

Choice Architecture and Smartphone Privacy: *There's A Price for That*

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Adverse selection in app markets

Example: SMS

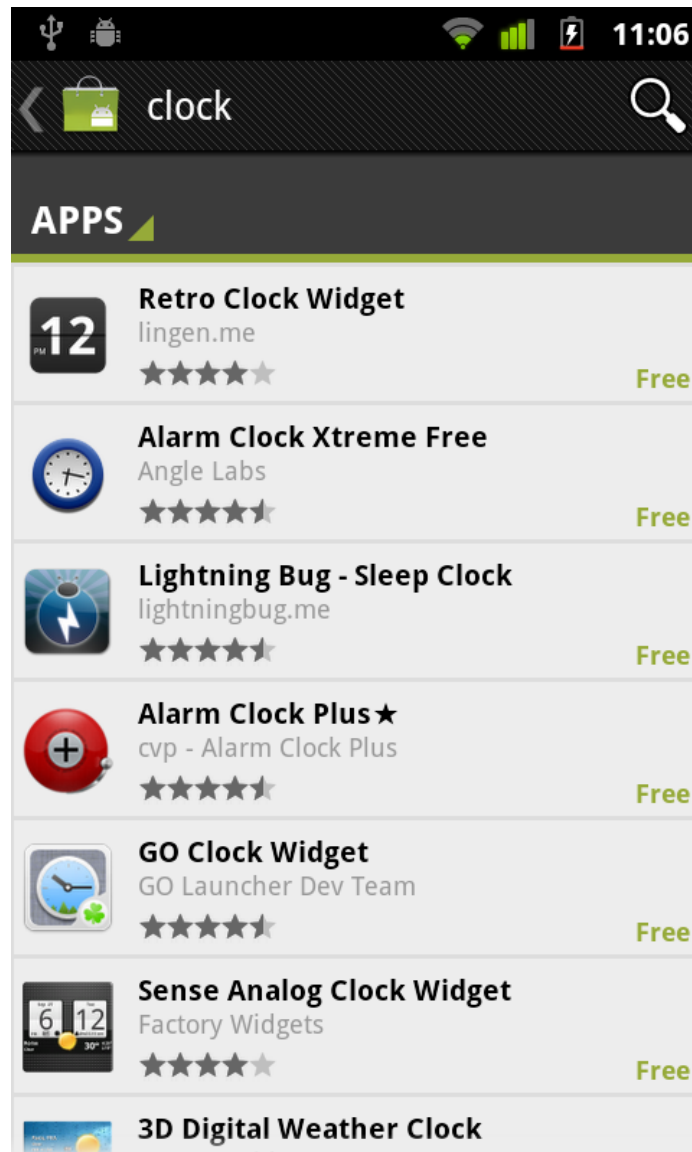
- 73% of malware uses SMS capability
- 3% of legitimate applications use it
- • SMS capability signals potential malware

Advice: *“Don’t use apps that require SMS”*

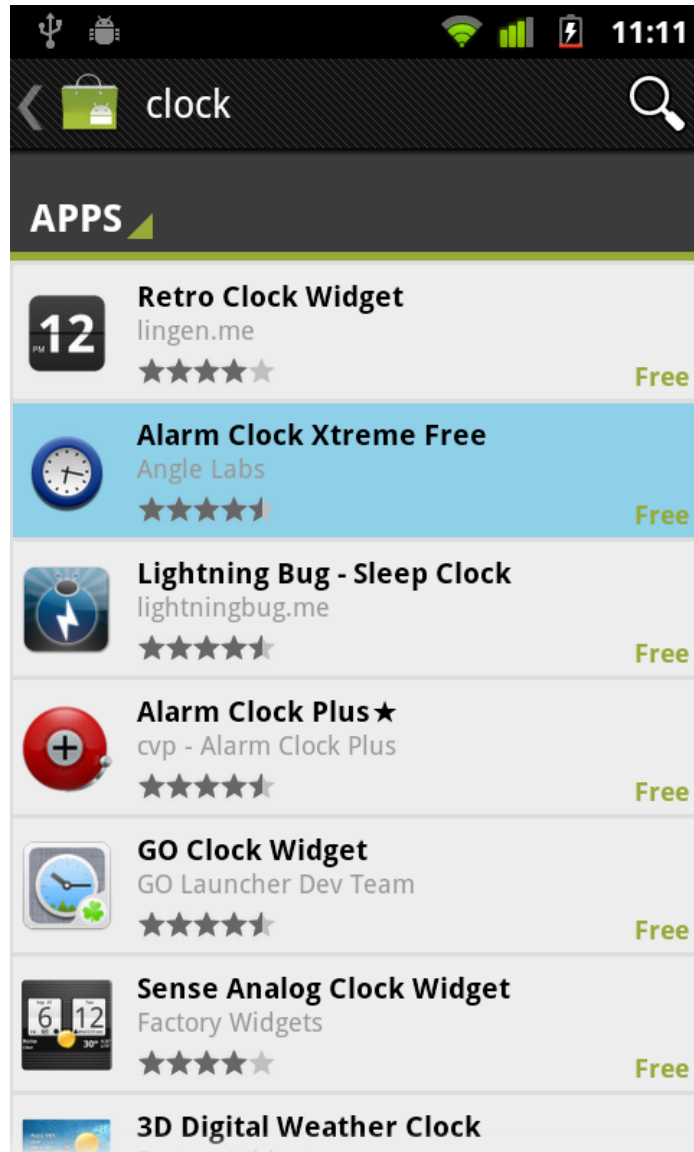
Is it possible to follow this advice?

EXAMPLE: INSTALLATION

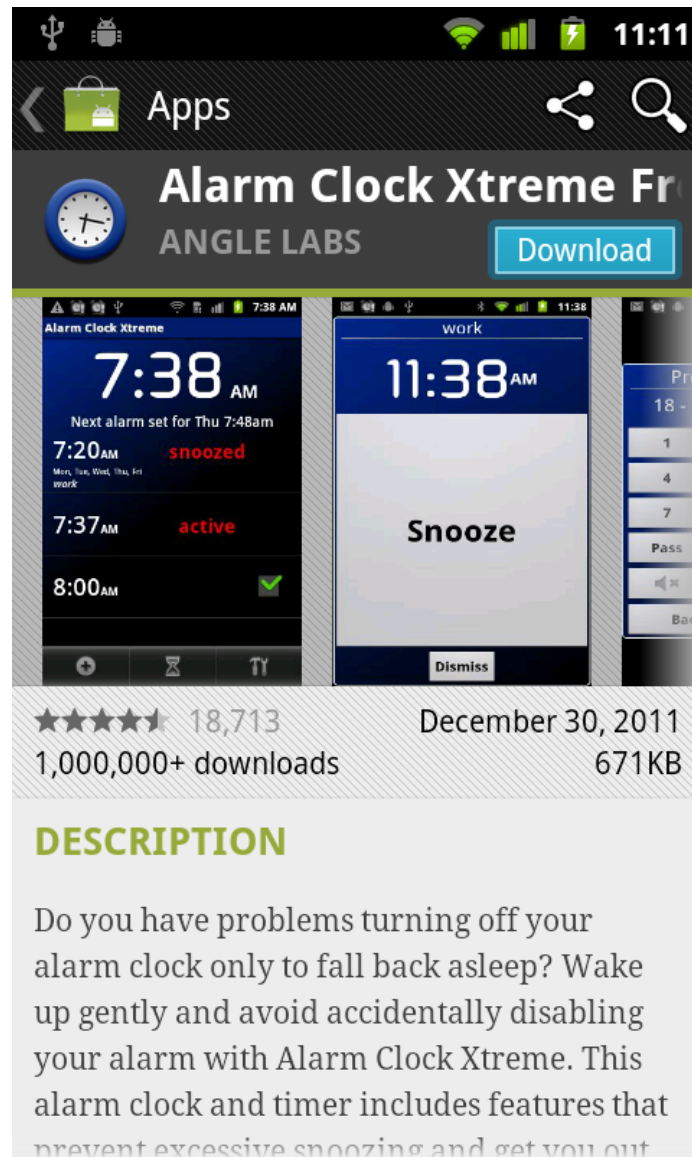
Step 1: Search



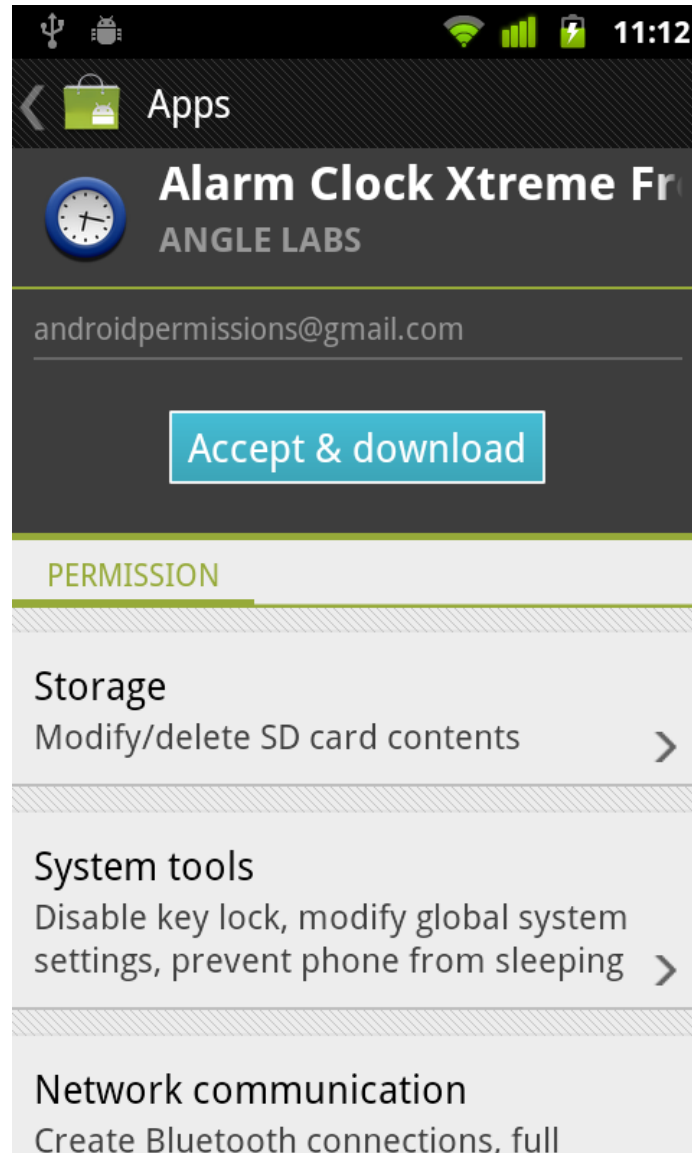
Step 2: Select application



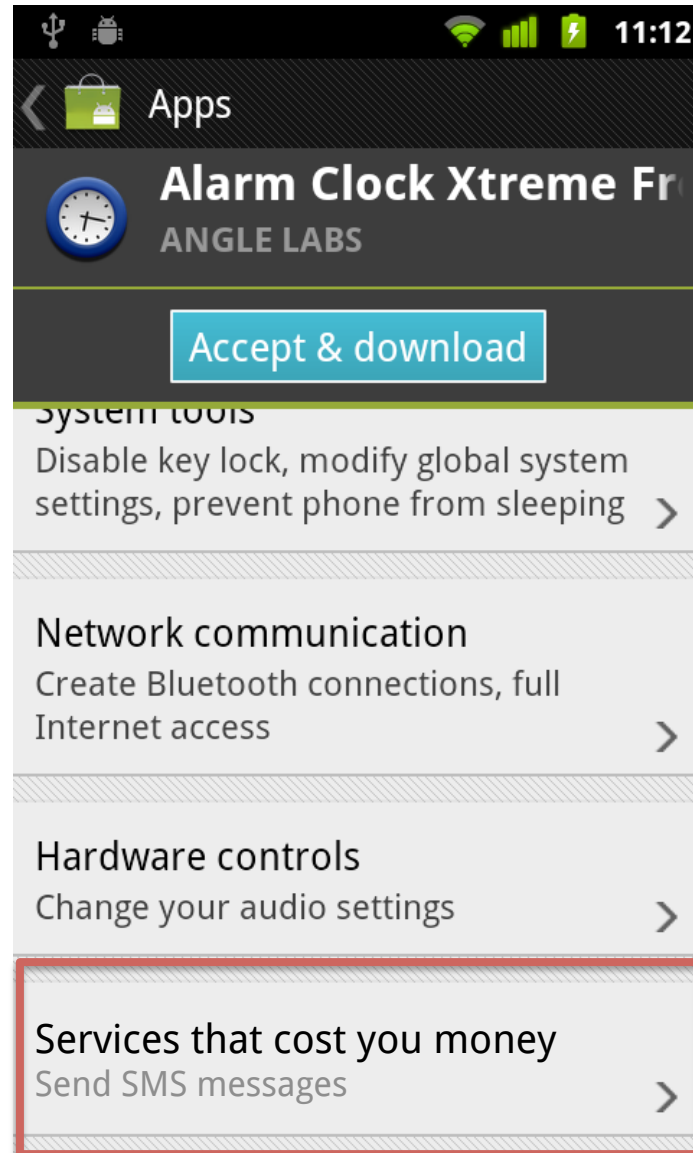
Step 3: View description



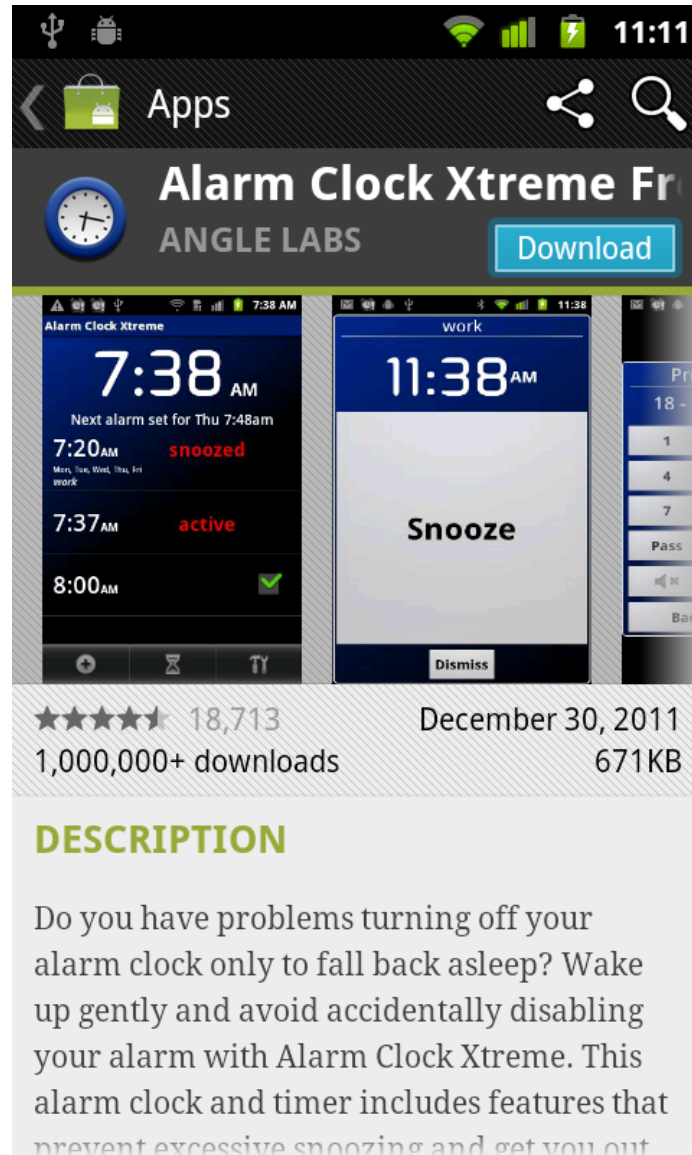
Step 4: View permissions



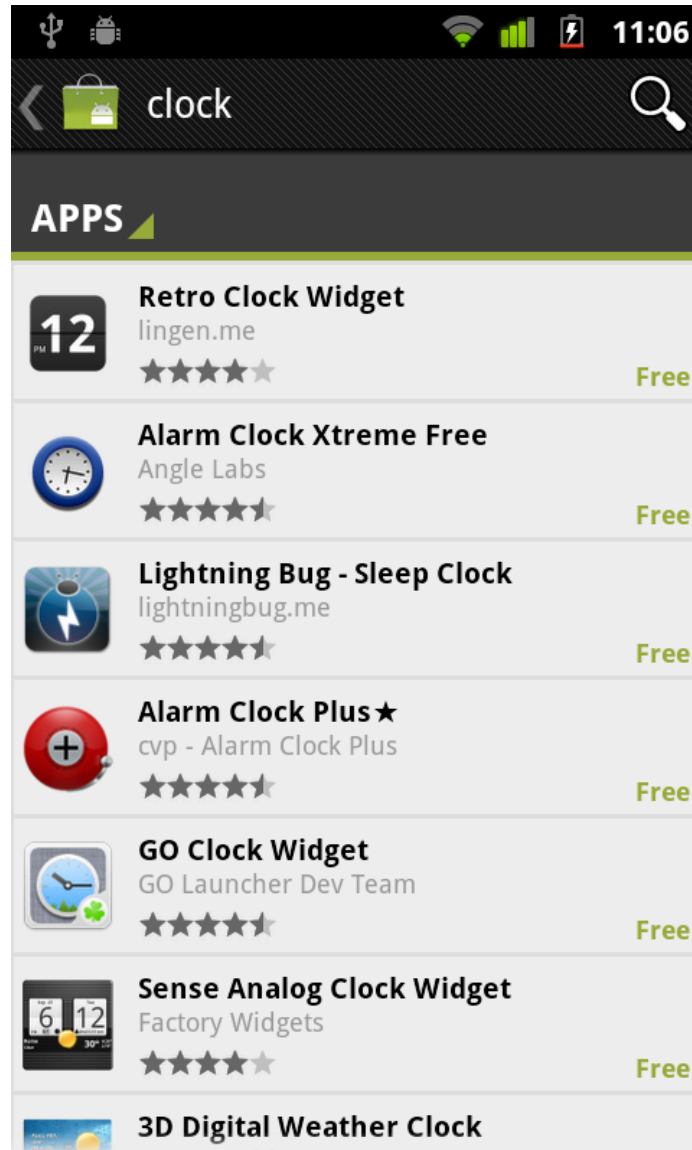
Step 5: View permissions...still



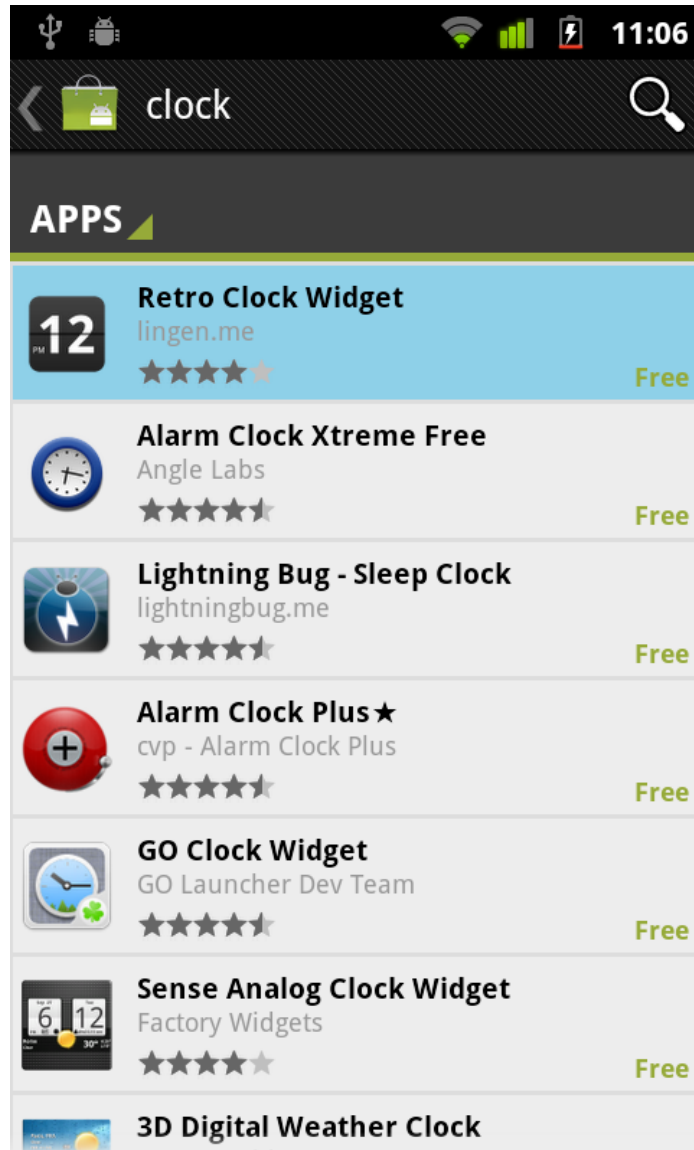
Step 6: Go back



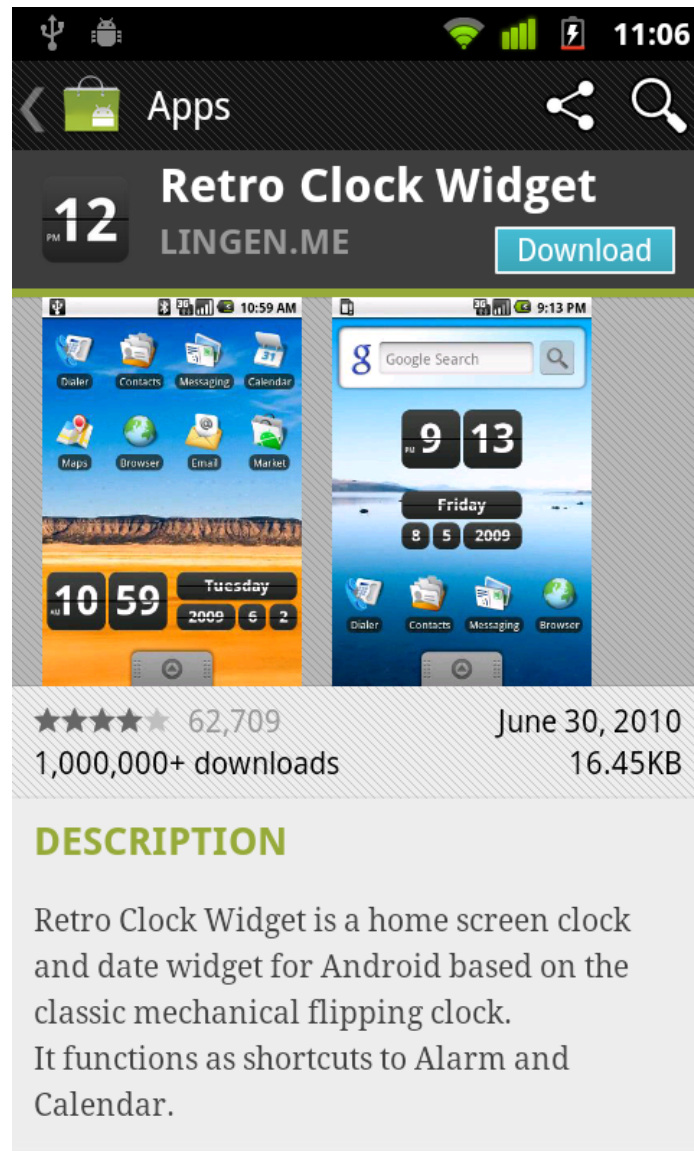
Step 7: Go back



Step 8: Select application



Step 9: View description



11:06

Apps

Retro Clock Widget
LINGEN.ME

Download

10:59 AM
Dialer Contacts Messaging Calendar
Maps Browser Email Market
10:59 Tuesday 2009 6 2

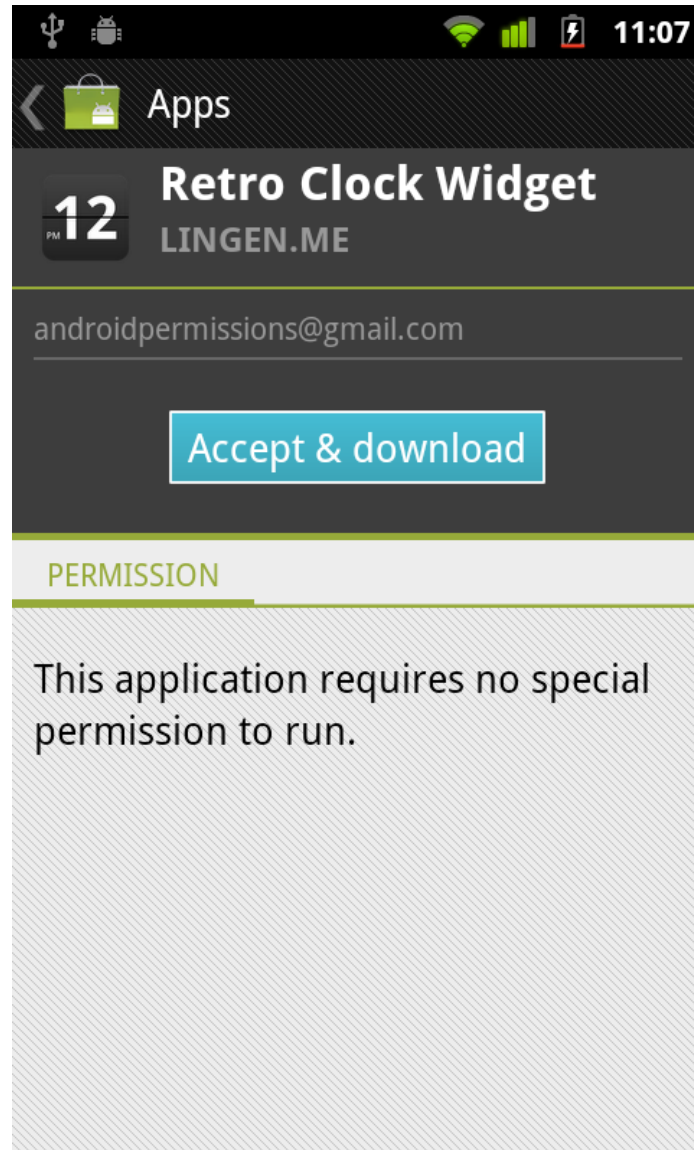
9:13 PM
Google Search
9 13
Friday
8 5 2009
Dialer Contacts Messaging Browser

★★★★☆ 62,709
1,000,000+ downloads
June 30, 2010
16.45KB

DESCRIPTION

Retro Clock Widget is a home screen clock and date widget for Android based on the classic mechanical flipping clock. It functions as shortcuts to Alarm and Calendar.

Step 10: View permissions



Android permissions

Users don't notice permissions

- Online survey:
 - 17.5% claimed to look at permissions
- Laboratory experiment:
 - 17% looked at permissions during installation
 - 42% completely unaware permissions existed

What permissions do users actually care about?

How does choice architecture impact user preference?

What do users actually care about?

Android currently has 124 different permissions

Only location has been extensively studied

Location represents 1% of the permission space

Experiment 1: an upper bound

When choice is made “obvious,” will users indicate a willingness to pay more to disclose less data?

Web-based survey of 483 U.S. residents

Recruited from Mechanical Turk

Asked to select app most willing to purchase

NewsFetch
ONTHEGO

\$0.49

September 19, 2011
Size: 0.98MB

5,000+ downloads

DESCRIPTION

Keep up to date with current events with NewsFetch. NewsFetch allows you to sync your mobile device with your favorite news sites and blogs.

New features allow you to share your favorite stories with friends!

NewsFetch
ONTHEGO

Total US\$0.49

Accept & buy

PERMISSIONS TERMS & CONDITIONS

Network Communication
Full Internet access

Your Location
Fine (GPS) location

Hardware Controls
Record audio

A

Updated
APPRUNNER

\$0.99

September 19, 2011
Size: 0.98MB

5,000+ downloads

DESCRIPTION

Stay updated with Updated!

Updated allows you to follow your favorite news sites and blogs while you're out and about with your mobile device. Save favorites or even share articles with friends

Updated
APPRUNNER

Total US\$0.99

Accept & buy

PERMISSIONS TERMS & CONDITIONS

Network Communication
Full Internet access

Hardware Controls
Record audio

B

Headlines
I-CONNECTED

\$1.49

September 19, 2011
Size: 0.98MB

5,000+ downloads

DESCRIPTION

Read all your favorite blogs and news websites on the go with Headlines, an app that syncs new posts.

New features allow you to share specific posts with friends and bookmark specific items to read later

Headlines
I-CONNECTED

Total US\$1.49

Accept & buy

PERMISSIONS TERMS & CONDITIONS

Network Communication
Full Internet access

Your Location
Fine (GPS) location

C

Reader+
PLAYTRONIK

\$1.99

September 19, 2011
Size: 0.98MB

5,000+ downloads

DESCRIPTION

Reader+ allows you to read your news sites and blogs wherever you are!

Syncing occurs automatically, so when you open the app, all unread items are waiting for you. Share selected items with friends!

Reader+
PLAYTRONIK

Total US\$1.99

Accept & buy

PERMISSIONS TERMS & CONDITIONS

Network Communication
Full Internet access

D

Methodology

Controlled for price and permissions:

\$0.49	\$0.99	\$1.49	\$1.99
Internet Location (GPS) Record Audio	Internet Record Audio	Internet Location (GPS)	Internet

Counter-balanced:

- Names
- Descriptions
- Icons
- Screenshots

Hypotheses

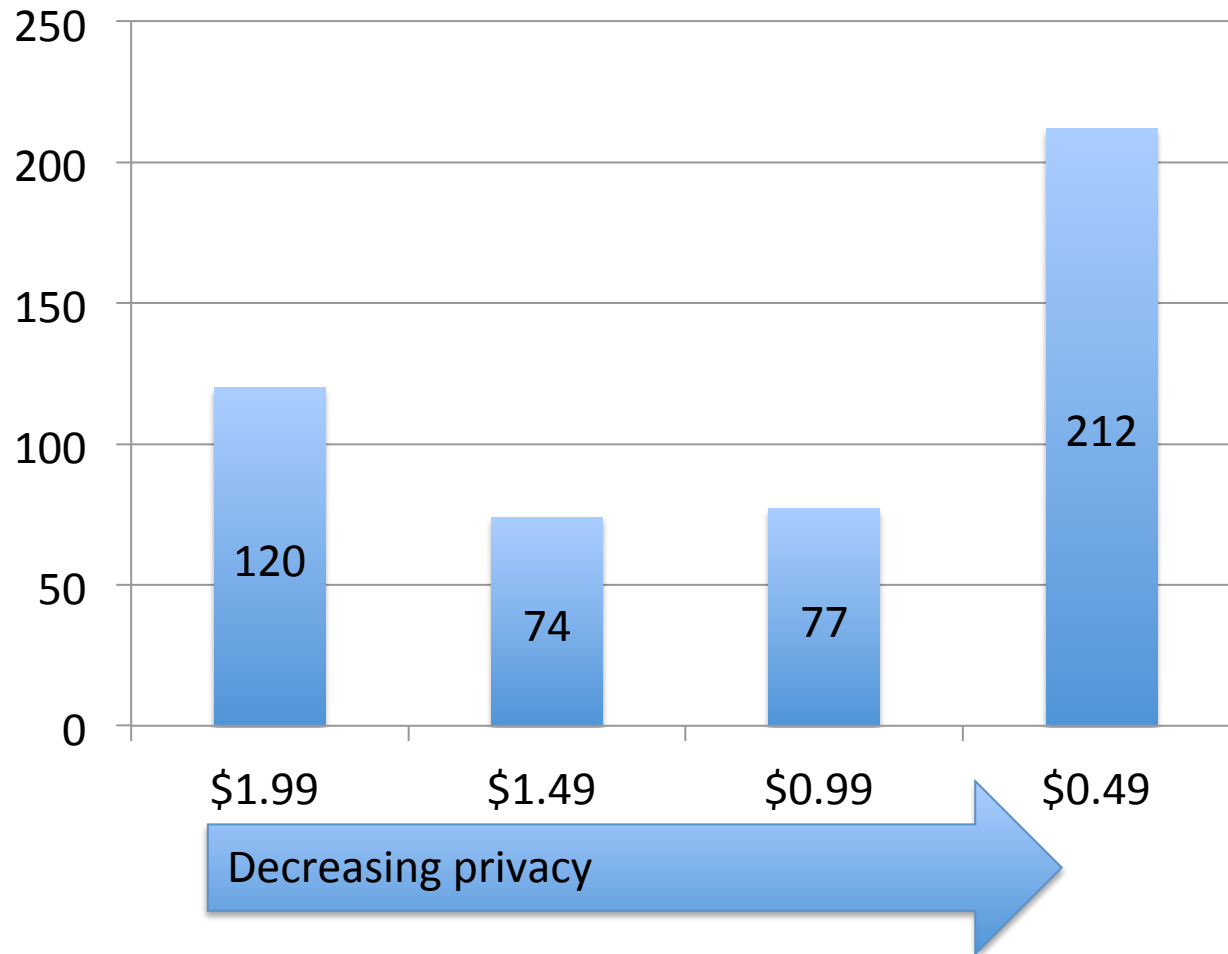
H_0 : Each price/privacy variant will be chosen with equal probability

H_1 : Price-sensitive participants will choose the least-expensive option

H_2 : Privacy-sensitive participants will choose the high-privacy option (i.e., most expensive)

Results

H_0 is rejected: $\chi^2=102.9$, $p<0.0005$



Exit survey

Rate the following influencing factors:

- Number of downloads
- Icon
- Size of app
- **Permissions requested**
- Description
- Name of app
- Rating/Reviews
- Familiarity with app
- **Cost**
- Manufacturer of app

Exit survey

Correlation between stated price sensitivity and price of app selected: $r=-0.39$, $p<0.0005$

Correlation between stated privacy sensitivity and price of app selected: $r=0.33$, $p<0.004$

\$1.99	\$1.49	\$0.99	\$0.49
1. Permissions (46%) 2. Description (23%) 3. Icon (9%)	1. Description (41%) 2. Permissions (18%) 3. Cost (16%)	1. Cost (33%) 2. Description (15%) 3. Icon (14%)	1. Cost (62%) 2. Description (15%) 3. Ratings (6%)
120	74	77	212

Summary

Participants less concerned with price were willing to consider other differences (e.g., privacy)

...but this represents an idealized version of the Market, where side-by-side comparisons occur

Experiment 2: app valuation

When presented with a single app, how do permission requests impact users' valuations?

Posed as an app developer soliciting users for a private beta.

Willingness to pay experiment modeled after Danezis et al.

Methodology

Single app presented with price (\$0.99)

– Permission requests were randomized:

1	2	3	4	5
Internet	Internet Contacts	Internet Location (GPS)	Internet Photos	Internet Contacts Location (GPS) Photos

How much compensation needed to install/use?

– Reverse Vickrey auction

Suggested retail price?



DealPlus
AIRZOOM

\$0.99



★★★★★ 158
5,000+ downloads

September 19, 2011
Size: 45MB

DESCRIPTION

Do you like saving money? Of course you do!

DealPlus helps you find coupons and discounts for all your favorite stores. Simply search for locations or specific businesses, and then present your



DealPlus
AIRZOOM

Total

US\$0.99

Accept & buy

PERMISSIONS

TERMS & CONDITIONS

Internet Access

Address Book Contacts

Your Location (GPS)

Your Photo Library

Results

353 Android-using participants

Bids changed only with respect to contacts:

	β	t	Significance
(Constant)		7.435	$p < 0.001$
Contacts	0.168	3.104	$p < 0.002$
Location	0.011	0.215	$p < 0.830$
Photos	-0.027	-0.494	$p < 0.622$
$F_3 = 3.294, p < 0.021$			

Permissions had no observable effect on suggested prices

– Strong anchoring effect

Concern with permissions

Exit survey asked about factors considered

- Cost was consistently first, regardless of permissions requested
- Permissions were more likely to be considered amongst those viewing request for all four than those only viewing request for Internet access ($U=6227, p<0.015$)
 - However, moved from 4th to 5th

Summary

When architecture supported side-by-side comparisons, 25% stated willingness to pay \$1.50 over \$0.49 base price for fewer permissions.

When valuating a single app, permissions are unlikely to be considered.

Relatively speaking, users unconcerned with location.

Caveats

Application-specific vs. function-specific searches

Stated willingness, rather than observation of completed transactions

Results are upper bounds

Caveats



Zombies vs. Wookies

AIRZOOM

\$0.99



★★★★★ 158

5,000+ downloads


September 19, 2011

Size: 45MB

DESCRIPTION

The zombies are invading the Wookiee homeworld of Kashyyyk!

The festivities surrounding Wookiee Life Day will be ruined without your help! Choose your weapon and head to the streets. Assemble a posse of



Zombies vs. Wookies

AIRZOOM

Total

US\$0.99

Accept & buy

PERMISSIONS

TERMS & CONDITIONS

Internet Access

Address Book Contacts

Your Location (GPS)

Your Photo Library

Moving forward

Architecture should support comparison shopping based on *concerning* permissions

...and not bother users with requests for unconcerning ones

Installation is not the most appropriate time to make most permission requests