AfriNREN

Visualising traffic and network structure of African NRENs

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What is an NREN?

- **N**ational **R**esearch and **E**ducation **N**etwork
  - interconnect institutional networks

- Aims of NRENs:
  - provide connectivity
  - reduce latencies
  - promote bandwidth sharing
  - improve traffic engineering

What are we doing?

- Collection of accurate network data
- Visualisations for analysis and use
- Web application

Why is this important?

- Internet collaboration
  - Transferring radio astronomy data
  - Knowledge sharing through videoconferencing and content sharing

https://www.skatelescope.org/multimedia/image/ska-mid-africa-close-up/

What is the Problem?

- 75% of traffic travel circuitous inter-continental routes
  - high latencies
- NRENs exchange large amounts of data across borders
- Little research done on quantifying amount or nature of traffic exchanged within and between NRENs

Proposed Solution

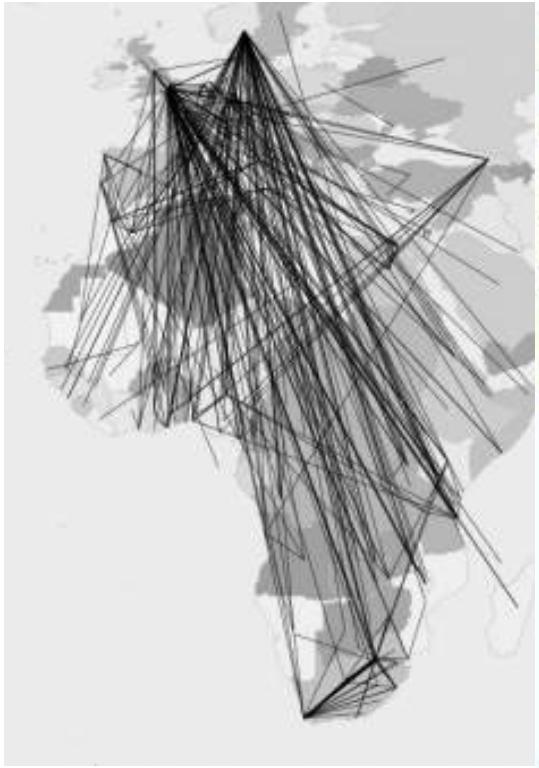
A *network visualisation tool* for our stakeholders that generates and *displays collected network traffic data* and topology information through a web application.

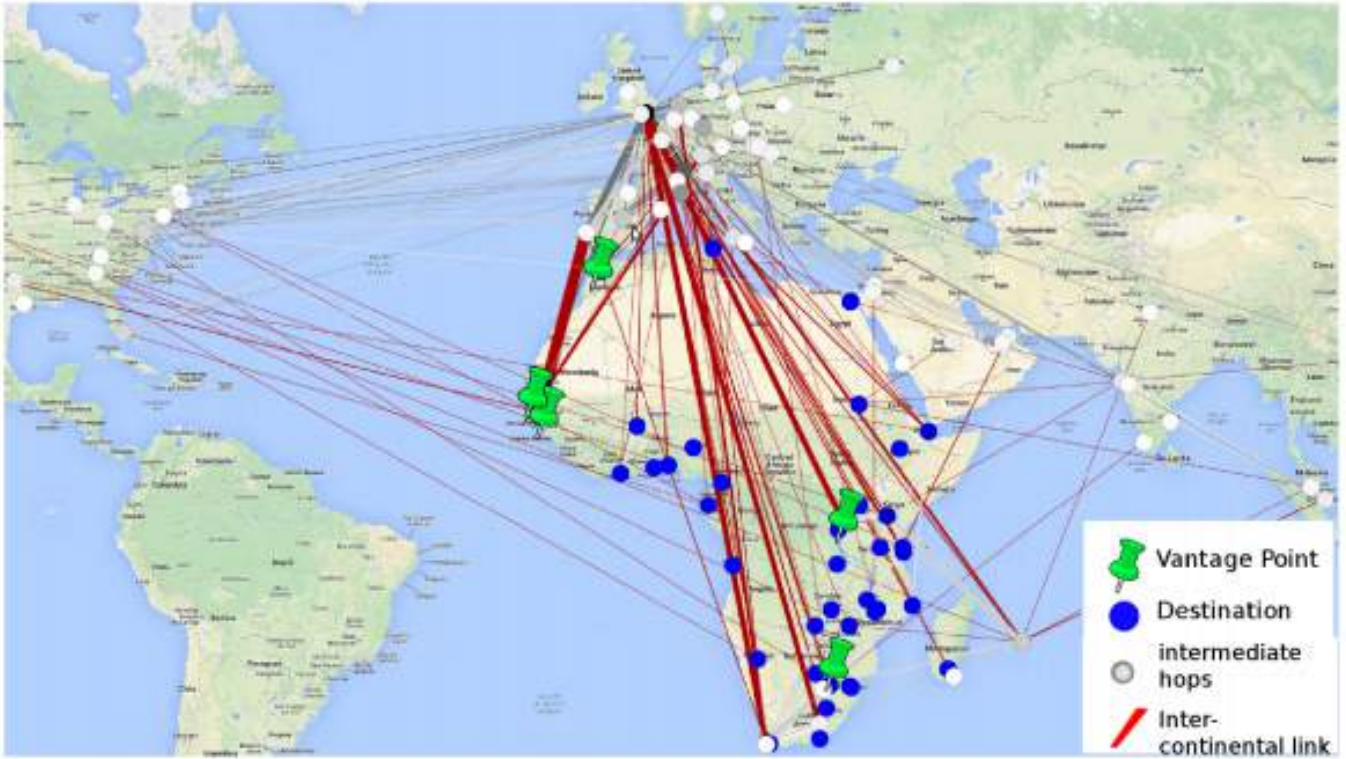
Separation of project

1. Data collection, evaluation and formatting

2. Visualisation of this data:
    - Geospatial Visualisation
    - Non-geospatial Visualisations

Related Work





Gilmour et al. 2007

Chavula et al. 2014

NetFlow Data

- Network traffic logs

Use

- to see where data is exchanged
- to calculate bandwidth
- as input to choose vantage points

Research Question

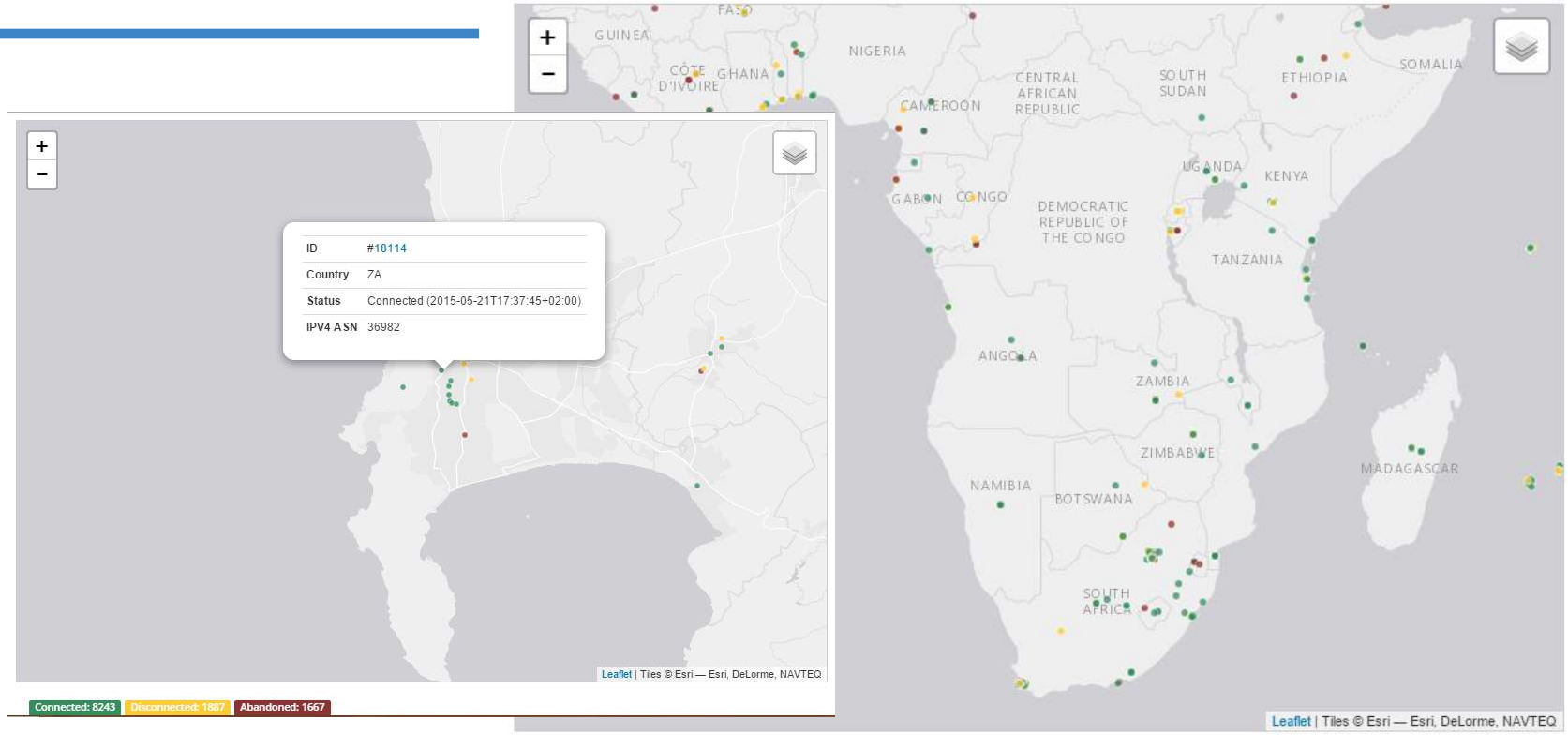
Can one *reliably* and *efficiently collect traceroute data* for this purpose

- increasing the accuracy of these measurements
- and reducing the number of measurements to perform?

RIPE NCC RIPE NETWORK COORDINATION CENTRE

https://atlas.ripe.net/about/

Vantage Points



https://atlas.ripe.net/results/maps/network-coverage/

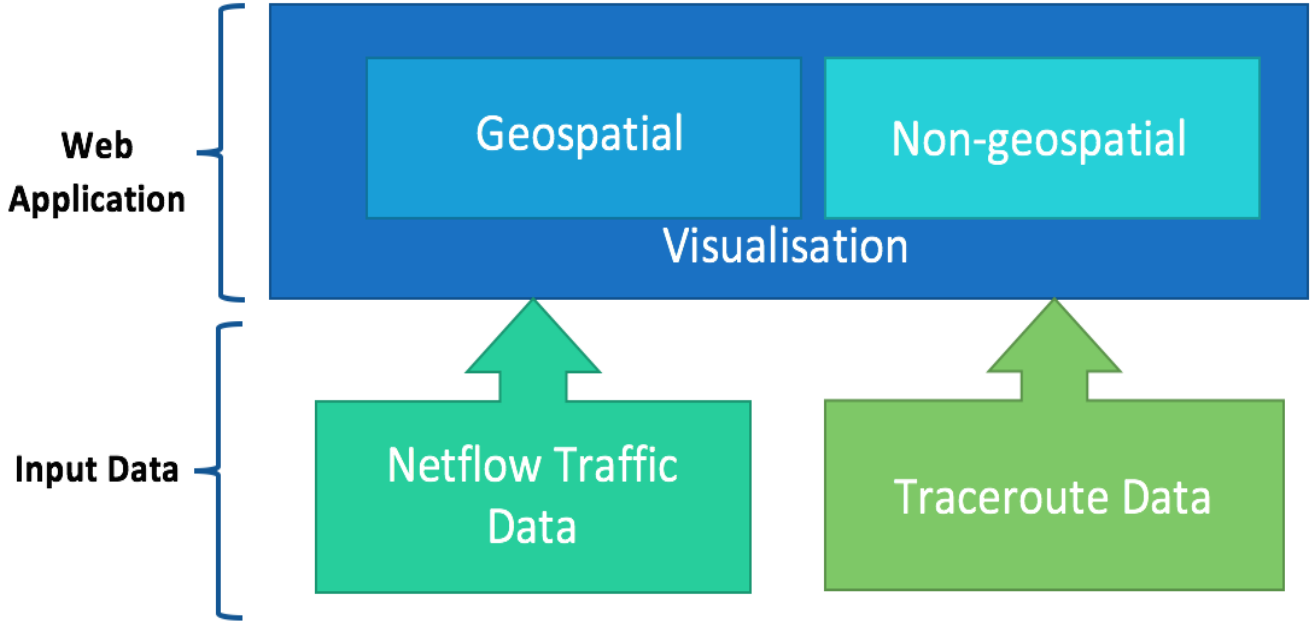
Measurements

- ICMP/UDP/TCP
  - Different protocols show different topologies
- Normal vs Paris traceroute
  - to compare different results

Challenges

- Graph analysis to choose which traceroutes to run to increase efficiency of collection
- Measure accuracy of traceroutes
  - compare with other tools and published results
  - get users to check for false or missing links
- Aggregate data to make most useful for visualisations

Visualisation



Visual Queries

Visual Query:

An information need that is addressed by a visualisation.

Some initial visual queries:

- Which institutions exchange large quantities of data for research purposes?
- What route does traffic take between A and B?
- Does traffic between A and B travel along circuitous intercontinental routes?

Dimensions of Data to Display

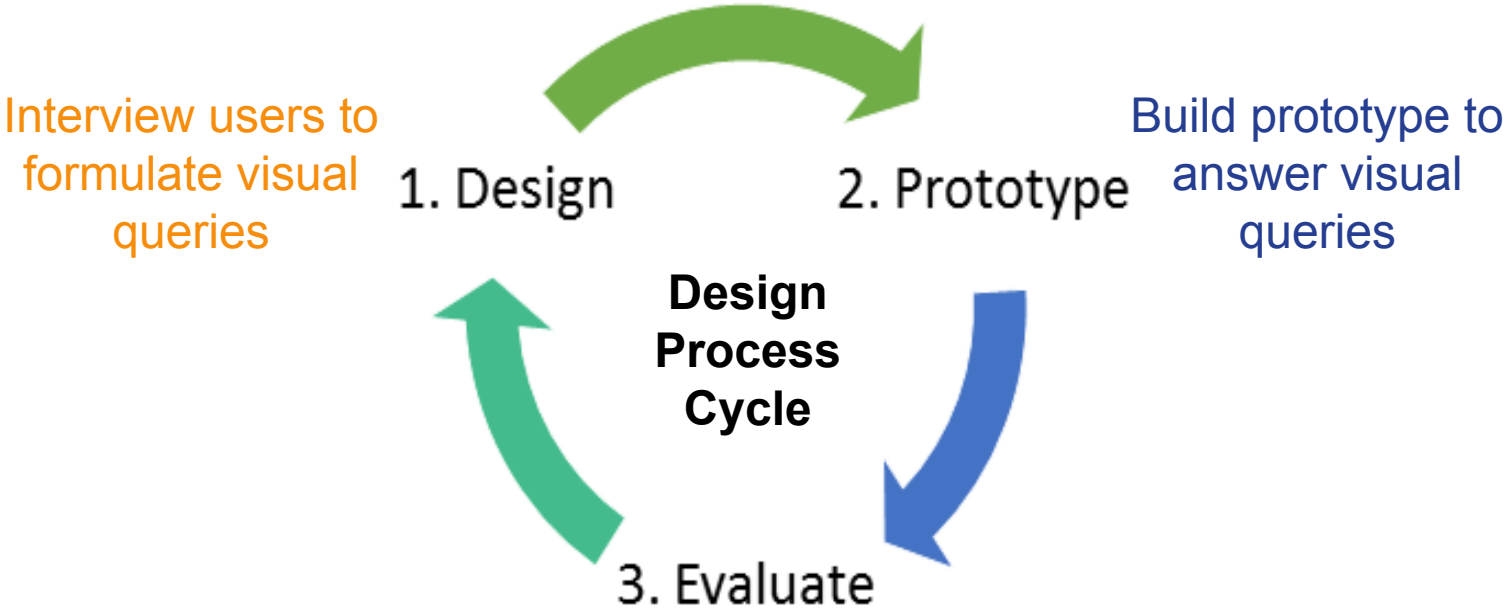
- Network Structure
- Latencies of traffic
- Traffic flow from one institution to another
- Bandwidth utilisation of links between NRENs

Visualisation Implementation

Frameworks for implementation:

- D3.js
- Processing language and Processing.js
- AmCharts.js

Methodology: User-Centred Design



User Testing

Preliminary user testing will be done with the help of CS students with knowledge of Networks.

Users:

- UCT Network Admins
- NREN CTOs
- UbuntuNet Alliance Policy Makers

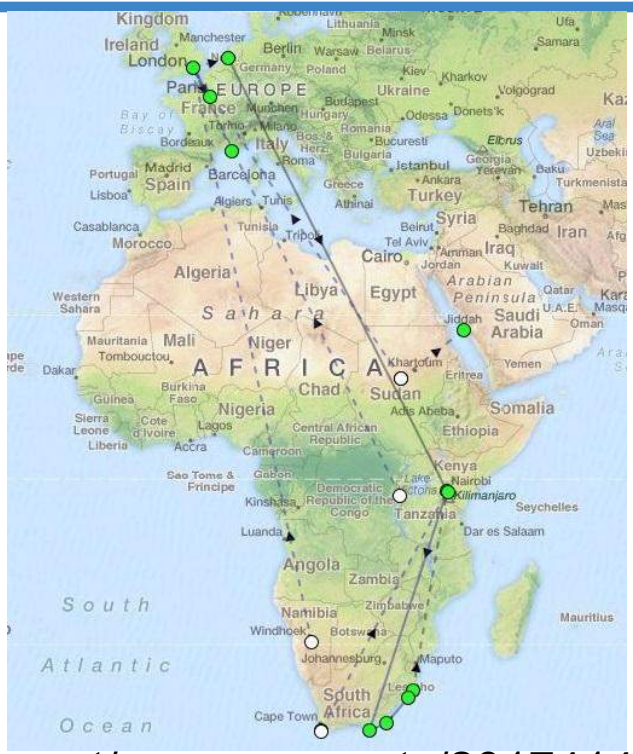
Geospatial Visualisation

Research Question:

Can a *geospatial visualisation* effectively and accurately communicate the network topology and network traffic information of African NRENs,

allowing users:

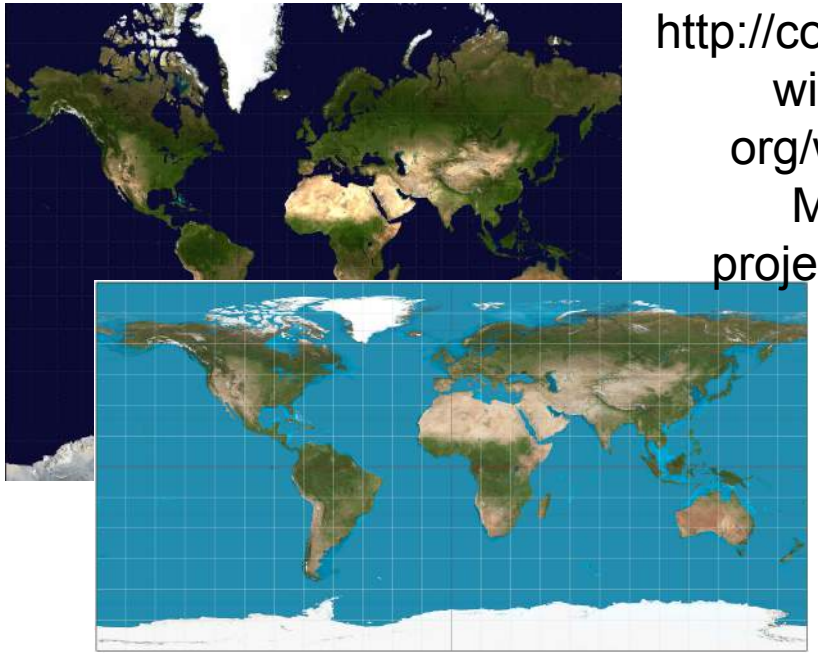
- to identify these networks
- where they connect
- what routes this traffic traverses?



https://atlas.ripe.net/measurements/2017414/#!openipmap

Challenges

- Map Projections:
  - Mercator Projection
  - Equirectangular Projection



http://commons.wikimedia.org/wiki/File:Mercator-projection.jpg

- Clustering/Occlusion:

  Large amounts of data in a single area obscures information

http://goo.gl/iMOT2o

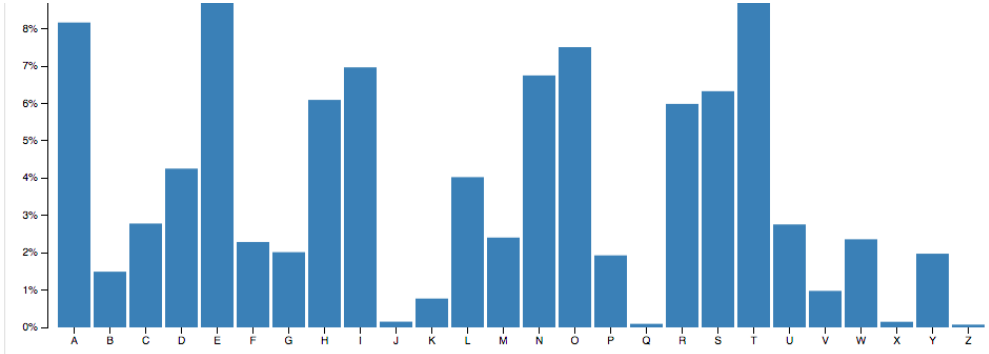
Interactivity Techniques

Category	Show me...
Select	… what I've marked
Explore	… something different
Reconfigure	… a different arrangement
Encode	… a different representation
Abstract/Elaborate	… more or less detail
Filter	… something conditionally
Connect	… the related things

Evaluating Effectiveness of Visualisations

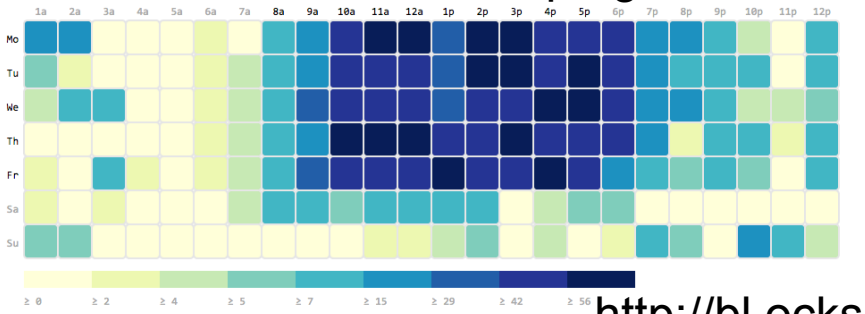
- Visual Queries
- Heuristics
  - Task Performance Metrics (eg. Time, Task Success)
- Simple User and Group Statistics

Interactive Non-geospatial Visualisations



http://bl.ocks.org/mbostock/3885304

http://guides.library.duke.edu/vis_types



http://bl.ocks.org/tjdecke/5558084

Research Question

Can a dashboard of *interactive non-geospatial visualisations* of network topology and NetFlow data effectively communicate latencies and network traffic information about a network to the network managers?

Challenges

- Display high-dimensional data
- Use of space to communicate data
- Design effective contextual view
- Design the interactivity features

Web Application Implementation

- Python
- Flask web development framework
- SQLAlchemy ORM tool-set
- PostgreSQL

SQLAlchemy

PostgreSQL

Expected Outcomes

Key Features of Web-application

- Two Visualisation types: Geospatial and non-geospatial
- Topology and traffic data visualised
- Interactivity: Selection, Explore, Reconfigure, Encode, Abstract/Elaborate (Zoom), Filter, Connect

Expected Outcomes

Key Success Factors

- User can successfully answer their specified visual queries
- Links constructed from traceroute measurements are verified by expert users

Ethical and Legal Issues

- Consent from users during user testing
- Terms of Use of Netflow data from participating institutions
- Professional confidentiality when handling data

Thank you

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References

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Risks

Risk	**Probability**	**Impact**	**Mitigation**
Loss of Team Member	Low to Medium	High	Adequate separation of project
Scope Creep	Medium	High	Set a realistic scope that is agreed upon by all stakeholders of the project.
Load shedding	High	Medium to High	Save work regularly, charge laptops.
Loss or Corruption of Data	Low to Medium	High	Backup data regularly across multiple devices.

Project Timeline & Deliverables

Deliverable	Due Date
Initial Feasibility Demonstration	20-24 July 2015
Final Complete Draft of report	16 October 2015
Project Report Final Submission	26 October 2015
Poster	2 November 2015
Website	9 November 2015
Reflection Paper	13 November 2015