**Cedos: a Practical Cellular Data Offloading System for Mobile Users**

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### Wi-Fi Offloading

- Detouring cellular data to high-bandwidth, low-cost Wi-Fi networks
- Wi-Fi APs are actively deployed by ISPs
- Delay helps increasing Wi-Fi contact chances (Wi-Fi offloading ratio: 60% → 93.7% with 1 hour delay\(^{[1]}\))

### Problem with on-the-spot Wi-Fi offloading

1. Change of IP address when switching Wi-Fi ↔ LTE
   - Causes all on-going TCP connections to fail
   - Requires retransmission of the same content
2. No practical system supporting delayed offloading
   - Exploits Wi-Fi contacts with deadline guarantee
   - Allows long disconnection and supports transport-level resumption

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### System Design

**D2TP: Delay and Disruption Tolerant Transport Layer**

- Binds a persistent flow id to a connection
  - Supports seamless switching over IP address change
- Hides network disruptions from the applications
- Exploits the delays allowed by the users
  - Maximizes the Wi-Fi offloading efficiency
  - But completes transmission within allowed delay

**D2Prox: Protocol Translation Proxy**

- A web caching proxy bridging D2TP and TCP
- Data delivery via opportunistic connection
  - In a store-and-forward manner
- Easy to migrate existing HTTP apps
  - Requires no modification on existing servers

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### Applications

**ReadyCast (Podcast downloader)**

- Designed to support delayed offloading
  - Users can specify the preferred delay
  - Now available at Google Play store

**Cedos-based VLC (Video streaming player)**

- Designed to support opportunistic offloading
  - Fetching the content via intermittent Wi-Fi
  - Modified only 61 lines out of 3.7M lines of code

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### Results

**User study with ReadyCast (8 weeks, 50 users)**

<table>
<thead>
<tr>
<th>Wi-Fi Offloaded</th>
<th>No delay</th>
<th>Delayed 0–1h</th>
<th>Delayed 1–3h</th>
<th>Delayed 3–6h</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>79.5%</td>
<td>93.4%</td>
<td>96.2%</td>
<td>99.5%</td>
<td>92.4%</td>
</tr>
</tbody>
</table>

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\(^{[1]}\) K. Lee, J. Rhee, J. Lee, S. Chong, and Y. K. Mobile Data Offloading: How Much Can Wi-Fi Deliver? (CoNEXT ’10)