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# AfriNREN

Visualising traffic and network structure  
of African NRENs

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# What is an NREN?

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- **National Research and Education Network**
  - interconnect institutional networks
- Aims of NRENs:
  - provide connectivity
  - reduce latencies
  - promote bandwidth sharing
  - improve traffic engineering

# What are we doing?

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

# Why is this important?

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- 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?

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- 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

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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

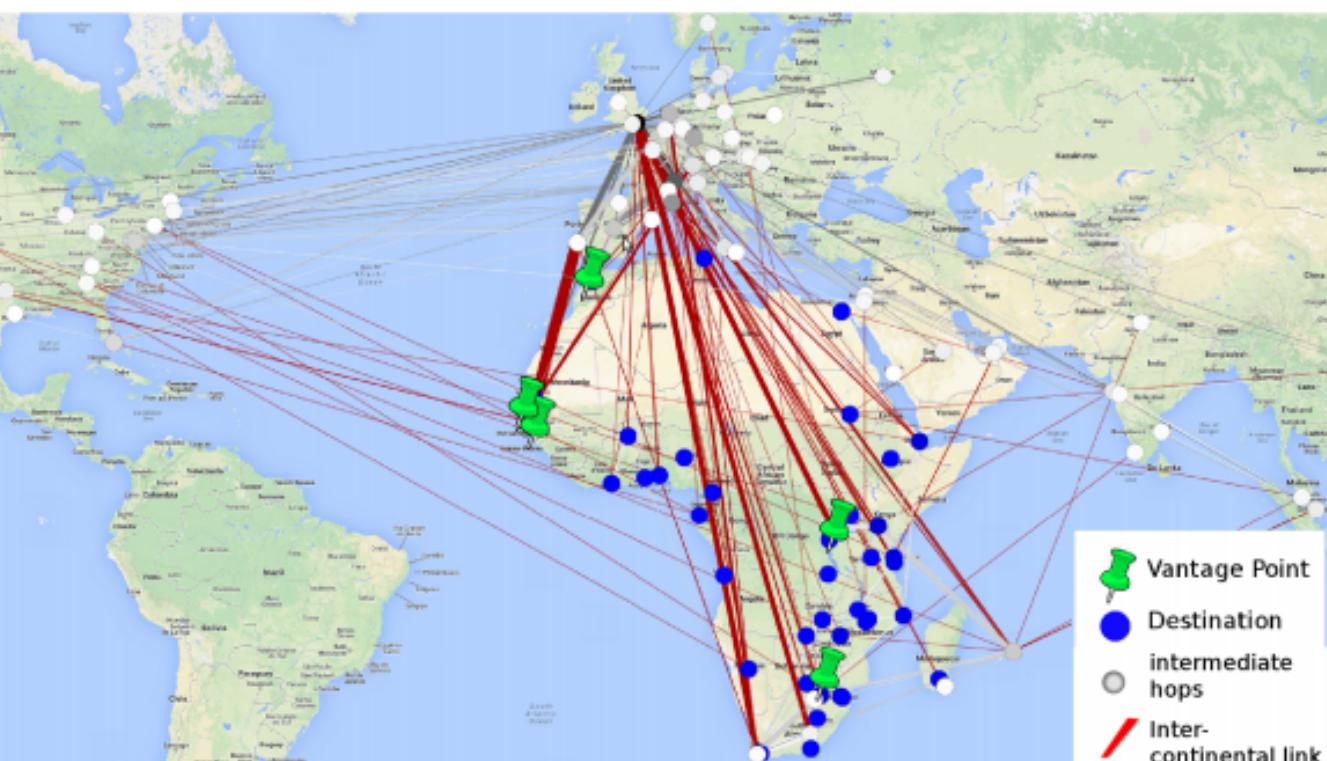
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1. Data collection, evaluation and formatting
2. Visualisation of this data:
  - Geospatial Visualisation
  - Non-geospatial Visualisations

# Related Work



Gilmour et al. 2007



Chavula et al. 2014

# NetFlow Data

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- Network traffic logs

## Use

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

# Research Question

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

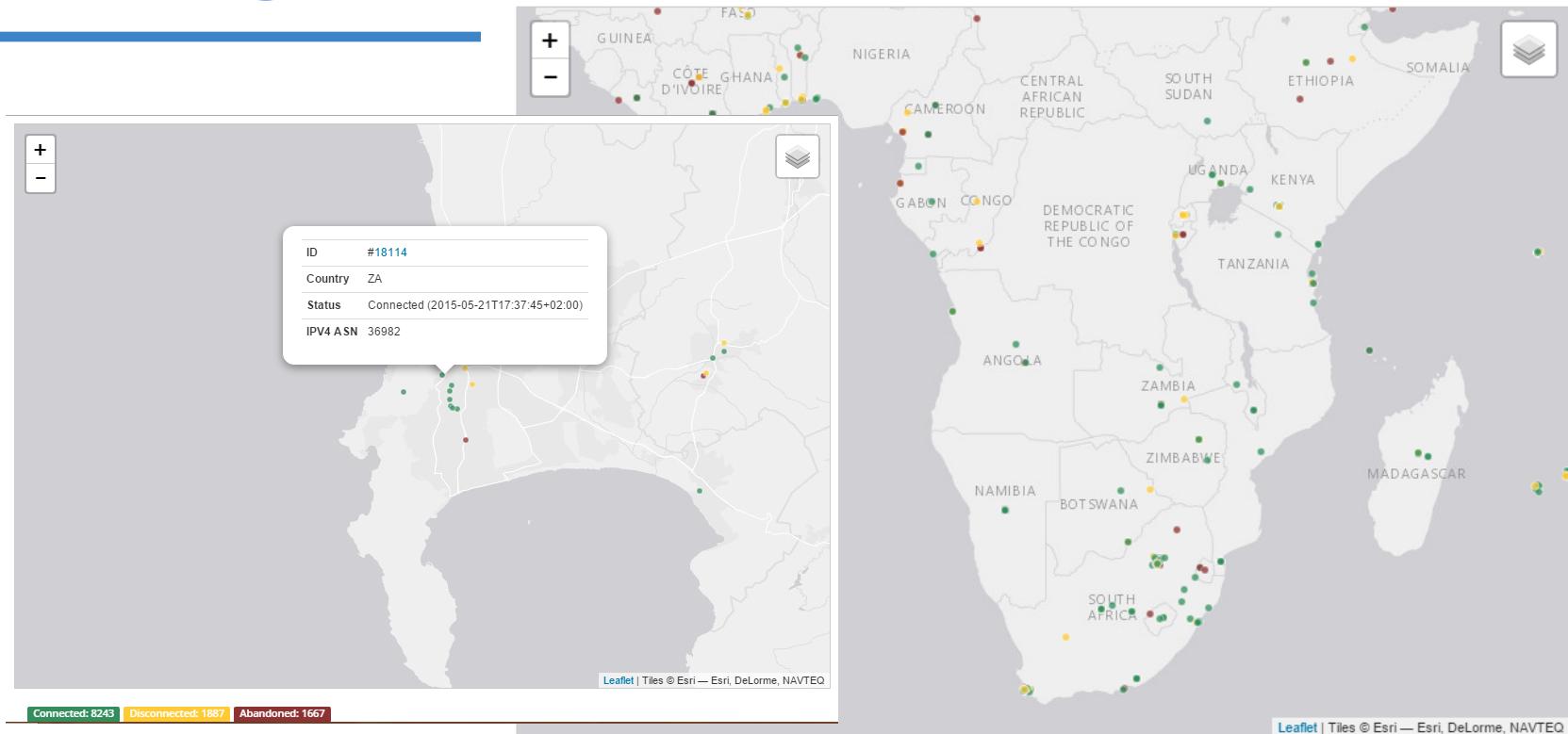
- increasing the accuracy of these measurements
- and reducing the number of measurements to perform?



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



# Vantage Points



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

# Measurements

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

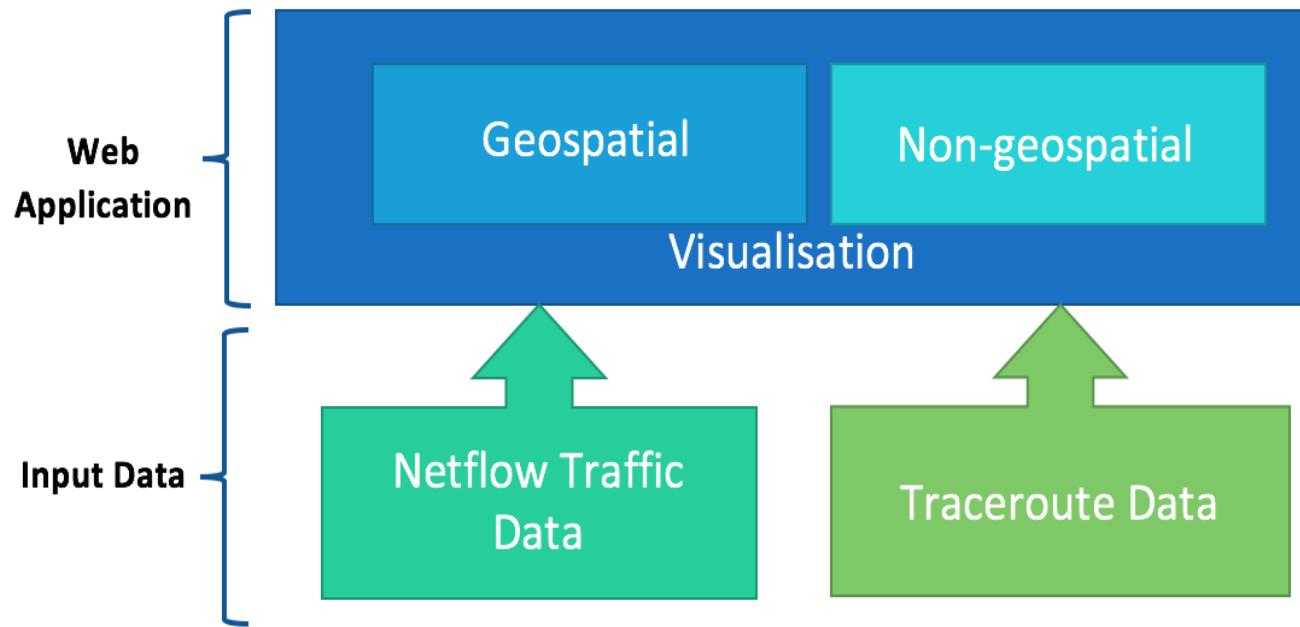
# Challenges

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- 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

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# Visual Queries

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## 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

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

# Visualisation Implementation

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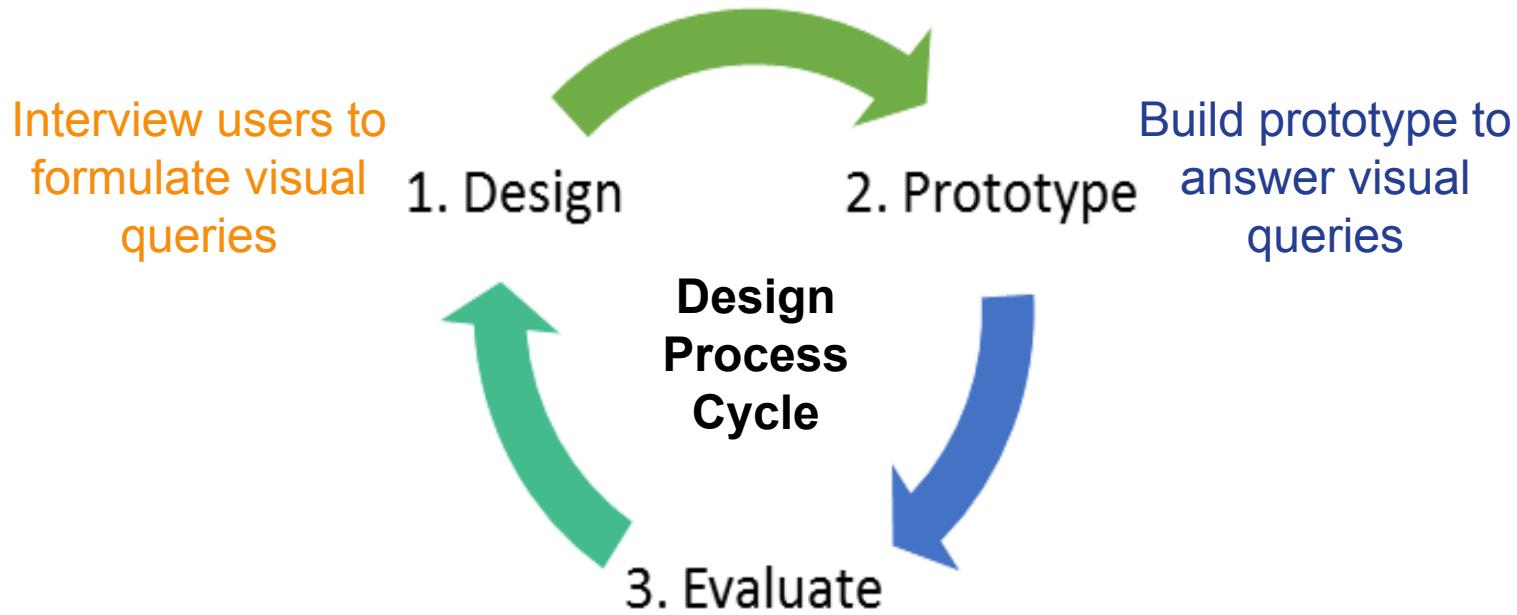
Frameworks for implementation:

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



# Methodology: User-Centred Design

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Conduct user testing to see how effectively  
prototype answers visual queries

# User Testing

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

## Users:

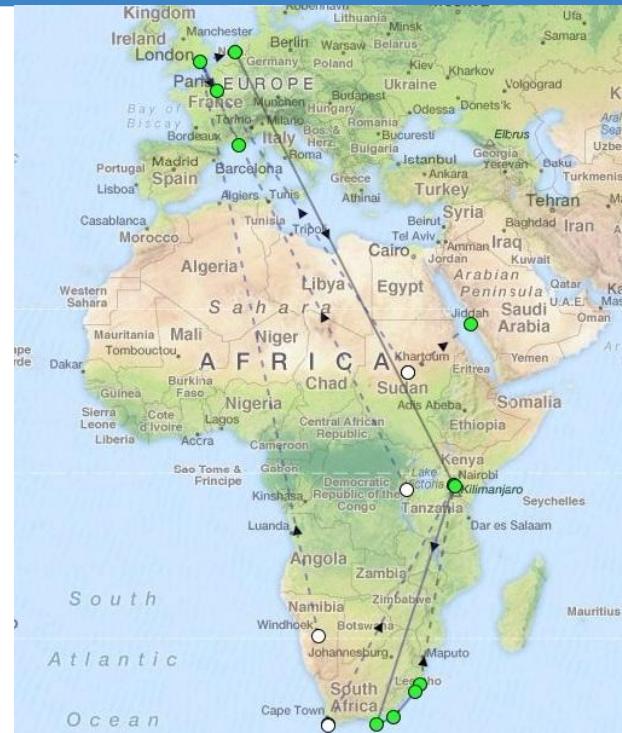
- UCT Network Admins
- NREN CTOs
- UbuntuNet Alliance Policy Makers

# 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?



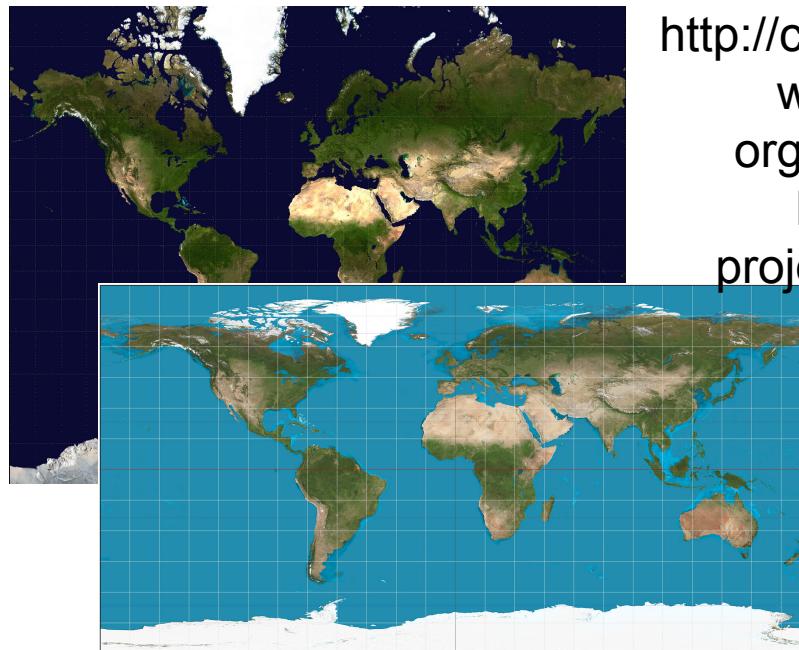
<https://atlas.ripe.net/measurements/2017414/#!openipmap>

# Challenges

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- Map Projections:
  - Mercator Projection
  - Equirectangular Projection
- Clustering/Occlusion:

Large amounts of data in a single area obscures information



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

<http://goo.gl/iMOT2o>

# Interactivity Techniques

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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

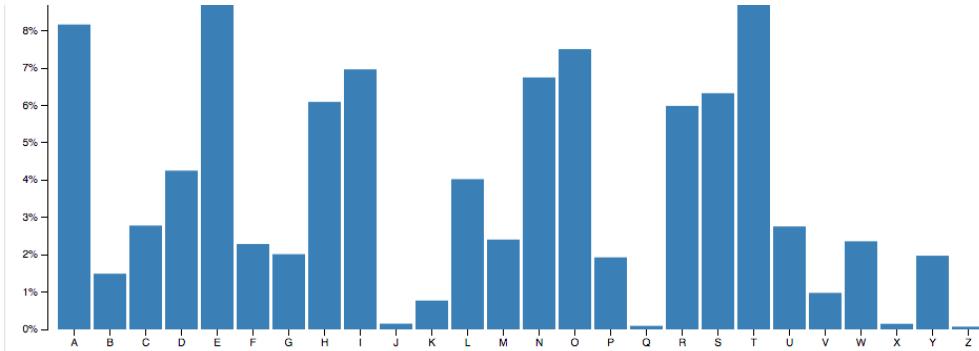
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# Evaluating Effectiveness of Visualisations

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

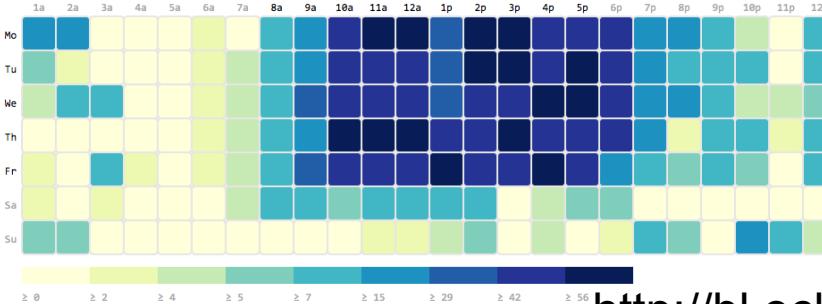
# Interactive Non-geospatial Visualisations



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



[http://guides.library.duke.edu/vis\\_types](http://guides.library.duke.edu/vis_types)



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

# Research Question

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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

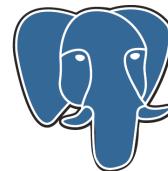
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- Display high-dimensional data
- Use of space to communicate data
- Design effective contextual view
- Design the interactivity features

# Web Application Implementation

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



**SQLAlchemy**  
PostgreSQL

# Expected Outcomes

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## 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

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## 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

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- 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

<u>Risk</u>	<u>Probability</u>	<u>Impact</u>	<u>Mitigation</u>
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

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<u>Deliverable</u>	<u>Due Date</u>
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