BlueMountain
Enabling Automated, Rich, and Versatile Data Management for Android Apps

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Mobile Apps - State of Art

- Use local and cloud storage; rich forms of interaction, backup, sharing etc.
- Large companies use their own cloud; smaller developers use public cloud
- Too many cloud providers, no standard interface
Life as a Developer

- Several design choices
- Consistency models, interface and semantics
- Tangential and repetitive
- Binds an app to a particular cloud

⇒ Developers want to reduce development time and provide more flexibility to users
Life as a User

- Constrained by the developer’s decisions
- Privacy concerns when data is moved to cloud
- Has to contact the developers for any customization

⇒ Users want flexibility and control
BlueMountain: Backup Scenario

Android App

BlueMountain

Dropbox

Secure Private Cloud
BlueMountain: P2P Sharing Scenario
BlueMountain Goals

- **Reduce development effort:** Focus on app logic; treat all storage operations as local
- **Automatically transform apps:** Enable richer forms of data interaction
- **Flexibility:** Customize without access to source code
- **Post-development cycle:** Works with existing apps; no modifications to the Android platform for ease of deployment.
BlueMountain

- A system that automatically integrates cloud storage services with Android apps
- Main components
  - **App Transformer**: Analyses and rewrites app binaries by virtualizing the storage calls and enables richer data interactions
  - **Runtime**: Runs as a regular app; and interacts with the cloud and manages policies
BlueMountain Architecture

- Apk
  - BlueMountain Transformer
    - Decompiler
    - Analyzer
    - Rewriter
  - Smarter Apk (Instrumented)
    - I/O
    - Local Storage (SD Card)
  - Cloud Storage
    - Upload / Download
  - BlueMountain Runtime
    - Cloud API
    - Policy Manager
Challenges: Storage Virtualization

- Can we virtualize storage calls?
- Android options:
  - Files
  - Database
  - Key/Value
Storage Call Virtualization

- Need to **statically identify** all possible storage options and their APIs
- More challenging than search and replace because of polymorphism

```java
public class MyClassOutputStream extends FileOutputStream {
    public int write (Bytes b) {
        //Overriding
    }
}

public class main {
    public static void main (String args[]) {
        Bytes b = 10;
        MyClassOutputStream obj = new MyClassOutputStream();
        myWrite (obj, b);
    }
    public static void myWrite (FileOutputStream obj, Bytes b) {
        obj.write (b);
    }
}
Challenges: Cloud APIs

- Sync API
- Custom API
- Realtime API

Clients

CRUD API

Common Interface

Storage Backend

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Challenges: Interface

- POSIX Filesystem calls
  - read()
  - write()
  - lseek()

- SharedPreferences
  - getInt()
  - putInt()

- Database calls
  - INSERT INTO table VALUES (value1, value2);

Object Store

How to translate?
Challenges: Semantics

- Handling concurrent updates
- Most clouds provide only eventual consistency
- Timing differences between local and cloud
- Time-bound eventually-consistent model?
- Getting additional inputs from the developers?
Related Work

- **Viewbox, Simba** - Fault tolerance and consistency guarantees
- **Cimbiosys** - Selective sharing of files
- **Procrastinator** - Rewriting the binary
- **MetaSync** - Enhances cloud services
- **CloudRail** - Unified API
Conclusion & Future Work

- Initial vision for BlueMountain - *storage virtualization* and *cloud integration*
- Developed a prototype to demonstrate these features
- Future work
  - Full implementation
  - Resolving interface and semantic mismatches
  - Analysing and categorizing the apps of Play Store and corporate apps which store data on their private cloud
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