Persistence and Availability of Floating Content in a Campus Environment

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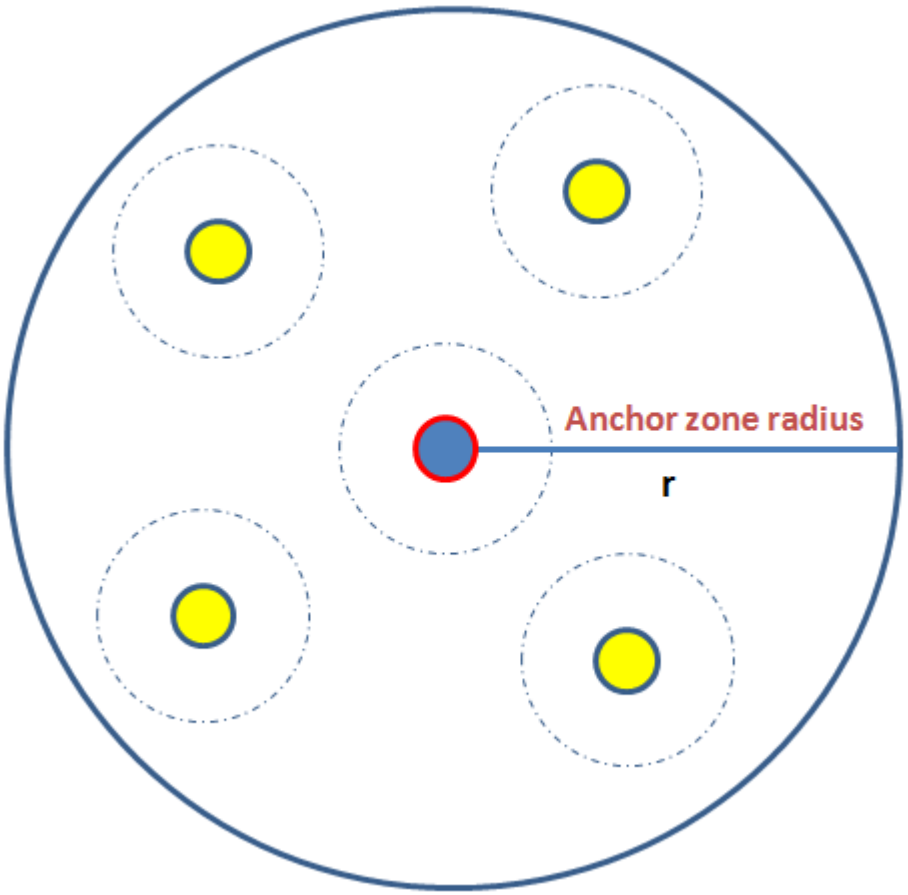
Floating Content: geographically constrained probabilistic storage

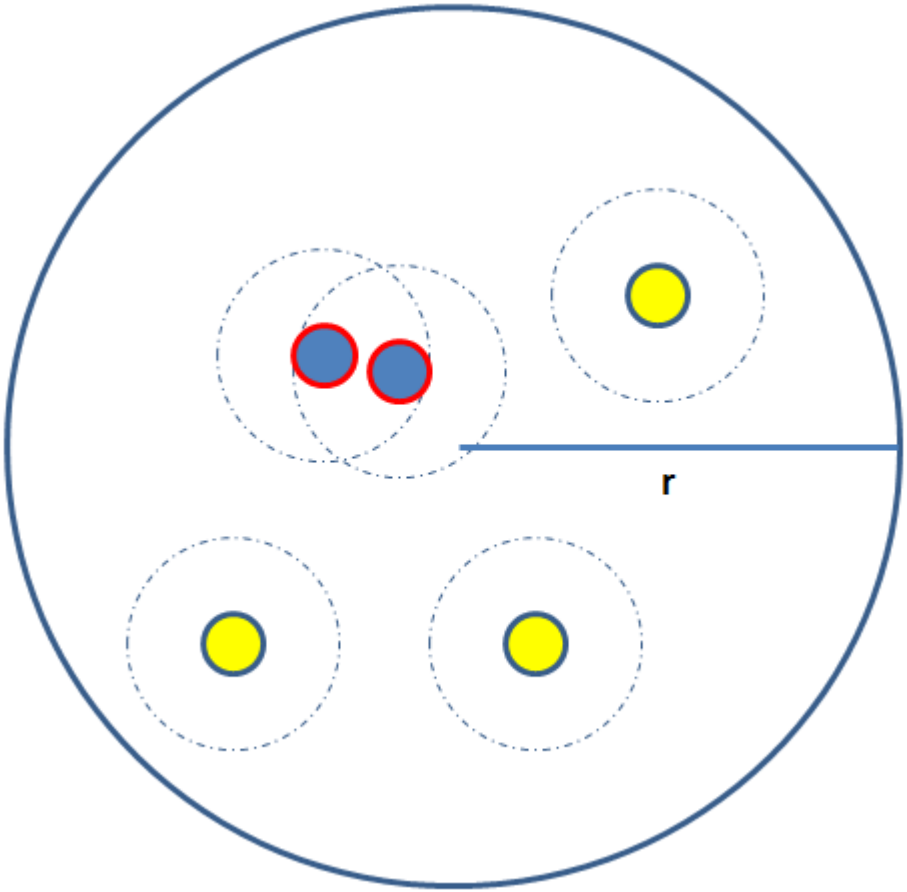
- It makes some piece of information available to mobile users
  - Without infrastructure support (via opportunistic replication)
  - Within a given geographical area ("Anchor Zone")
  - For a given time interval
- Applications
  - Emergency warning
  - Advertising
  - Social networks,…

Floating Content operation



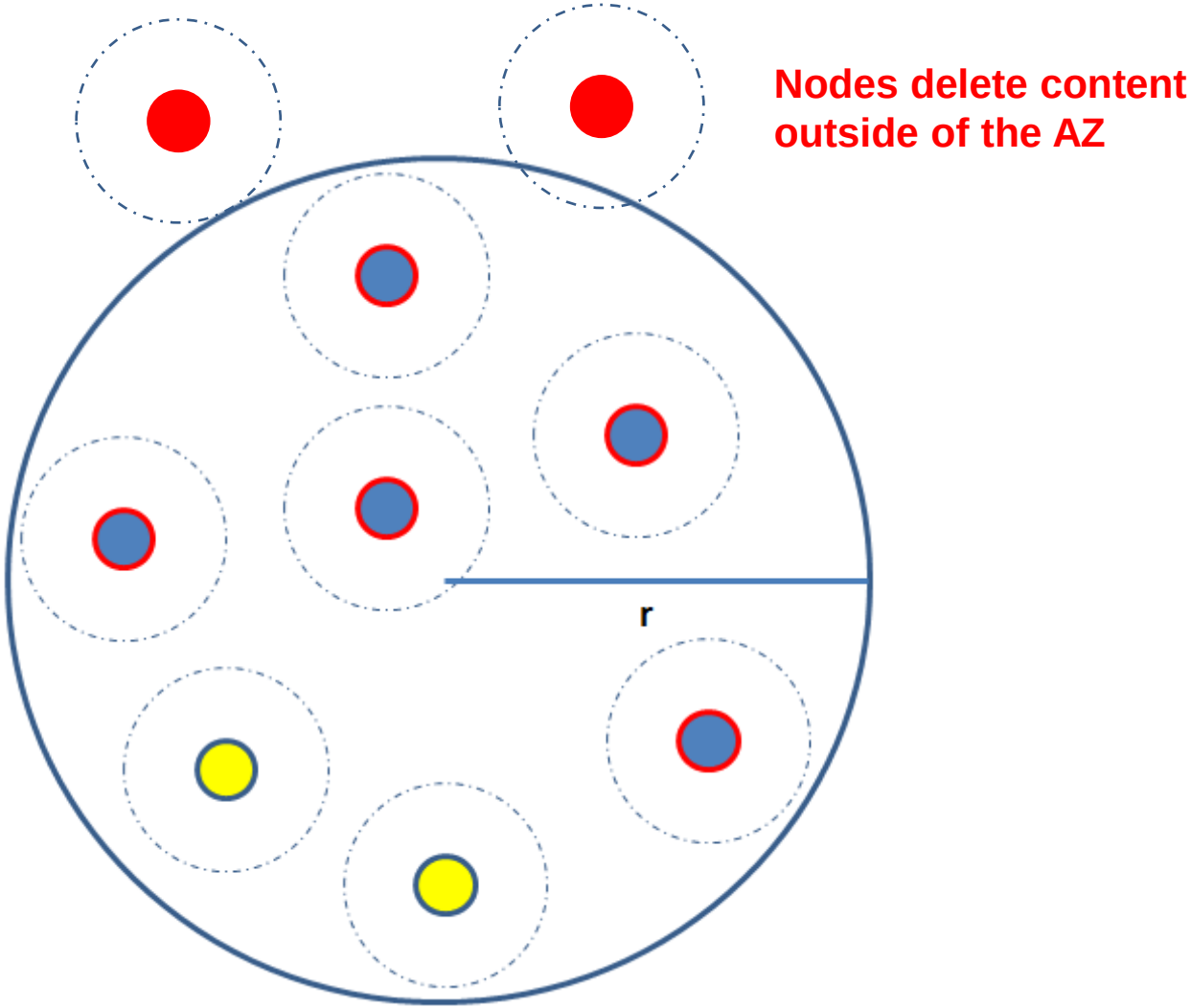
One (or more) nodes generate content

Floating Content operation



Content is replicated opportunistically

Floating Content operation



Content "floats" within the Anchor Zone

FC requires a critical mass for content to persist

Criticality condition

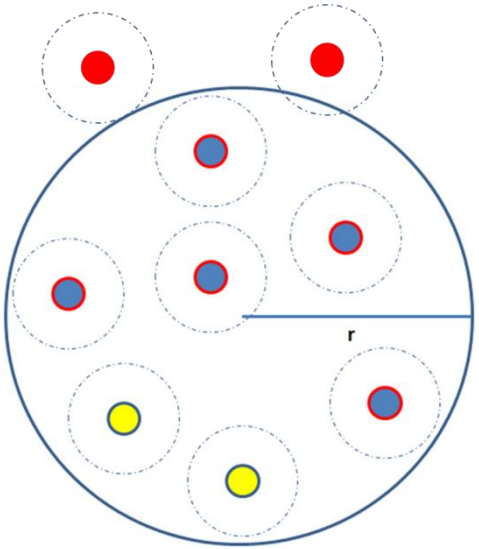
minimum user density for content to float indefinitely *with high probability*

Content Availability:

% users with content in the AZ

Success ratio:

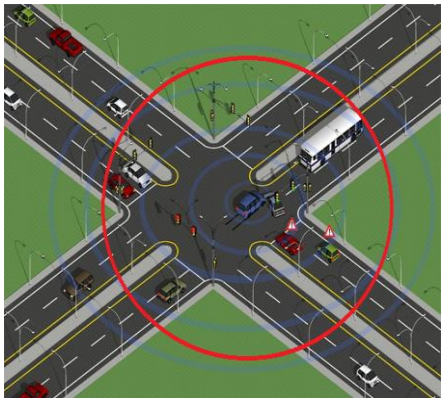
% users which leave the AZ with a copy of the content



- Existing results: CC and success ratio for various MM

How does Floating Content perform in realistic scenarios?

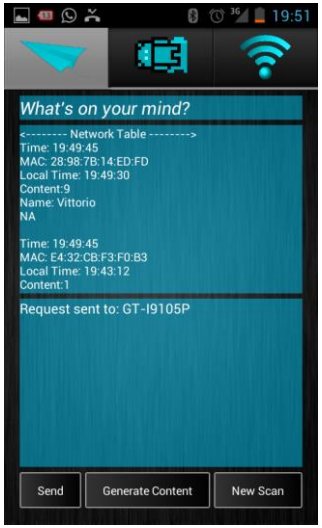
- FC performance is highly sensitive to:
  - mobility model,
  - AZ shape and size, etc.
- User density, mobility patterns vary over time



⇨ Available models do not predict performance of FC in realistic scenarios

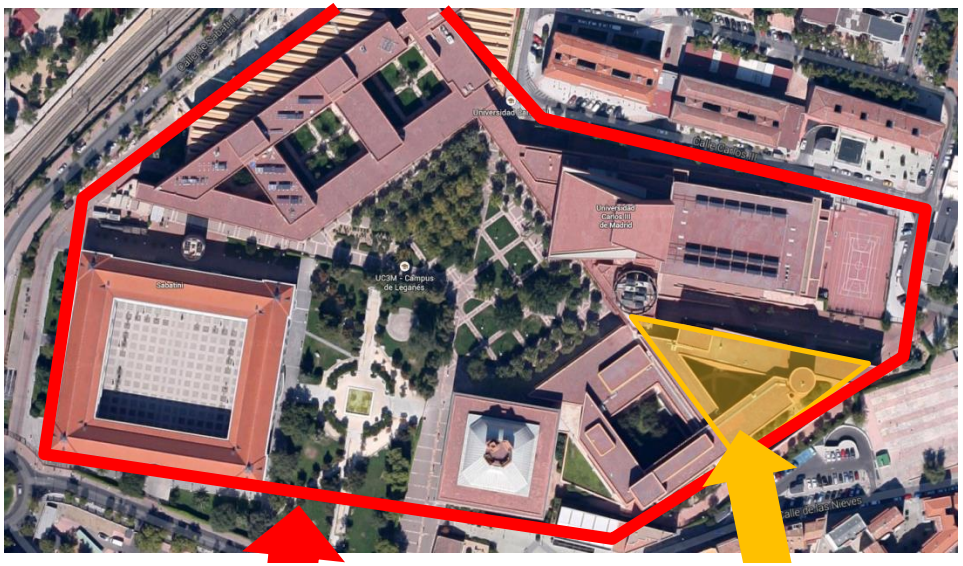
⇨ Need of experimental characterization of Floating Content service

Making content float in a campus environment: The Floaty app

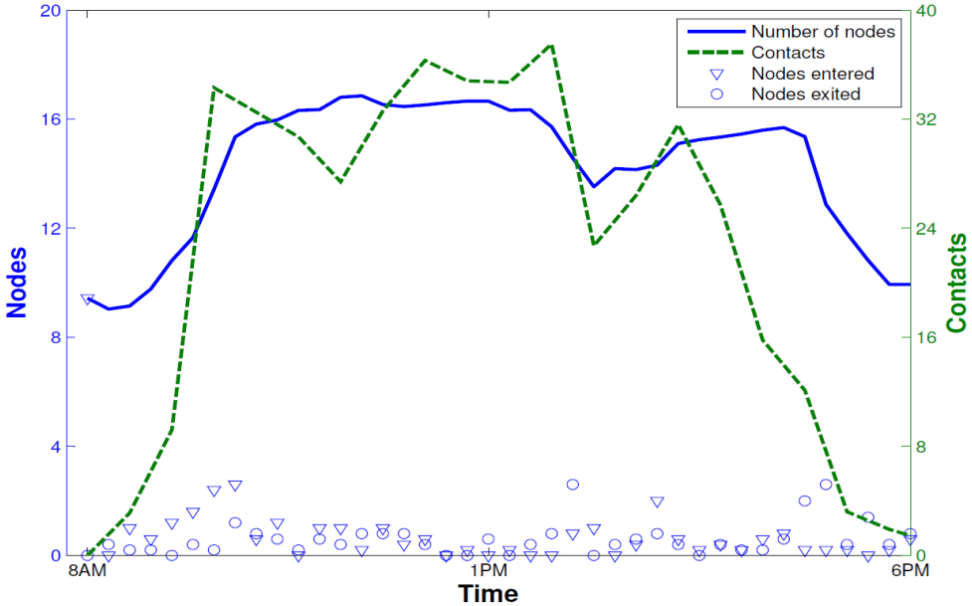


- An Android based application implementing Floating Content
  - Only the communication service, no application
- WiFi for coarse-grained localization
  - Check visibility of one or more APs
- Bluetooth for message exchange
  - Periodic scanning, pairing
- Energy efficient, discrete
- Many experiments at once:
  - a new content every 15 mins

Experimental setup: UC3M Campus



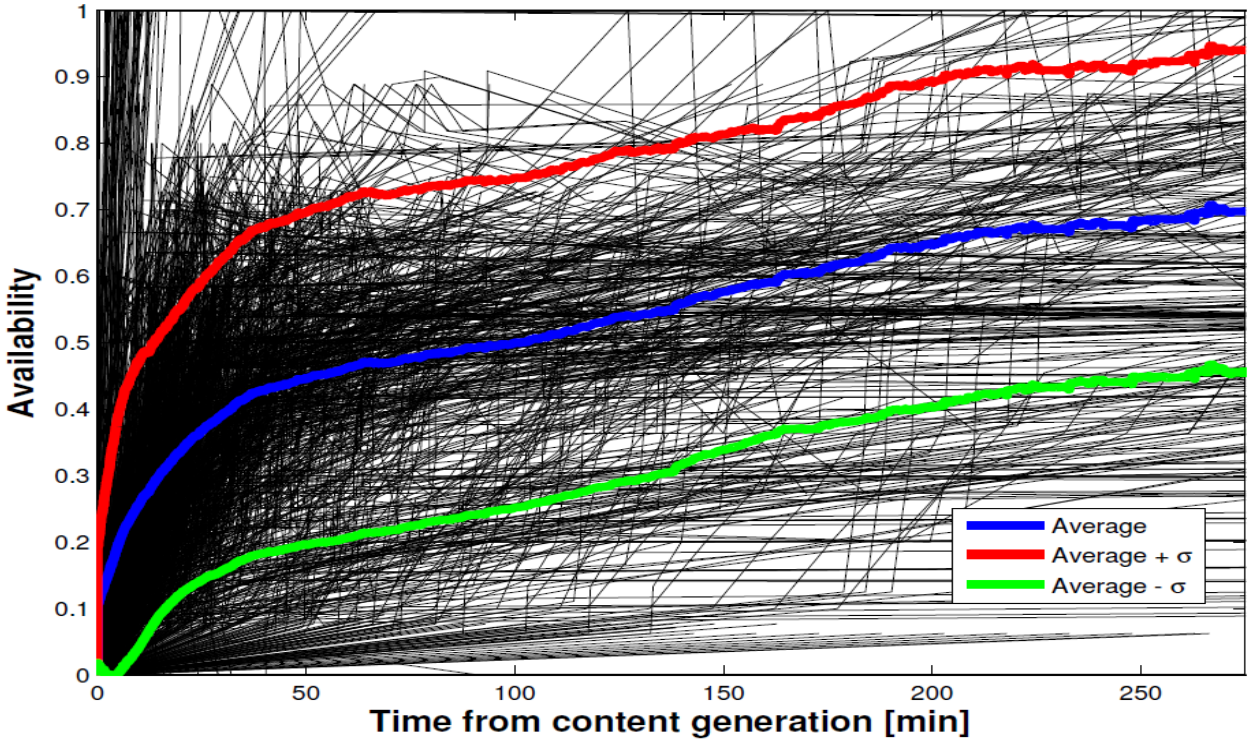
- AZ area: 7700 m2
- 64 users on three floors
- Duration: one week
- Total number of contents in experiment: 923



Theory: average contact rate and # of users too low for good performance and content persistence

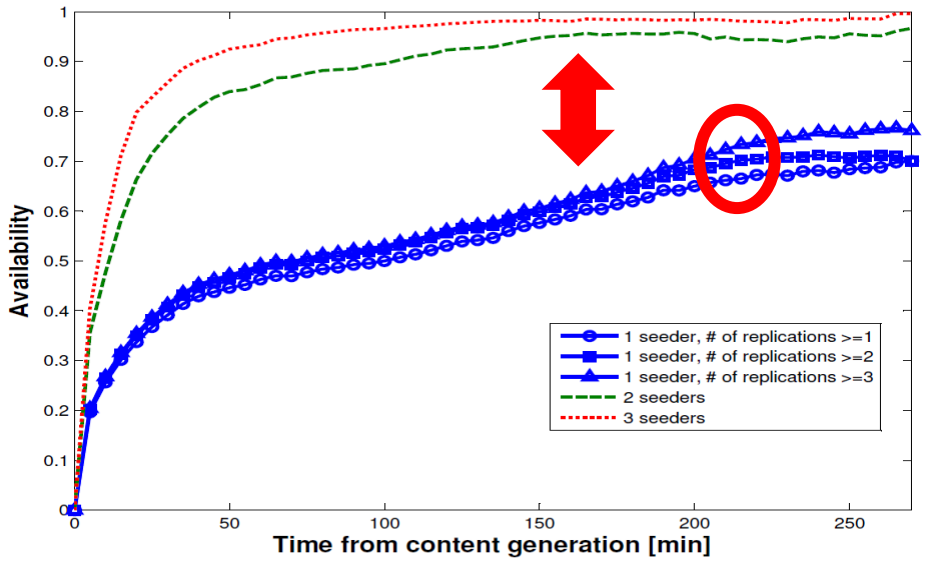
In experiments, content (almost) never disappears

Per-content availability during content lifetime:



- **Only 5% of contents disappear**
- **Mean availability 50%: content is well replicated**
- **Fast initial diffusion + slower growth**

Low user mobility and user clusterization determined experimental FC performance



- Increasing # seeders improves availability
- Not due to content mortality

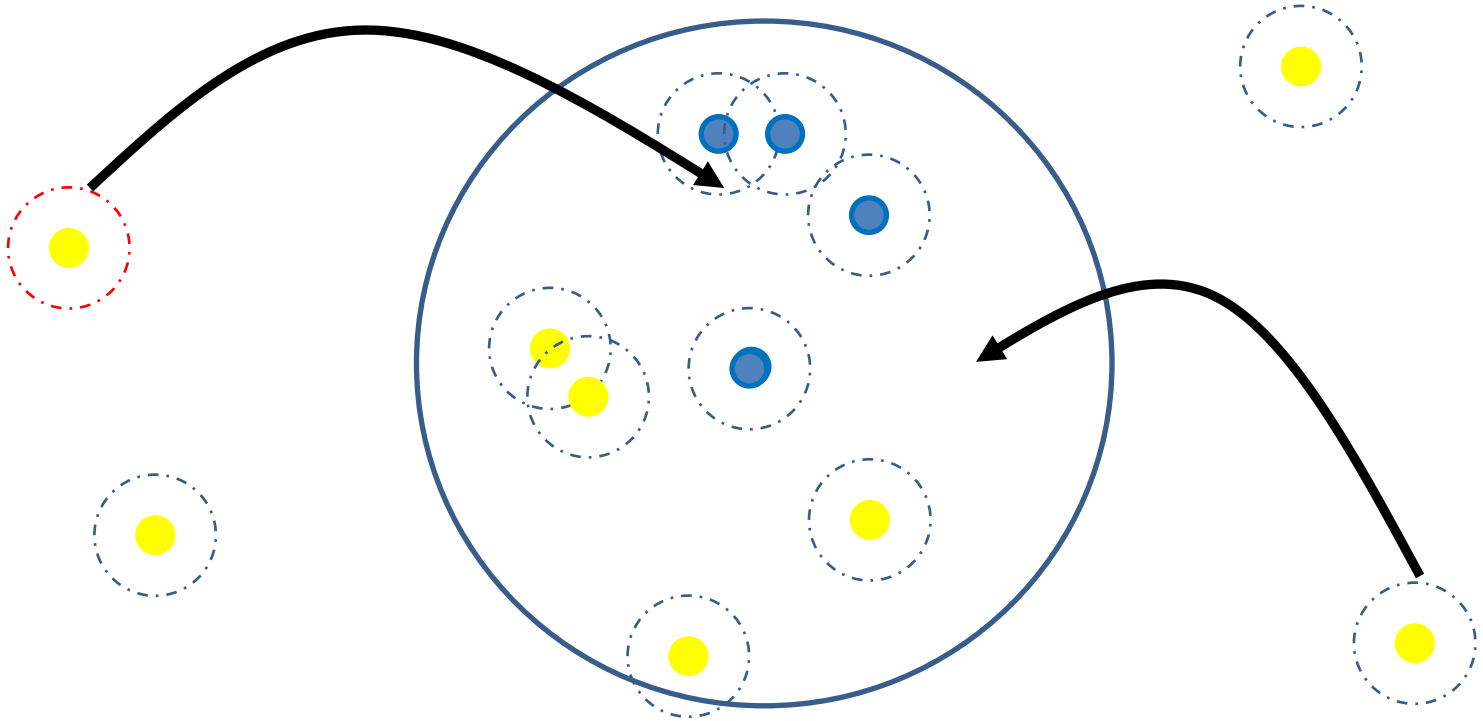
Hypothesis: clusters of users with few, unfrequent interactions between them

➡ Initial fast diffusion: within transmission range

➡ Slow diffusion: through user mobility

We elaborated a new model based on a Poisson jump mobility model

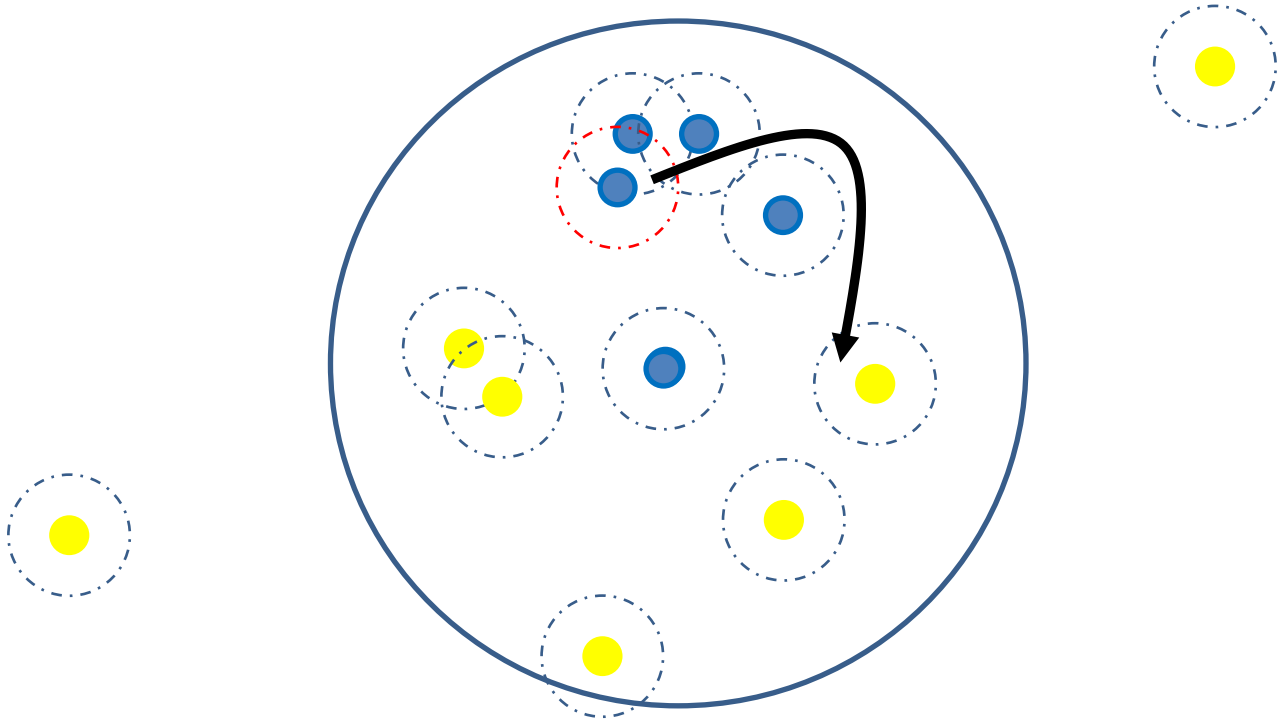
- **Poisson Jumps mobility model**= random waypoint with *infinite* speed



Users jump into the AZ at rate γ

We elaborated a new model based on a Poisson jump mobility model

In the AZ, each user jumps at a rate μ.
Each jump has a probability 1-p to lead out of the AZ



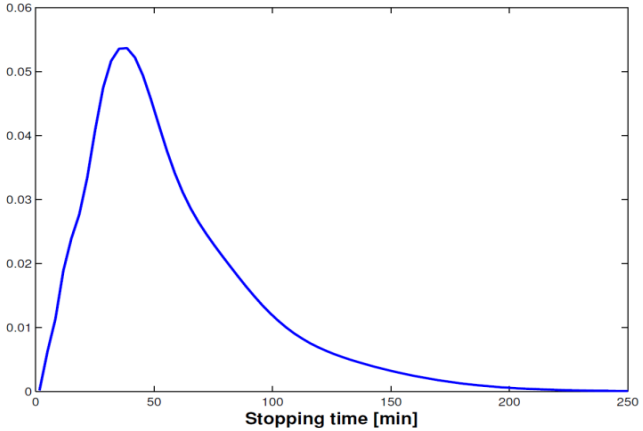
Poisson Jumps model predicts fairly accurately experimental FC perfomance

Success probability:

$$P = \frac{p_{jump}}{1 - p(1 - p_{jump})}$$

P(getting content after a jump): $p_{jump} = 1 - e^{-r^2 \frac{\overline{n}}{R^2}}$

Empirical distribution of stopping times:



	Model	Measured
Average Availability	0.50	0.562
Average Success Ratio (Success Probability)	0.47	0.514

Conclusions

- We have characterized some critical aspects of FC performance, relevant for applications
- Clustering and cluster dynamics in campus environment allow satisfactory performances even at very low user densities

Future developments:

- Consider FC performance from the point of view of one (or of a family) of application
- Focus on performance over shorter timescales (<1h)
- Model clustering effects and correlation bw user mobility patterns

Thanks!