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

Nodes delete content outside of the AZ
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 $\gamma$
We elaborated a new model based on a Poisson jump mobility model.

In the AZ, each user jumps at a rate $\mu$. Each jump has a probability $1-p$ to lead out of the AZ.
Poisson Jumps model predicts fairly accurately experimental FC performance

Success probability:

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

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

Empirical distribution of stopping times:

<table>
<thead>
<tr>
<th></th>
<th>Model</th>
<th>Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Availability</td>
<td>0.50</td>
<td>0.562</td>
</tr>
<tr>
<td>Average Success Ratio (Success Probability)</td>
<td>0.47</td>
<td>0.514</td>
</tr>
</tbody>
</table>
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!