Intro/Deobfuscation

- What's a Mobile Ambulatory Assessment System?
- Mobile Experiments with computers, phones, sensors
- Records constantly

Intro

- We worked on one system used for alcohol craving and drinking prediction
- Collected survey, GPS data

Problem

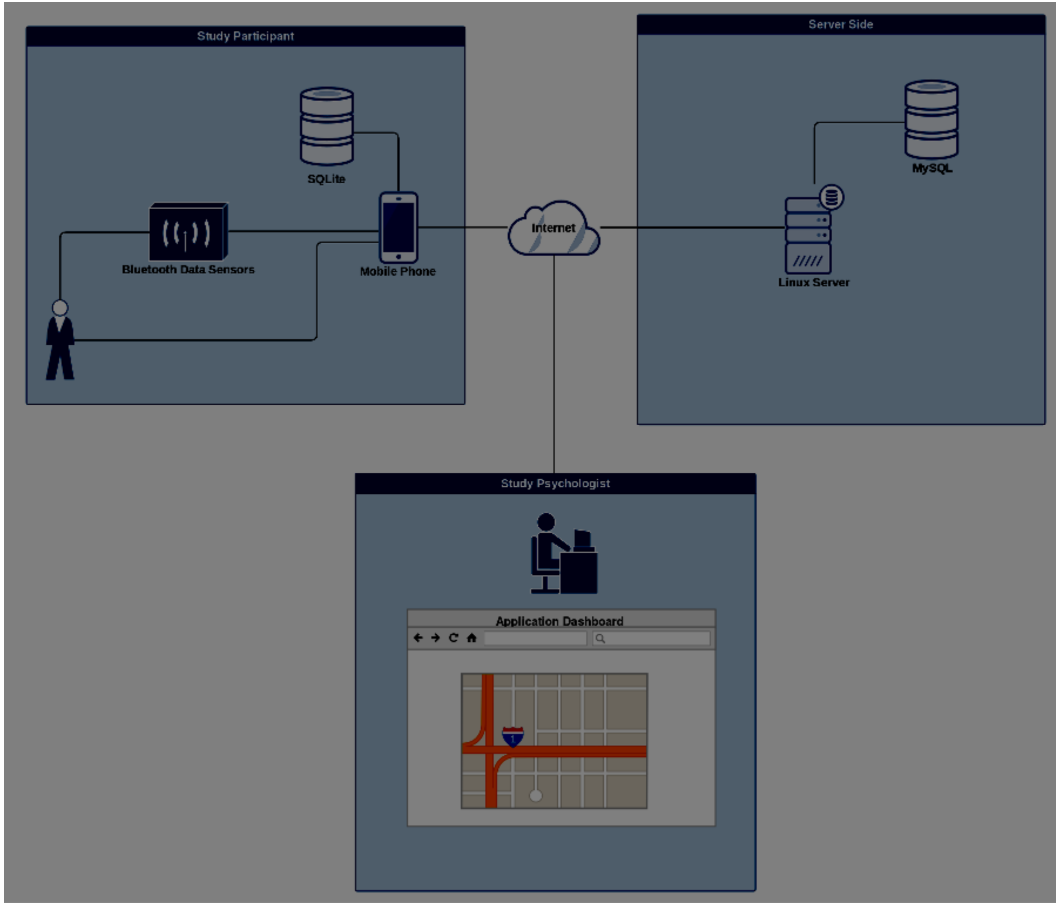
- The app wasn't yet robust
  - Failed to send data if network was disrupted
- Energy consumption could have been better
  - Reported to last 10 hours. Not bad, but what if it could be better?

Motivation

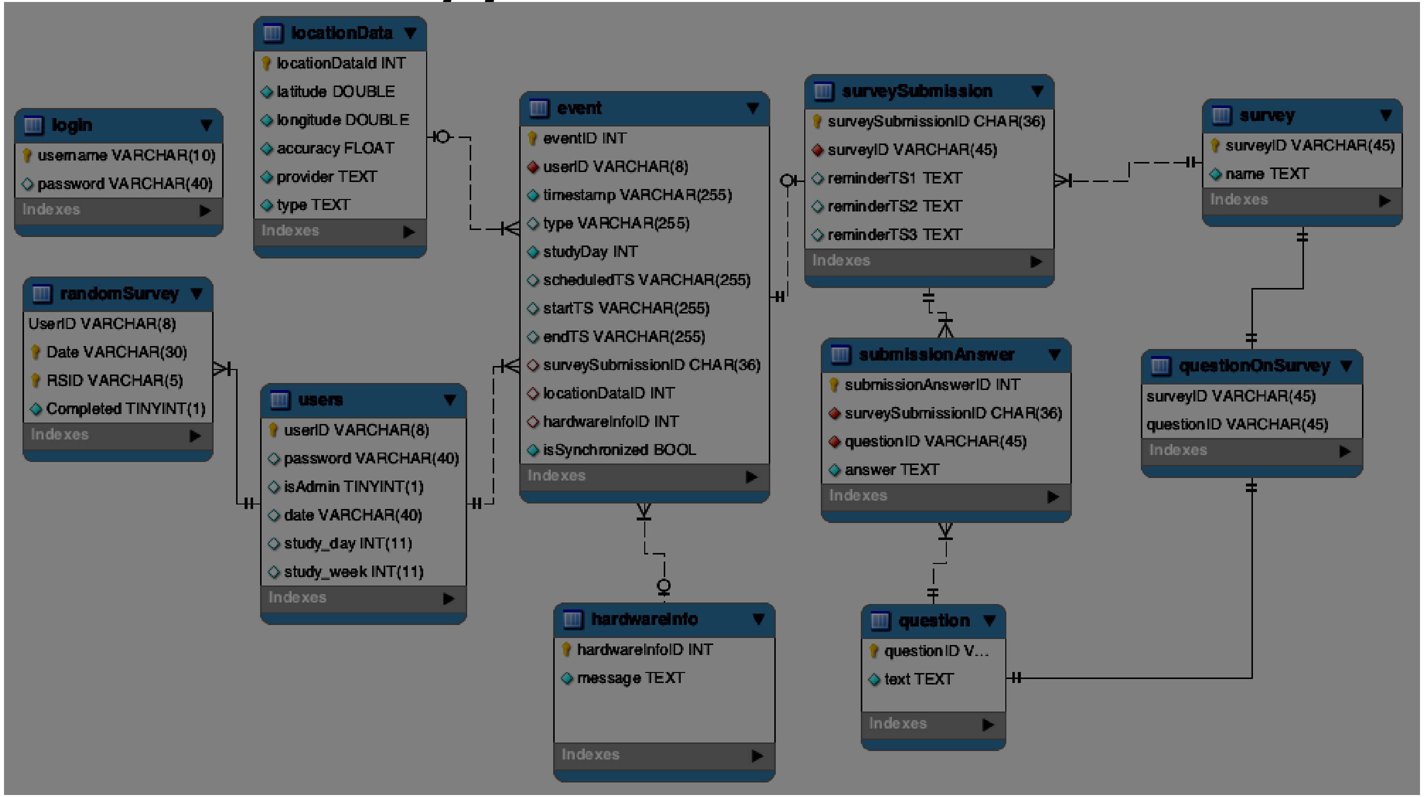
- mAAS type systems are becoming popular for research
- Energy consumption is a problem for mAAS type systems in general

Solution

- Bundling: collect data over time
- Submit bundles of data periodically


Study Participant
SQLite
Bluetooth Data Sensors
Mobile Phone
Internet
Server Side
MySQL
Linux Server
Study Psychologist
Application Dashboard

Designed a Database



login
- username VARCHAR(10)
- password VARCHAR(40)
- Indexes

locationData
- locationDataId INT
- latitude DOUBLE
- longitude DOUBLE
- accuracy FLOAT
- provider TEXT
- type TEXT
- Indexes

randomSurvey
- UserID VARCHAR(8)
- Date VARCHAR(30)
- RSID VARCHAR(5)
- Completed TINYINT(1)
- Indexes

users
- userID VARCHAR(8)
- password VARCHAR(40)
- isAdmin TINYINT(1)
- date VARCHAR(40)
- study_day INT(11)
- study_week INT(11)
- Indexes

event
- eventID INT
- userID VARCHAR(8)
- timestamp VARCHAR(255)
- type VARCHAR(255)
- studyDay INT
- scheduledTS VARCHAR(255)
- startTS VARCHAR(255)
- endTS VARCHAR(255)
- surveySubmissionID CHAR(36)
- locationDataID INT
- hardwareInfoID INT
- isSynchronized BOOL
- Indexes

hardwareInfo
- hardwareInfoID INT
- message TEXT
- Indexes

surveySubmission
- surveySubmissionID CHAR(36)
- surveyID VARCHAR(45)
- reminderTS1 TEXT
- reminderTS2 TEXT
- reminderTS3 TEXT
- Indexes

submissionAnswer
- submissionAnswerID INT
- surveySubmissionID CHAR(36)
- questionID VARCHAR(45)
- answer TEXT
- Indexes

question
- questionID V...
- text TEXT
- Indexes

survey
- surveyID VARCHAR(45)
- name TEXT
- Indexes

questionOnSurvey
- surveyID VARCHAR(45)
- questionID VARCHAR(45)
- Indexes

Database

- Designed for this mAAS and for similar mAAS's
  - hardware info
  - location data
  - survey questions
  - survey types
  - timestamps

Data Collection

- Application collects info from hardware, like GPS location
- Survey data gets collected
- All converted to JSON
- Inserted into database

Data Communication

- Three conditions are met:
  - *x* seconds have transpired
  - New data to be synced
  - Connection is available
- Then, sync
  - Send JSON to server

Upload to Server

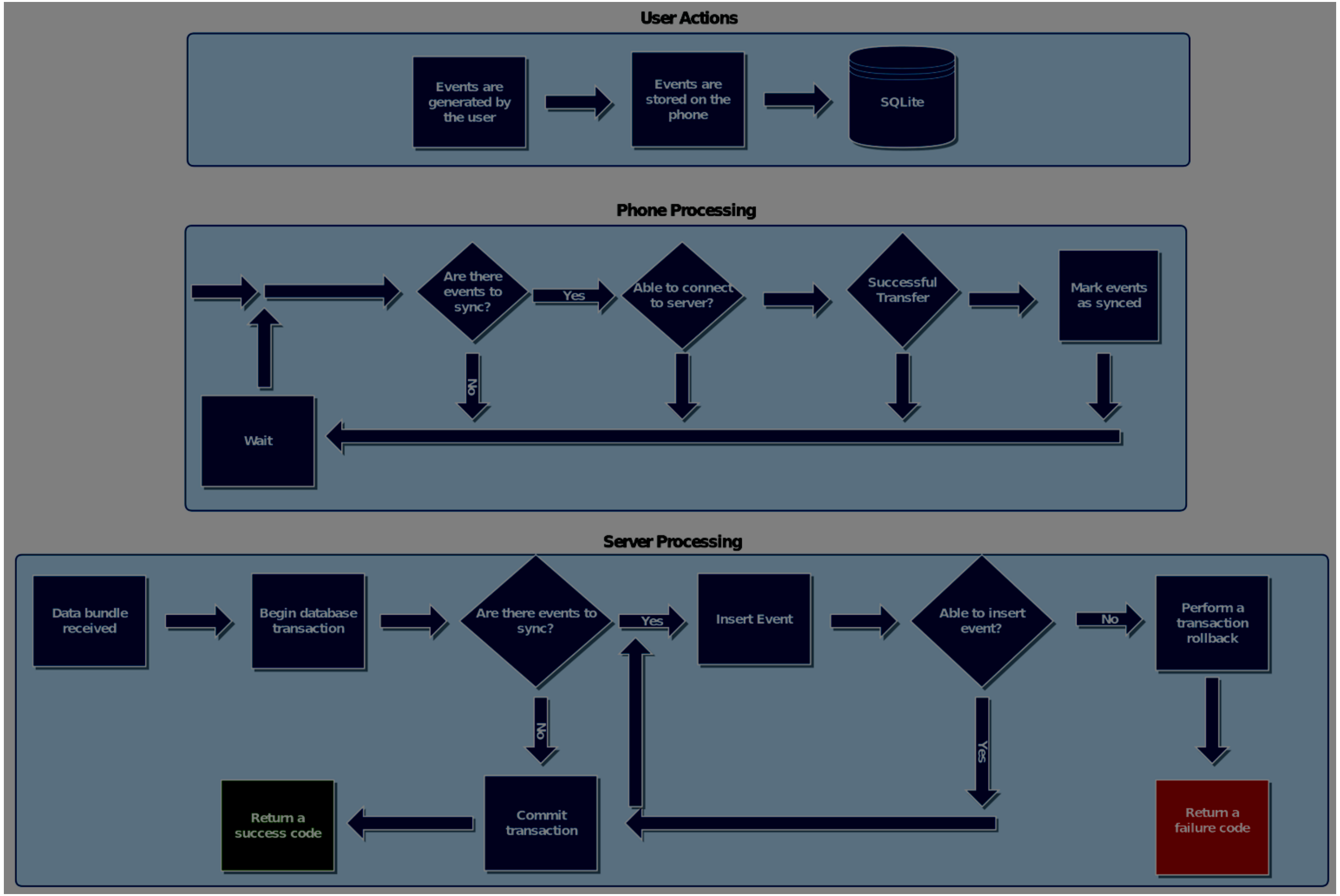
- Three conditions are met:
  - *x* seconds have transpired
  - New data to be uploaded
  - Connection is available
- Then, upload data
  - Send JSON to server

Phone-Server Communication

- Begin Transaction
- If anything goes wrong, rollback any changes
- If things go right, deposit received info
- Return status code appropriately in header

Phone-Server Communication

- If good status is code received, mark events
- If bad status code received, don't mark those events as processed
  - Hopefully server will be working later



User Actions

Events are generated by the user

Events are stored on the phone

SQLite

Phone Processing

Are there events to sync?

Yes

No

Able to connect to server?

Successful Transfer

Mark events as synced

Wait

Server Processing

Data bundle received

Begin database transaction

Are there events to sync?

Yes

No

Insert Event

Able to insert event?

No

Yes

Perform a transaction rollback

Commit transaction

Return a success code

Return a failure code

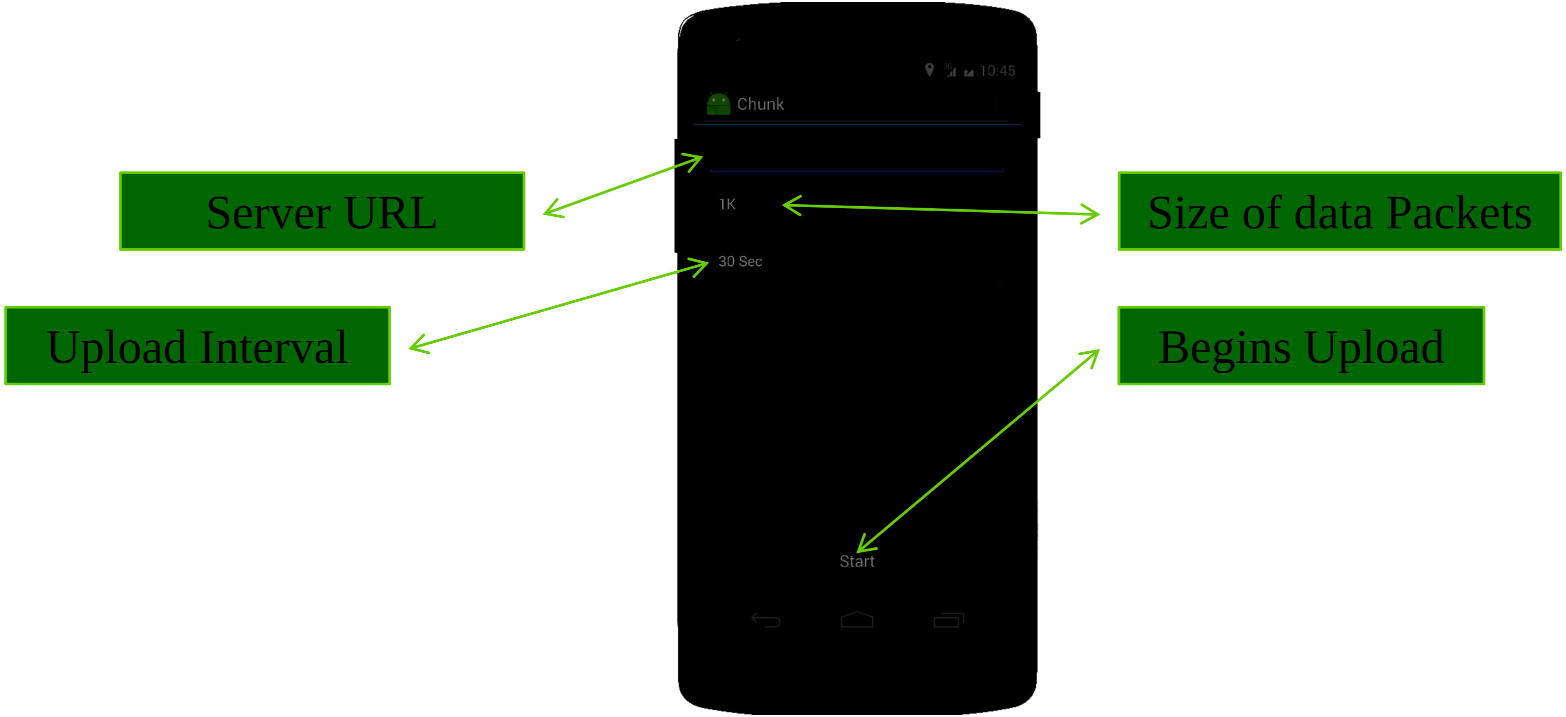
Energy Consumption Analysis

- Wanted to try different realtime approaches w/ bundling
- Look at tradeoffs between realtimeness and energy consumption
- Created Chunk

Chunk

- Simulates bundling
- Sends garbage data of specified sizes at specified interval

Chunk



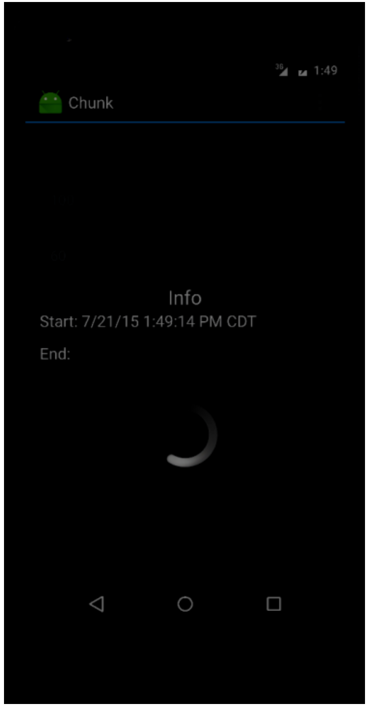
Server URL

Size of data Packets

Upload Interval

Begins Upload

Chunk



Chunk

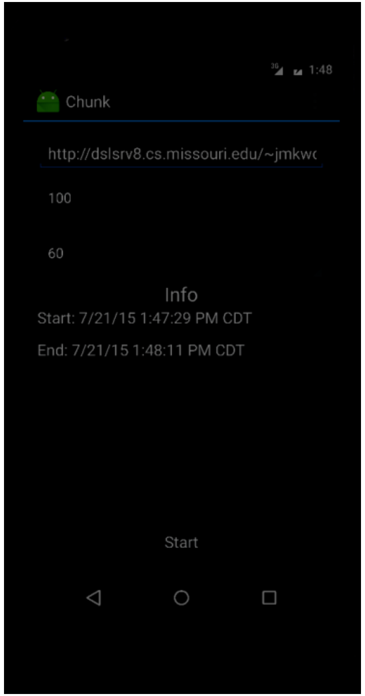
100

60

Info

Start: 7/21/15 1:49:14 PM CDT

End:



Chunk

http://dslsrv8.cs.missouri.edu/~jmkwc

100

60

Info

Start: 7/21/15 1:47:29 PM CDT

End: 7/21/15 1:48:11 PM CDT

Chunk Experiment

- Trials lasted 1 hour each
- Nexus 5 Phones in same place
- Began at 90%, played a sound when done
- Measured efficiency by

  [(Start % - End %) * 2300 mAh] / Total KB Sent

Interpretation of Results

- Bundling is better per hour

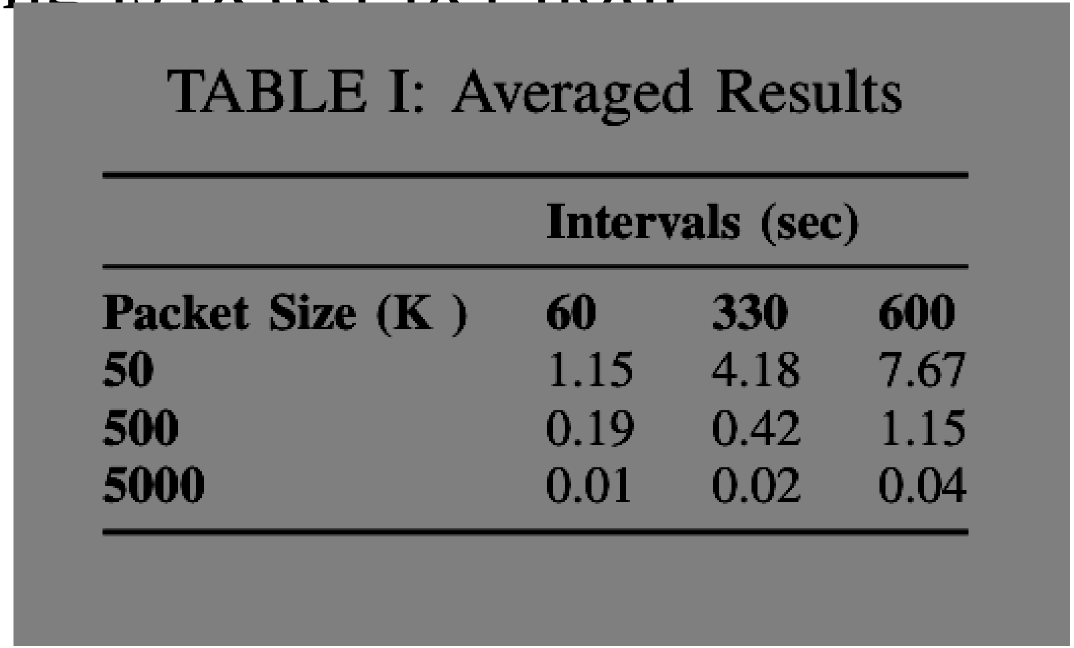


TABLE I: Averaged Results

	Intervals (sec)		
Packet Size (K)	**60**	**330**	**600**
50	1.15	4.18	7.67
500	0.19	0.42	1.15
5000	0.01	0.02	0.04

Conclusion

- Our results were consistent with the literature
- Continuous uploading can be problematic
- Recommend data size reduction if possible,
- Or bundling