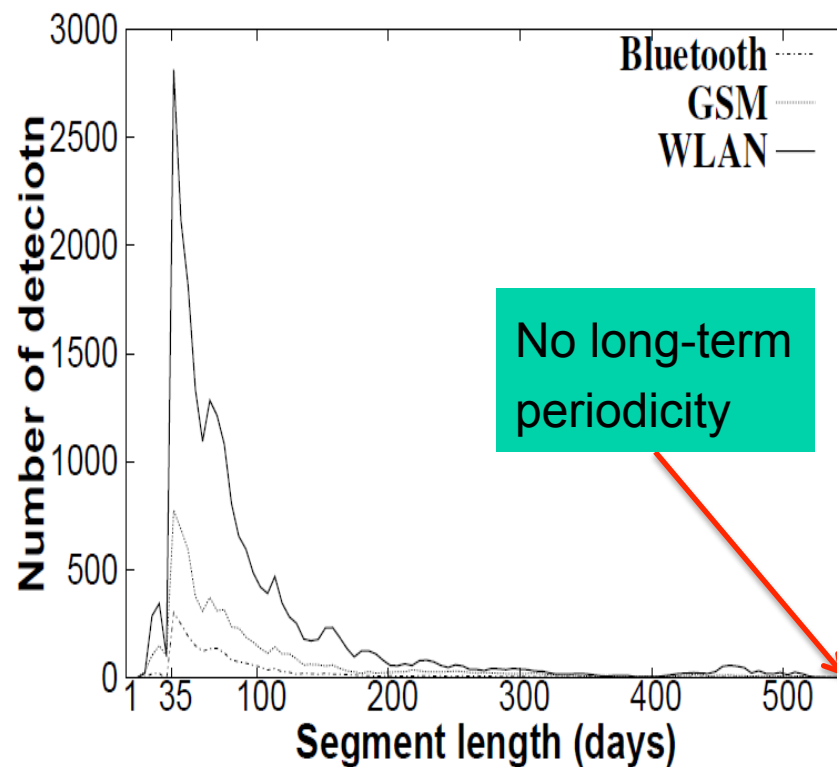
Period length distribution

No long-term periodicity
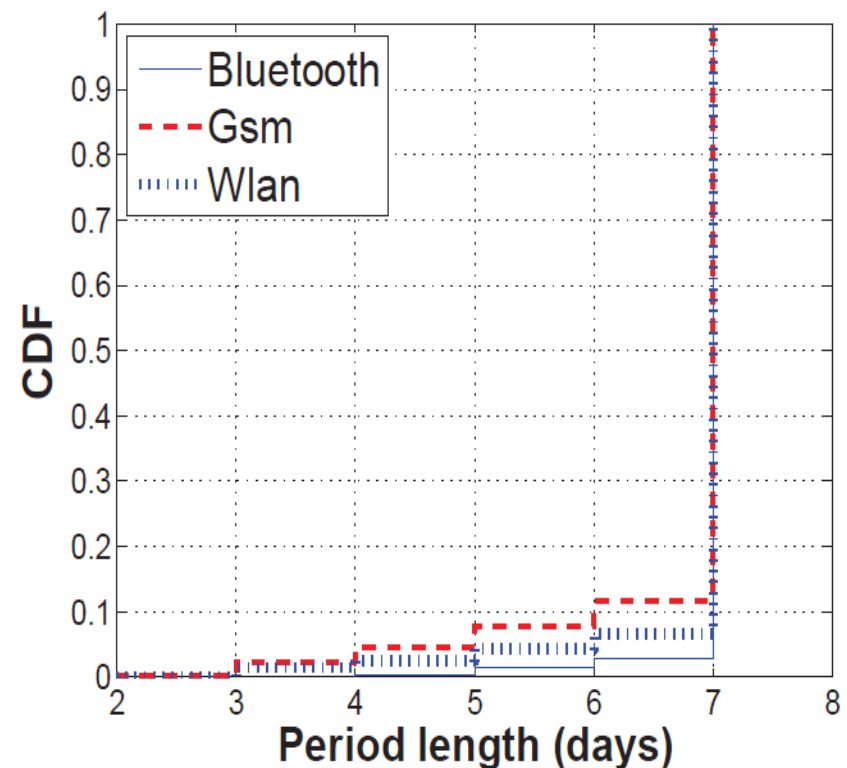
Persistence of periodic behaviour

- **Two thresholds**

  - θ = the degree to which the number of periodic encounters within an interval match those in a discovered pattern

    e.g. $\theta = 1/2$ if only one periodic encounter is found in the current interval when the pattern detected contains two encounters, e.g., the pattern detected is *0100100* vs. the actual encounter *0000100*

  - Δ = the maximum number of intervals not satisfying θ
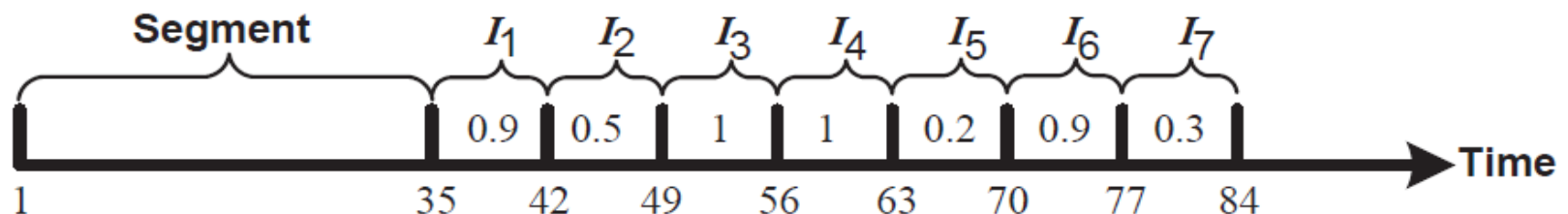
Persistence of periodic behaviour

matching probability, θ

a) $\Delta = 0$

θ threshold	35-day
0.1	54.68 days
0.3	39.9 days
0.5	29.01 days
0.7	22.28 days
0.9	14.59 days

# of missing intervals, Δ

b) $\theta = 0.9$

Δ threshold	35-day
0	14.59 days
1	17.29 days
2	23.41 days
3	29.17 days

Conclusion

- **Three contributions:**

  - discovered strong daily and weekly patterns in Nokia-MDC datasets

  - evaluated the persistence of periodic behaviour

  - examined the small-world structure in the network formed by periodic behaviour

- **Exploring periodic encounter behaviour for routing in DTMNs.**

Thank you!

Questions?