# A Business Model Analysis of Mobile Data Rewards

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# I. Background

- Explain what are mobile data rewards.

# Mobile Data Rewards

- Conventionally, users pay subscription fees to the network operators to gain mobile data.
  - e.g., Orange Mobile: €17/month for a 5GB monthly plan.
- Recently, some network operators offer mobile data rewards: users can complete certain tasks (e.g., watch ads, take surveys, and download apps) to earn free mobile data.

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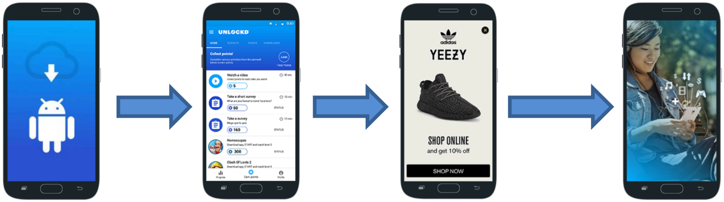
# Example of Ad-Sponsored Data Rewards

Steps to gain data rewards:




| Download the dedicated app | Select tasks (e.g., watching ads) | Watch ads to accumulate *"credits"* | Gain mobile data from operator based on *"credits"* |
|---|---|---|---|

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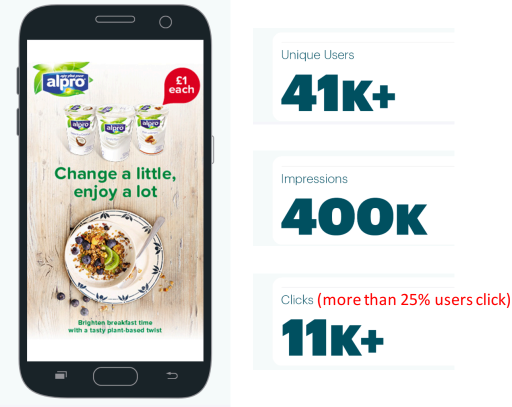


Effectiveness of *Alpro Yoghurt*'s ad

(displayed on the app shown in the last slide)

# Win-Win-Win Outcome

Data rewards lead to a win-win-win outcome for network operators, users, and advertisers.

# Key Market Players

*Operators implementing data rewards*

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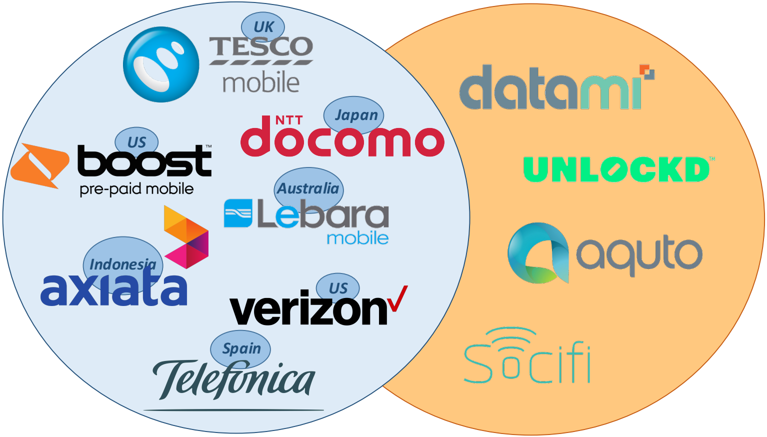


*Operators implementing data rewards* *Companies providing technical support (e.g., connecting with advertisers)*

# II. Problem Description

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  - Scheme 1: Only the data plan's subscribers.
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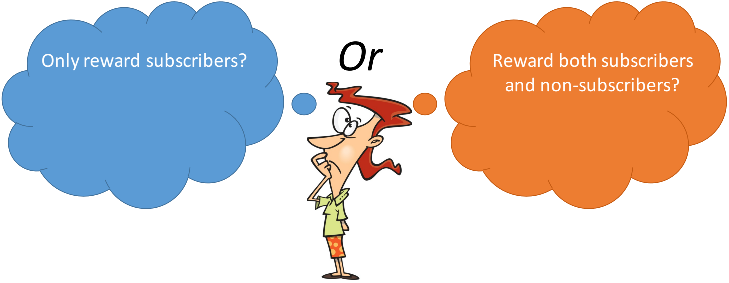


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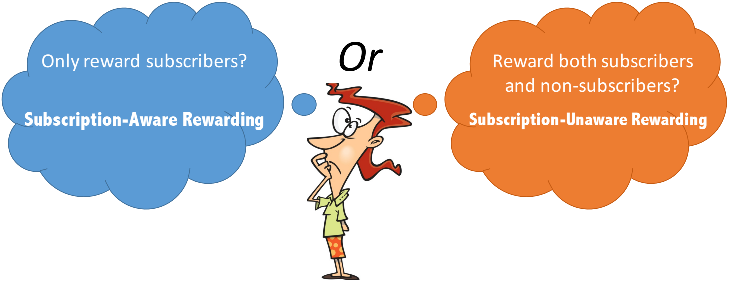


Network Operator

# Related Work

- Mobile data rewards: [Bangera *et al.* 2017] and [Sen *et al.* 2017] conducted surveys and experiments to evaluate the effectiveness of rewarding users for watching ads.
  - Our work conducts the first analytical analysis of ecosystem.

# III. Model

- Model the strategies and payoffs of the users, advertisers, and network operator.

# Model: Heterogeneous Users

- We consider a continuum of users, with a total mass of $N$.
- Each user's type $\theta$ captures its valuation for mobile service. $\theta \in [0, \theta_{\max}]$ follows a general distribution with PDF $g(\cdot)$.
- Each user decides:
  - $r \in \{0, 1\}$: whether to subscribe to (monthly) data plan.
  - $x \geq 0$: total numbers of ads to watch per month.
- A type-$\theta$ user's payoff is

$$\Pi^{\text{user}}(\theta, r, x, \omega) = \underbrace{\theta u \Bigg( \underbrace{Qr + \omega x}_{\text{total data}} \Bigg)}_{\text{utility}} - \underbrace{Fr}_{\text{payment}} - \underbrace{\Phi x}_{\text{ads disutility}}.$$

  - $u(\cdot)$: a general utility function, e.g., logarithmic function.

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  - $Q > 0$: data amount associated with subscription.
  - $F > 0$: data plan subscription fee.
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# Model: Homogeneous Advertisers

- We consider $K$ advertisers, and each advertiser decides $m \geq 0$: the total number of ads displayed by the operator per month.
- An advertiser's payoff is

$$\Pi^{\mathrm{ad}}(m,\omega,p) = \underbrace{\mathbb{E}_\theta\left[\underbrace{Bg(m,x^*(\theta,\omega)) - Ag(m,x^*(\theta,\omega))^2}_{\text{ads' effectiveness on a type}-\theta\text{ user}}\right]}_{\text{expected ads' effectiveness on all users}} N - \underbrace{mp}_{\text{payment}}.$$

  - Ad effectiveness on a user is quadratic in $g(m,x^*(\theta,\omega))$.
  - $g(m,x^*(\theta,\omega))$: the number of **this advertiser**'s ads seen by a type-$\theta$ user. It increases with both $m$ and $x^*(\theta,\omega)$.
    - $g(m,x^*(\theta,\omega))$ can be computed under concrete ad displaying rules. Our work considers *random sampling w/o replacement*.
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# Model: Operator

- The operator decides
  - Unit data reward $\omega \geq 0$: the amount of data that a user receives for watching one ad.
  - Ad price $p > 0$: the price for displaying one ad.
- The operator solves the following problem:

$$\max_{\omega \geq 0, p > 0} \underbrace{NF \int_0^{\theta_{\max}} r^*(\theta, \omega) h(\theta)\, d\theta}_{\text{revenue from subscription}} + \underbrace{K m^*(\omega, p) p}_{\text{revenue from advertising}}$$

$$\text{s.t.} \quad \underbrace{N \int_0^{\theta_{\max}} \left( Q r^*(\theta, \omega) + \omega x^*(\theta, \omega) \right) h(\theta)\, d\theta}_{\text{total data demand}} \leq \underbrace{C}_{\text{network capacity}},$$

$$\underbrace{K m^*(\omega, p)}_{\text{total number of displayed ads}} \leq \underbrace{N \mathbb{E}_\theta \left[ x^*(\theta, \omega) \right]}_{\text{total number of ads users will watch}}.$$

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# Two-Stage Game

| **Stage I** |
|---|
| Operator decides unit data reward $\omega$ and ad price $p$. |

$\Downarrow$

| **Stage II** |
|---|
| Users make subscription decisions $r$, ad watching decisions $x$.<br>Advertisers decide number of displayed ads $m$. |

We compare two data rewarding schemes:

- Subscription-Aware Rewarding: $x > 0$ only if $r = 1$.
- Subscription-Unaware Rewarding: $x \geq 0$, regardless of $r$.

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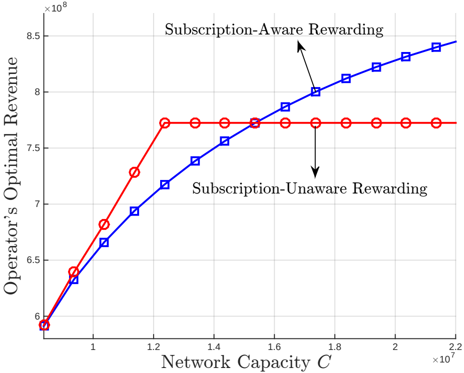
# IV. Key Results

- Comparison between two rewarding schemes.

# Comparison Between SAR and SUR Schemes

When users have logarithmic utility $u(\cdot)$, we have




- Observation: *When network capacity C exceeds a threshold, operator should only reward subscribers; otherwise, operator should reward both subscribers and non-subscribers.*

# Conclusion

- Conclusion: We study the data rewarding ecosystem, and analyze the operator's optimal choice of rewarding scheme.

- Future directions
  - Consider competition between operators;
  - Consider targeted advertising (increasing ad effectiveness and reducing users' disutility).

# THANK YOU