Towards smarter public transport

Sensing, Modeling and Visualizing Urban Mobility and Copresence Networks

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Madeira Interactive Technologies Institute

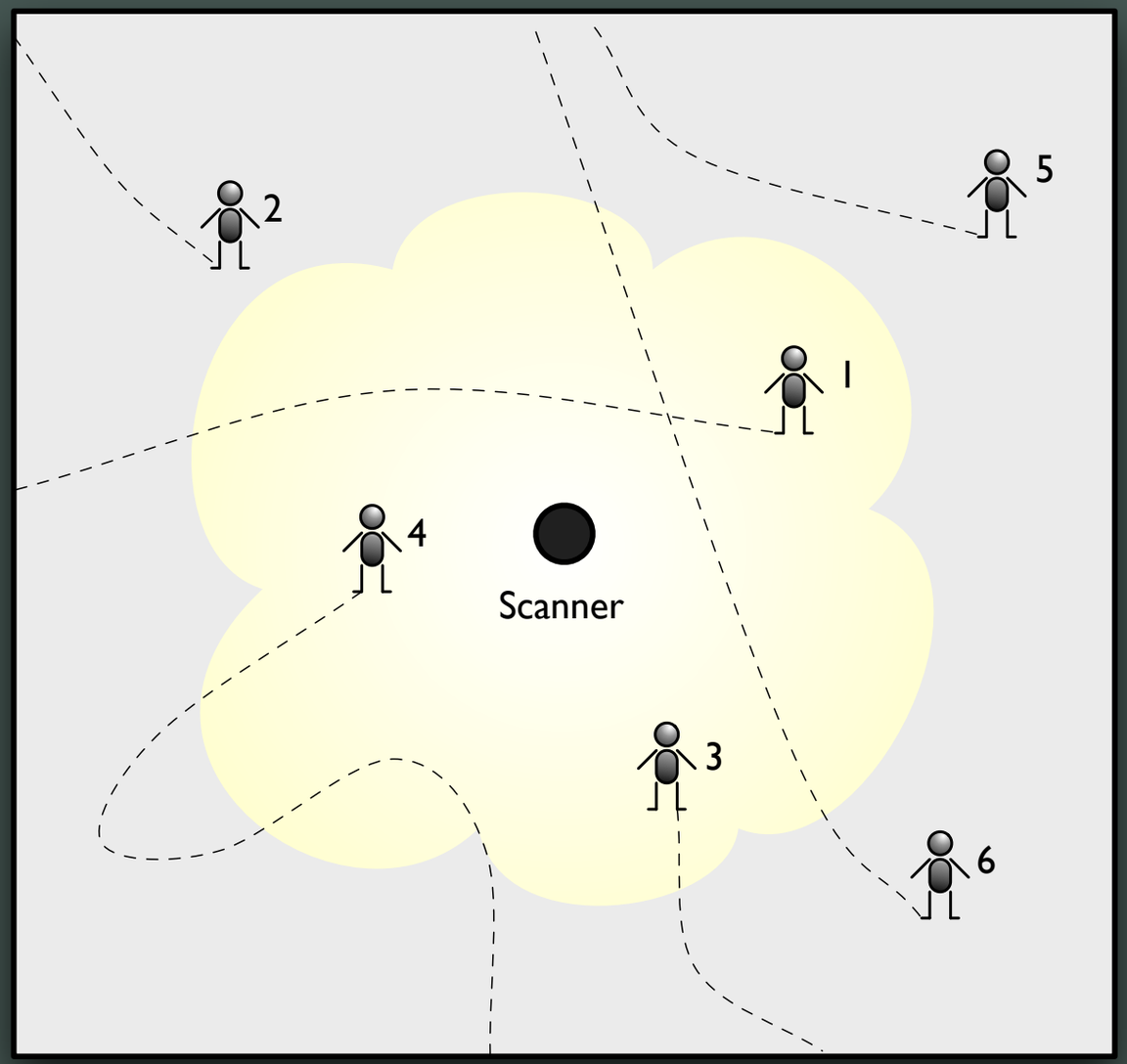
Motivation

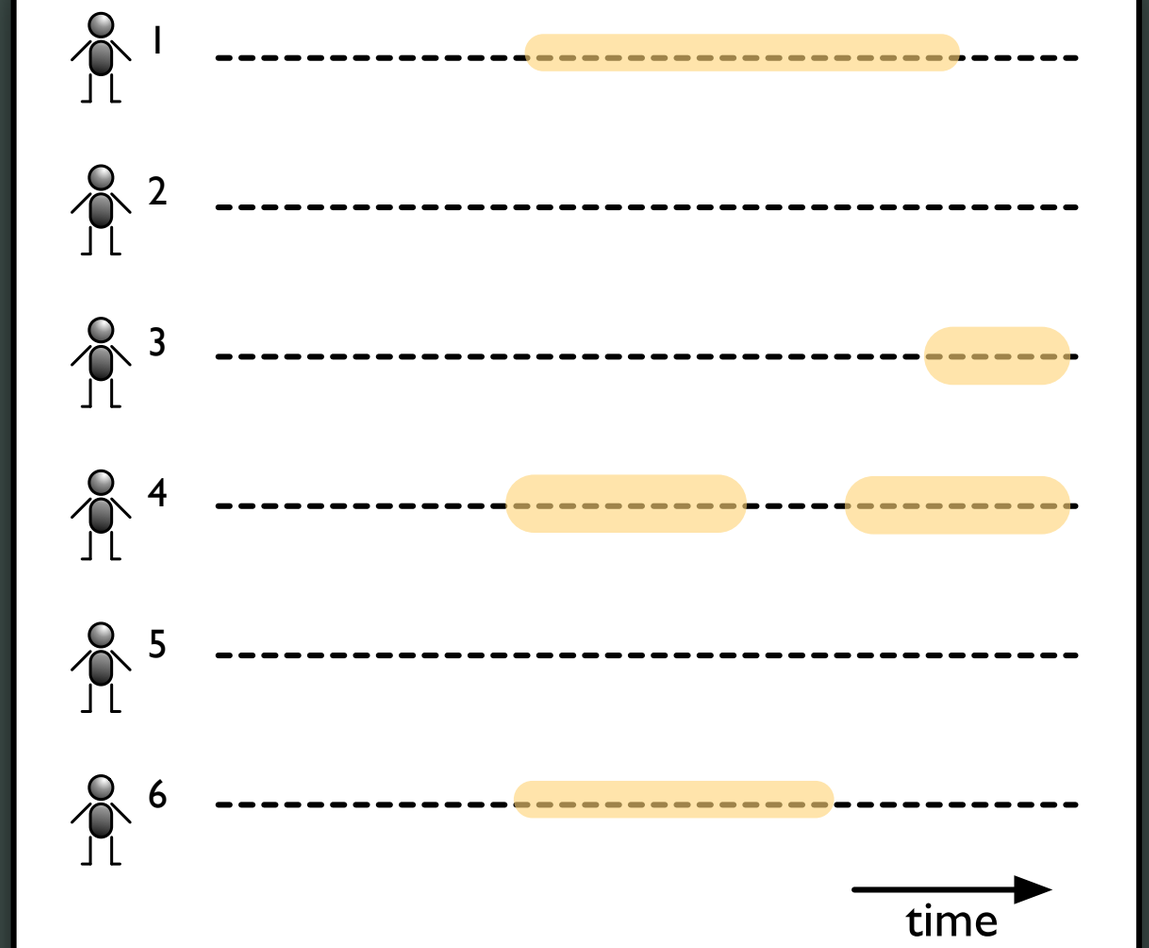
- People increasingly carry mobile communication technologies
- By taking advantage of technology that **passengers** carry
  - Better understanding of passenger behaviour
  - Increase bus seat occupation
    - Optimise network
    - Provide passengers with better information services

Outline

- Describe the enabling technology & algorithms
- Applications
  - End-to-end passenger counting
  - Contextual services

Exploiting people's phones to collect mobility data





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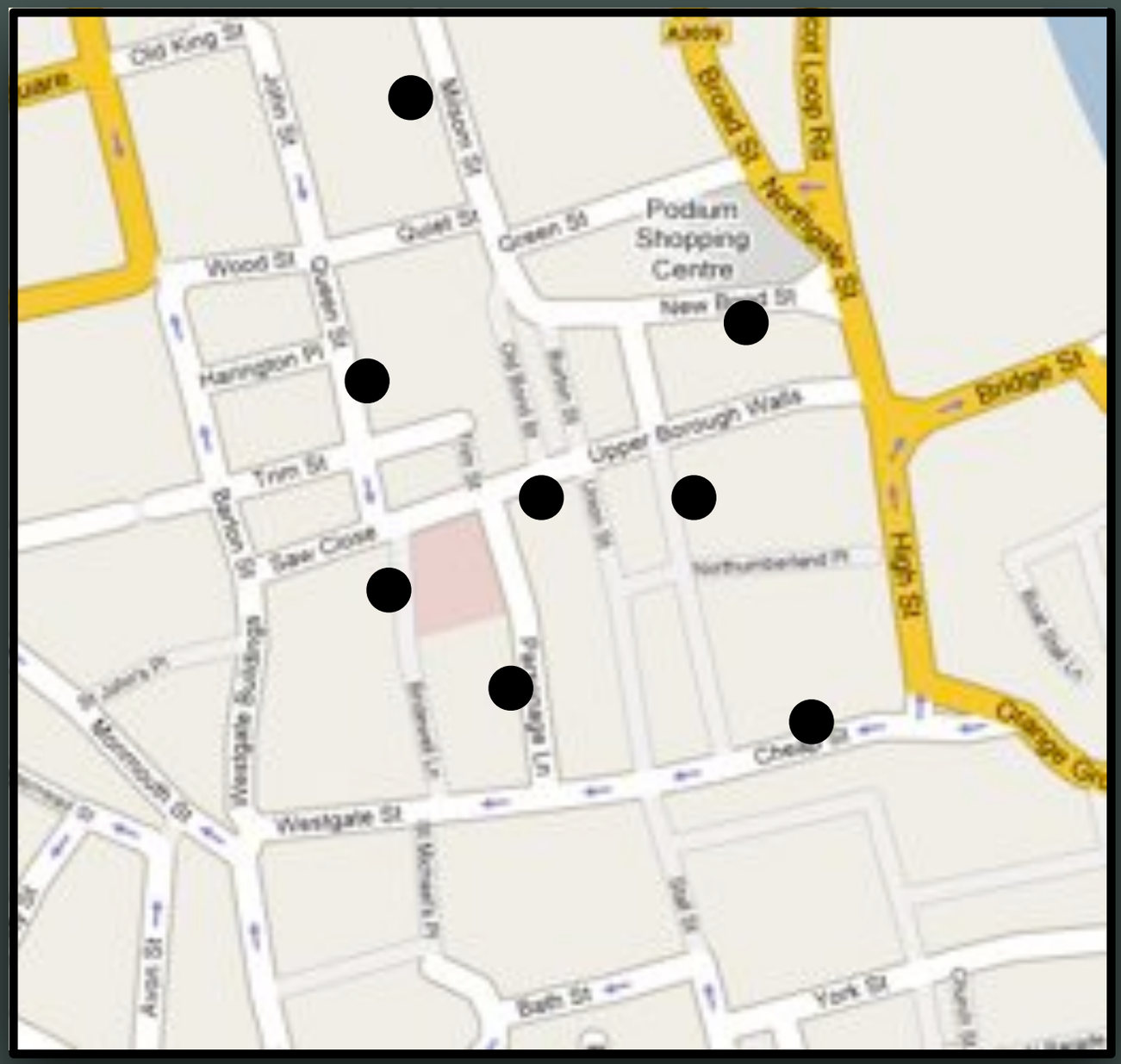

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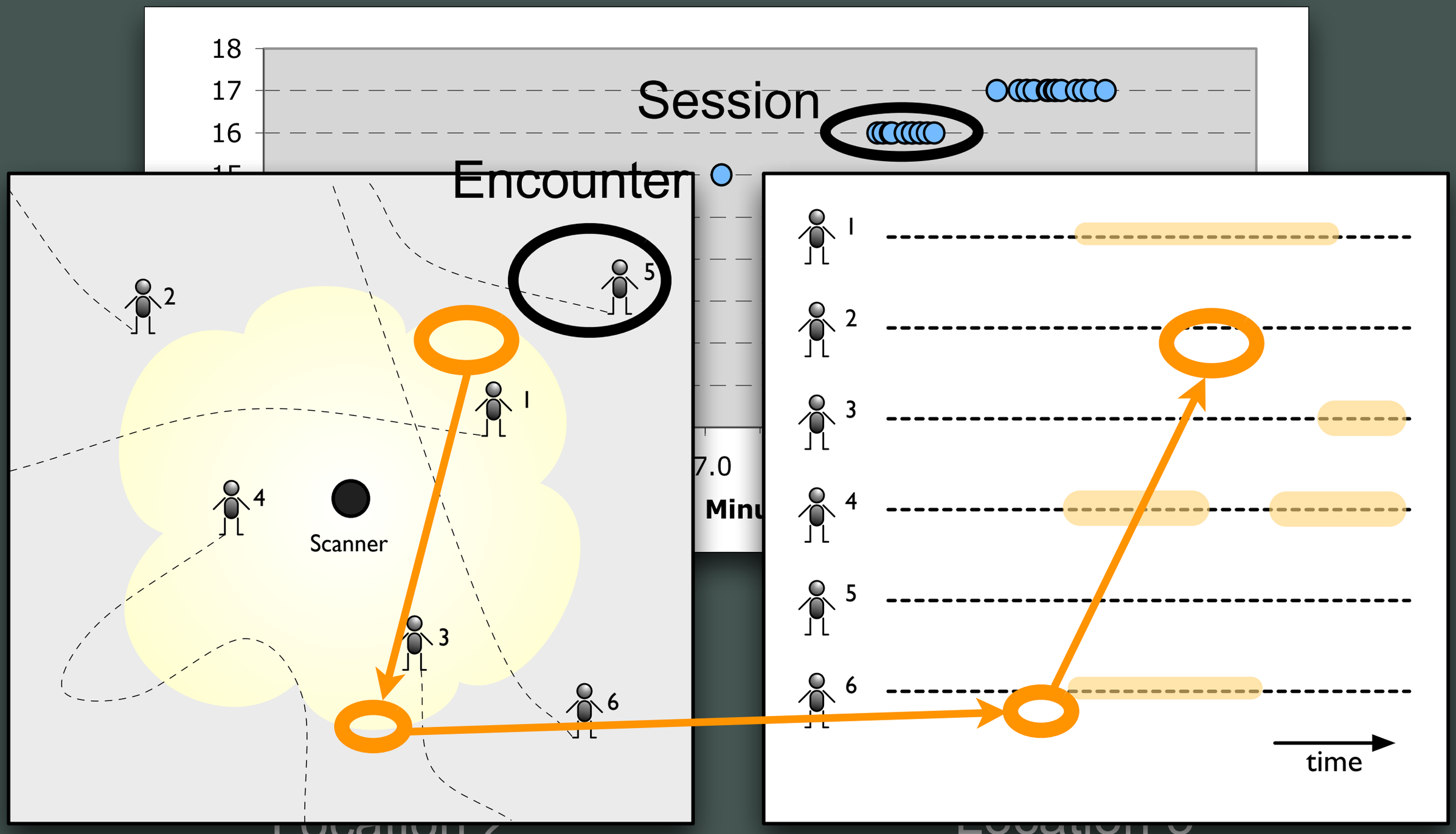
Main concepts

- Sessions
- Trails
- Encounters

Location 1



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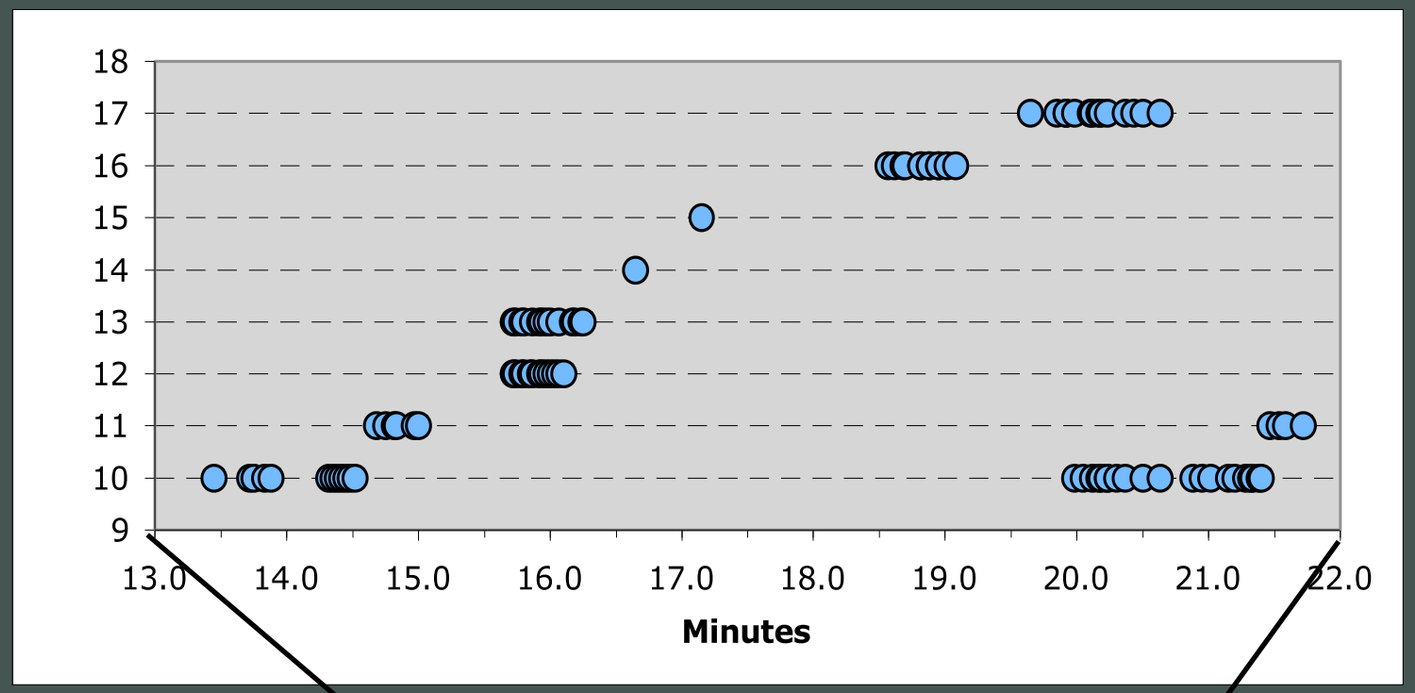
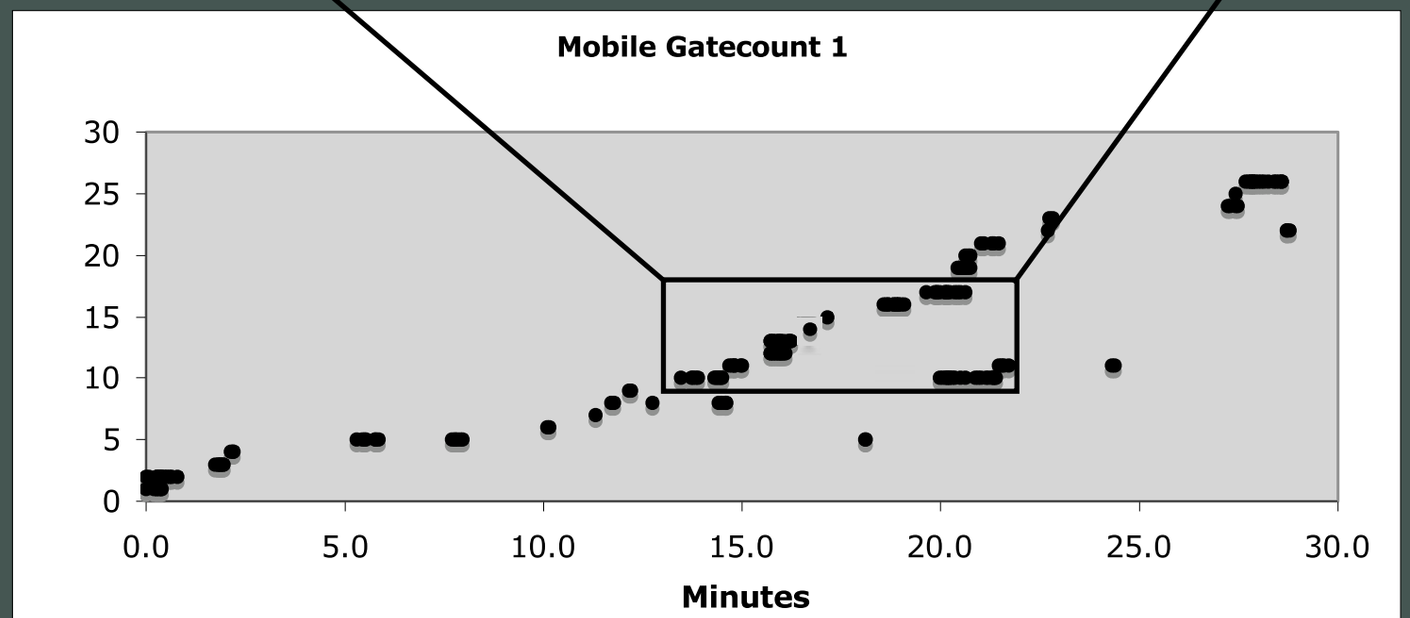
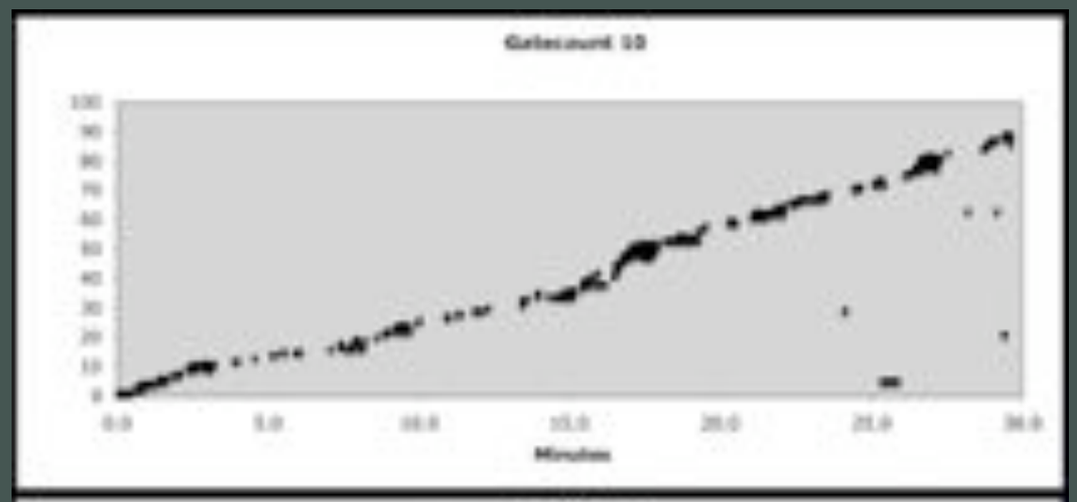
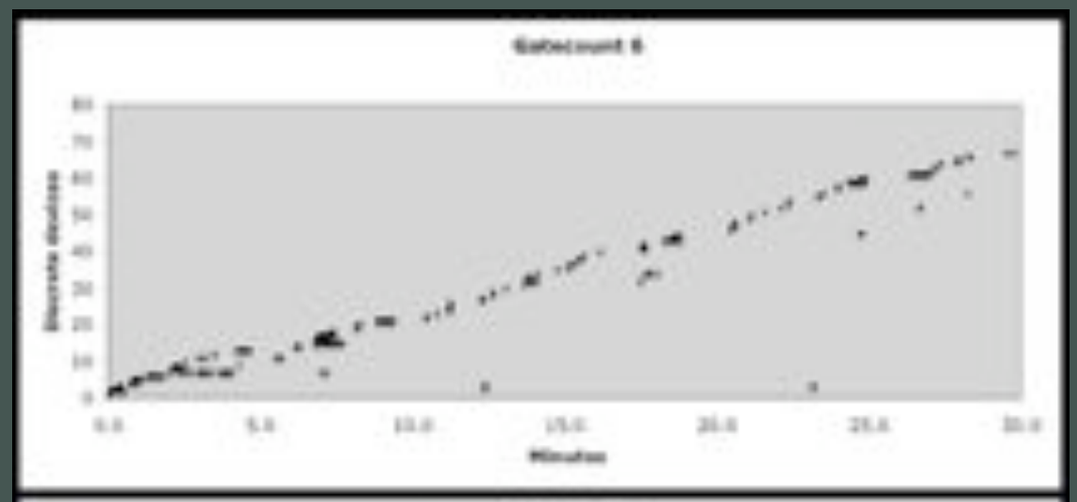
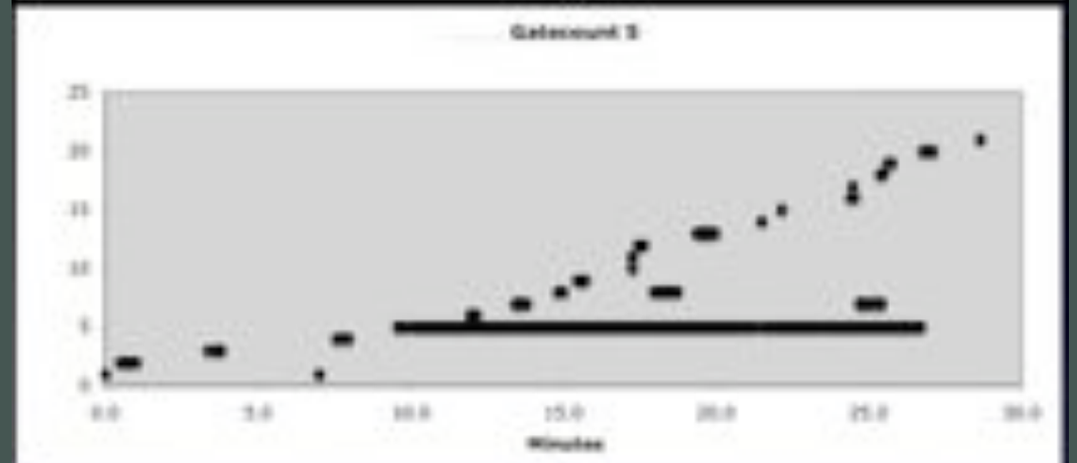
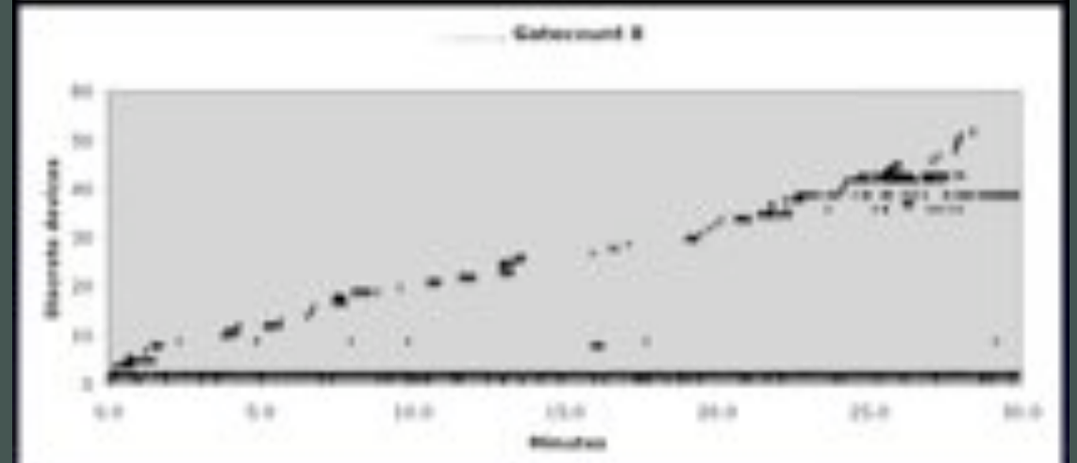

18
17
16
15
14
13
12
11
10
9
13.0
14.0
15.0
16.0
17.0
18.0
19.0
20.0
21.0
22.0
Minutes

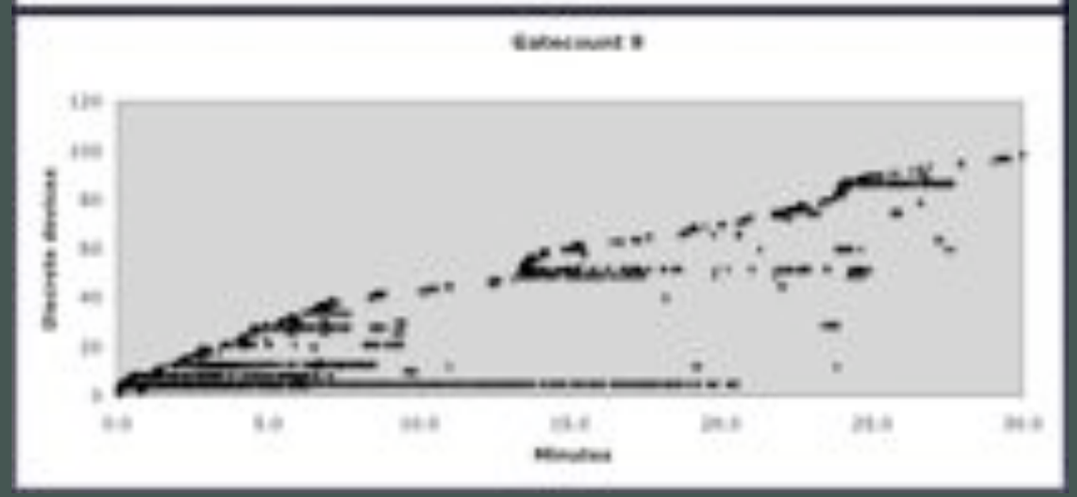

Mobile Gatecount 1
30
25
20
15
10
5
0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
Minutes

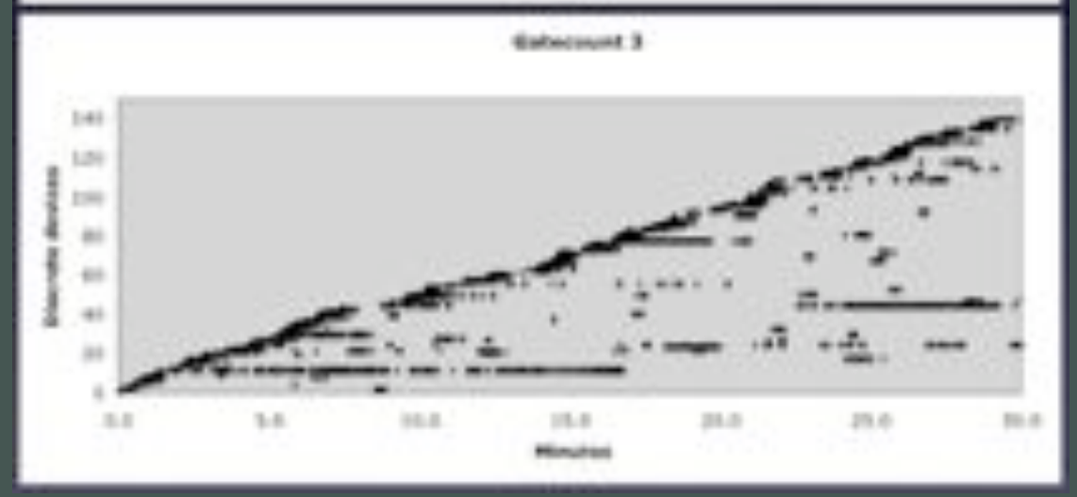

Gatecount 10
Minutes

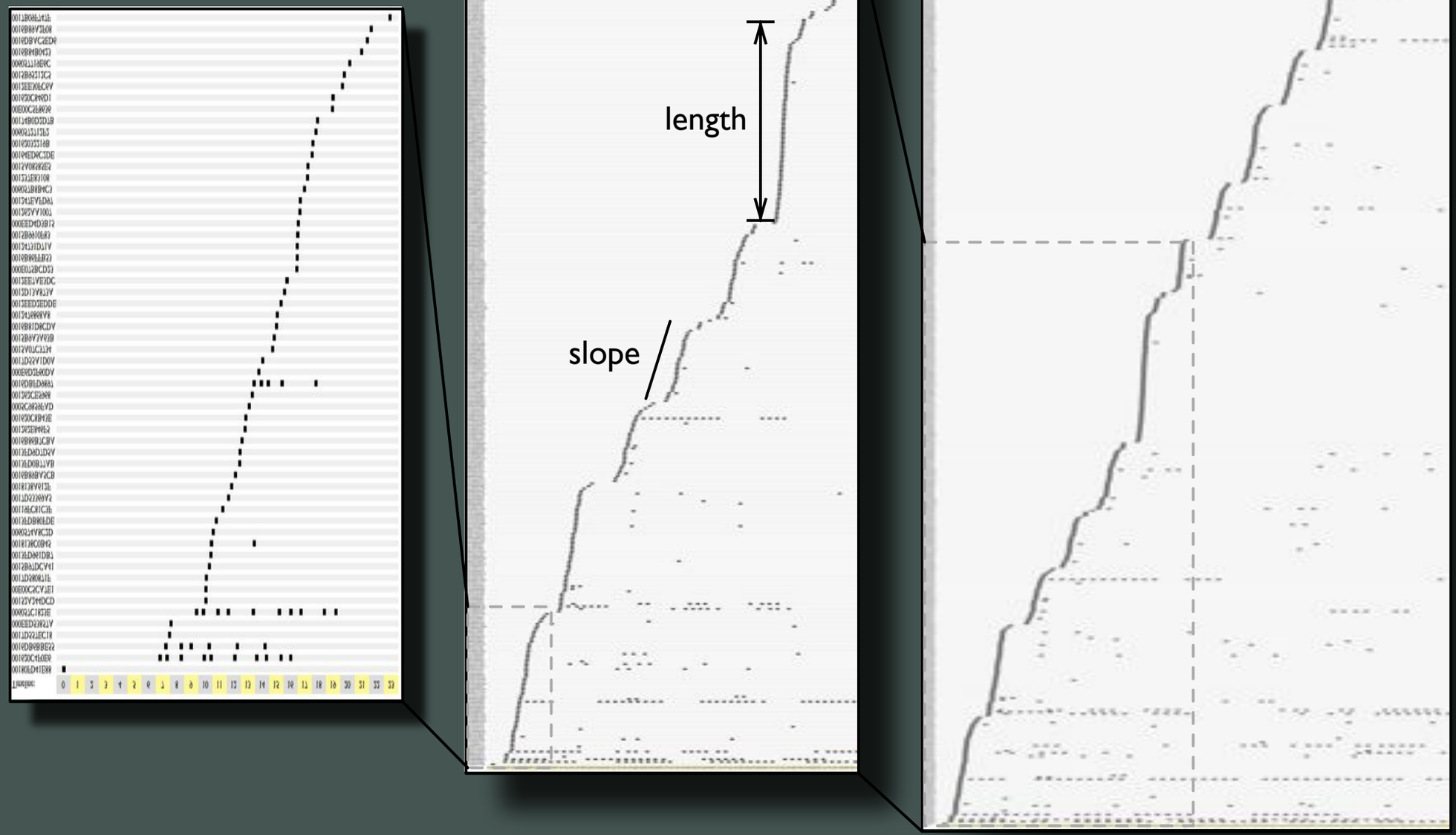

Gatecount 6
Minutes


Gatecount 5
Minutes

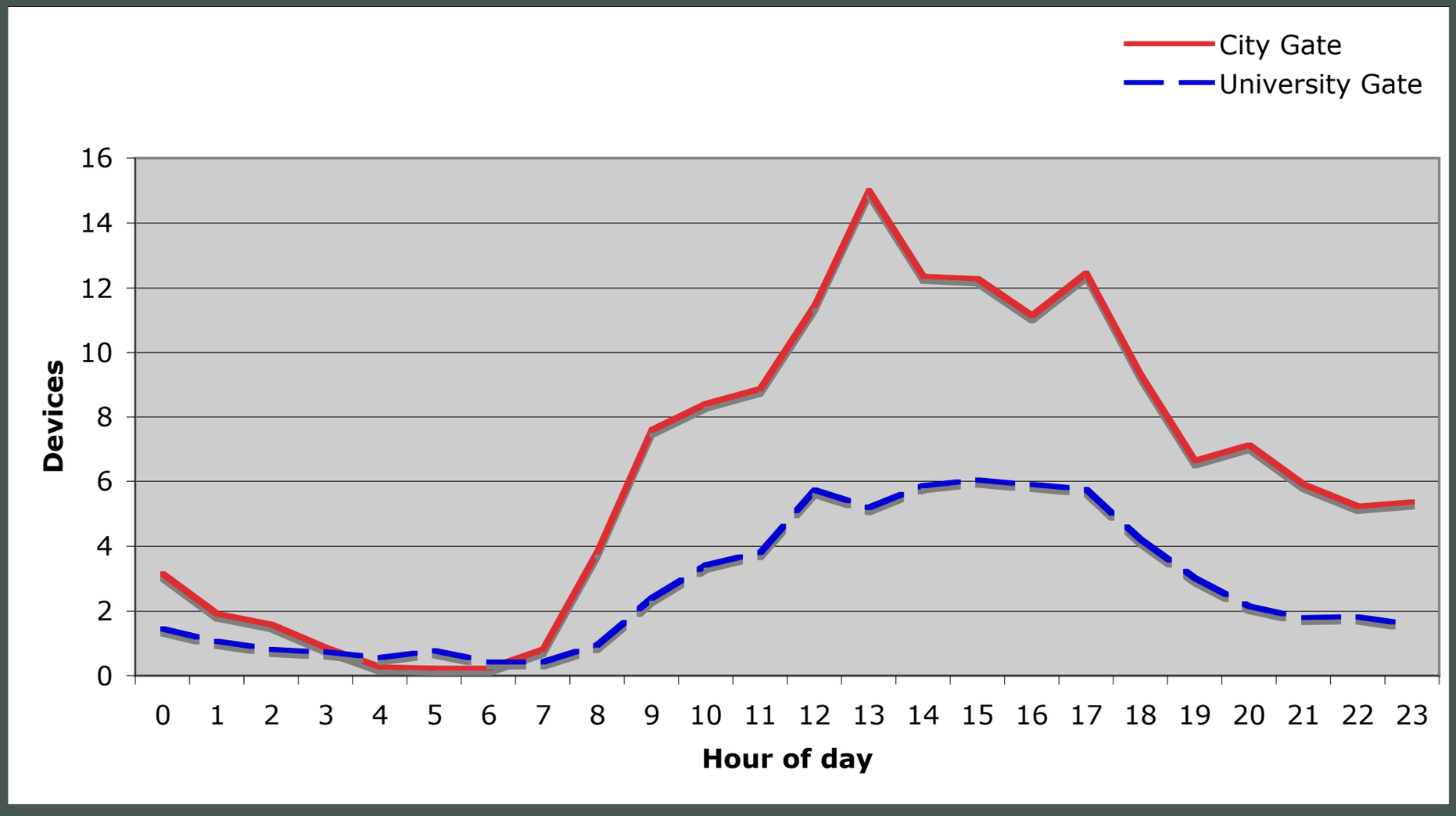

Gatecount 8
Minutes

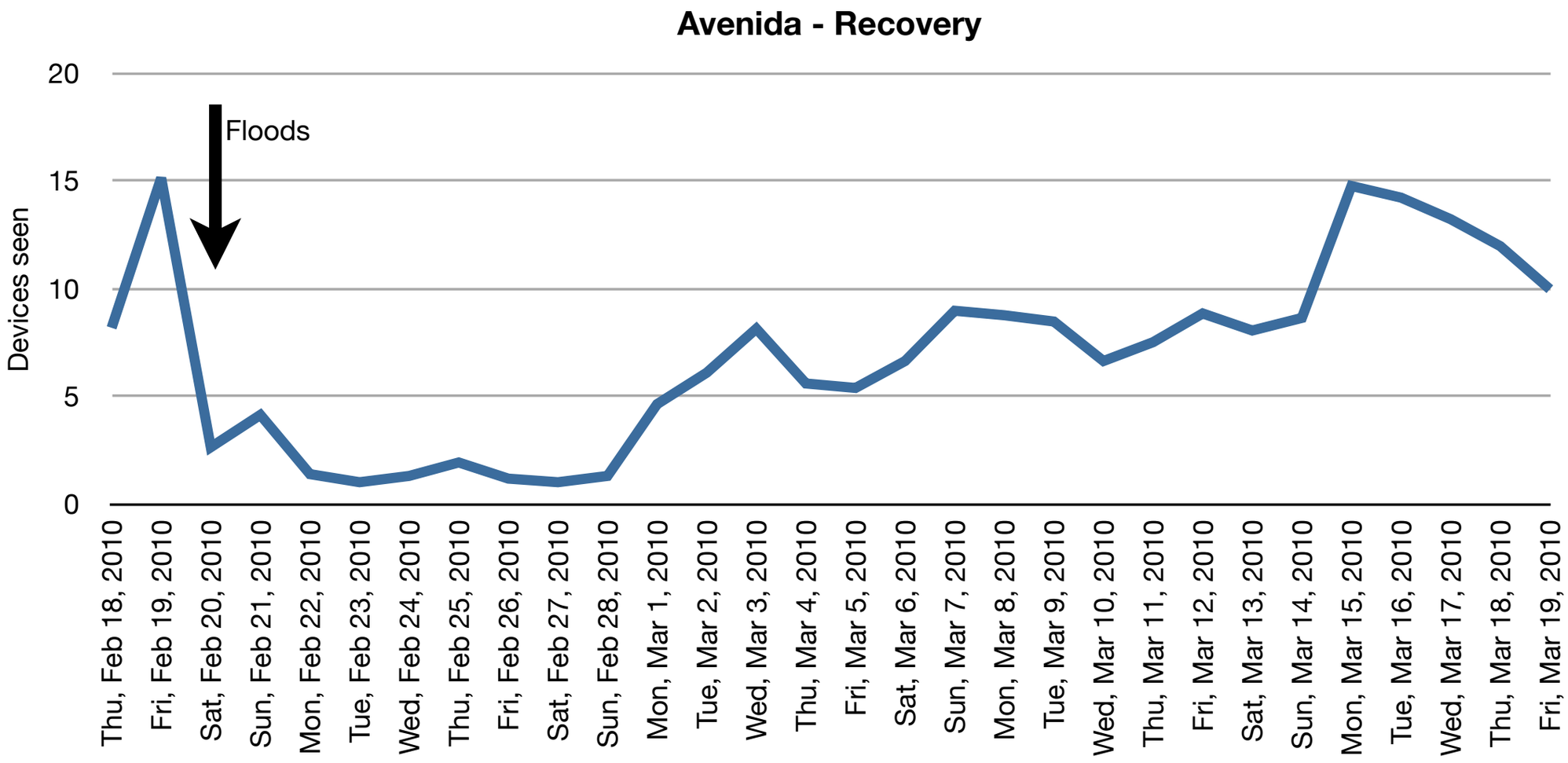

Gatecount 9
Minutes

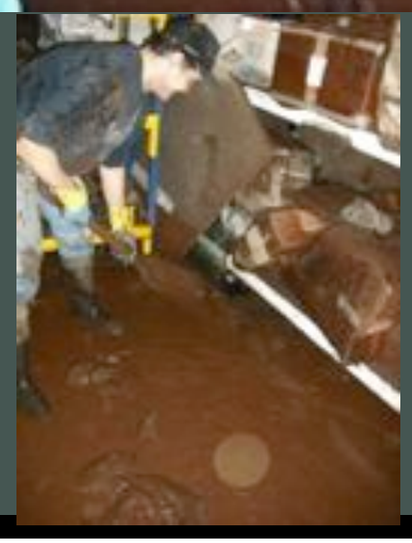

Gatecount 3
Minutes


length
slope

Flow of people



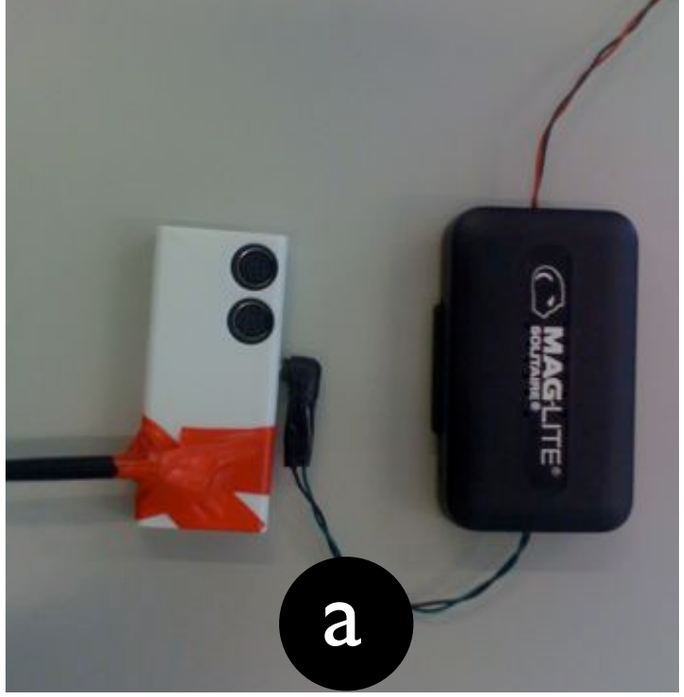

Avenida - Recovery
Devices seen
20
15
10
5
0
Floods
Thu, Feb 18, 2010
Fri, Feb 19, 2010
Sat, Feb 20, 2010
Sun, Feb 21, 2010
Mon, Feb 22, 2010
Tue, Feb 23, 2010
Wed, Feb 24, 2010
Thu, Feb 25, 2010
Fri, Feb 26, 2010
Sat, Feb 27, 2010
Sun, Feb 28, 2010
Mon, Mar 1, 2010
Tue, Mar 2, 2010
Wed, Mar 3, 2010
Thu, Mar 4, 2010
Fri, Mar 5, 2010
Sat, Mar 6, 2010
Sun, Mar 7, 2010
Mon, Mar 8, 2010
Tue, Mar 9, 2010
Wed, Mar 10, 2010
Thu, Mar 11, 2010
Fri, Mar 12, 2010
Sat, Mar 13, 2010
Sun, Mar 14, 2010
Mon, Mar 15, 2010
Tue, Mar 16, 2010
Wed, Mar 17, 2010
Thu, Mar 18, 2010
Fri, Mar 19, 2010



End-to-end passenger detection on busses

Deployment

- Install the equipment onboard a bus
- Integrate with Automated Vehicle Location data


MAG-LITE
SOLITAIRE
a

b

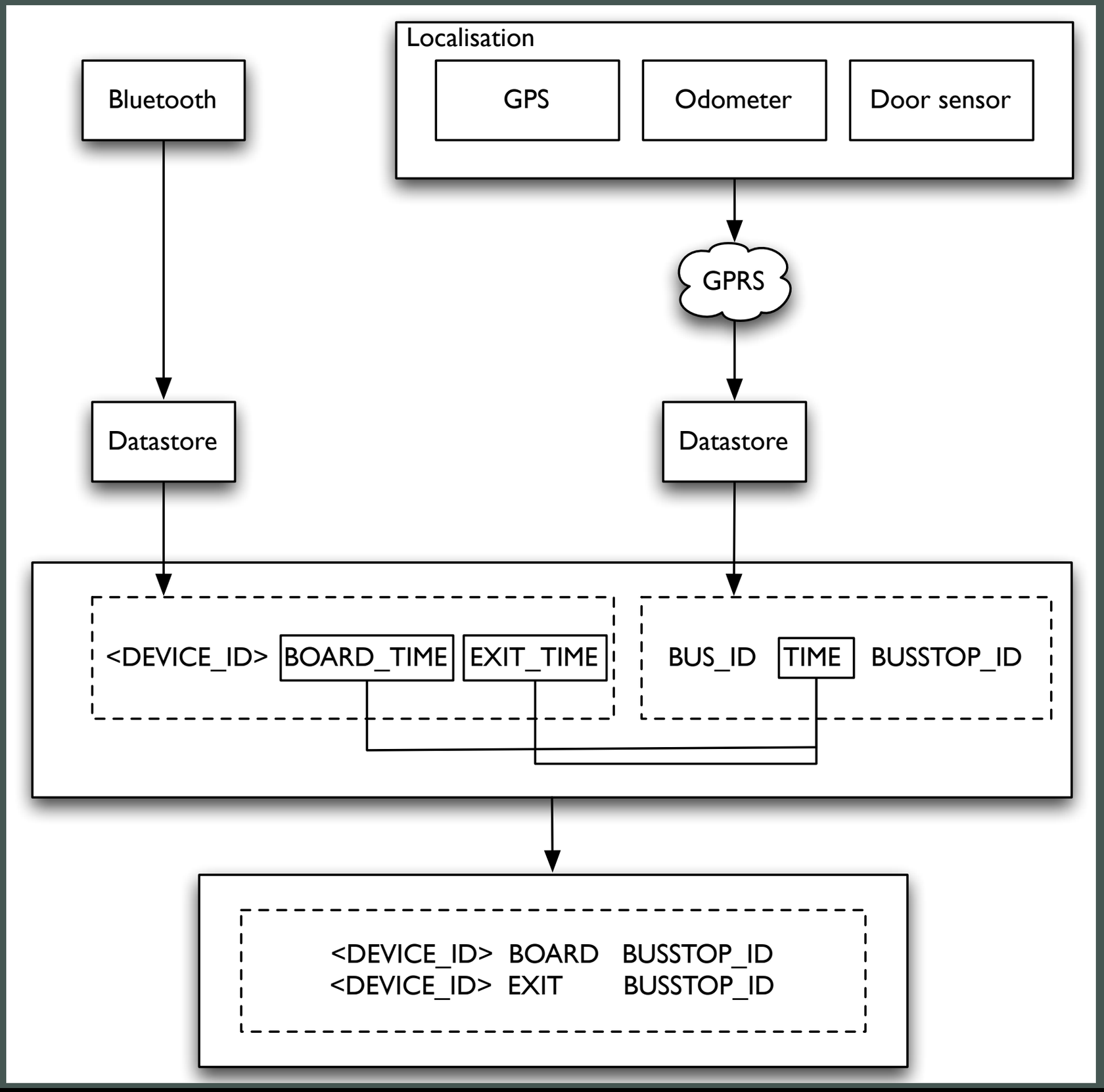
c

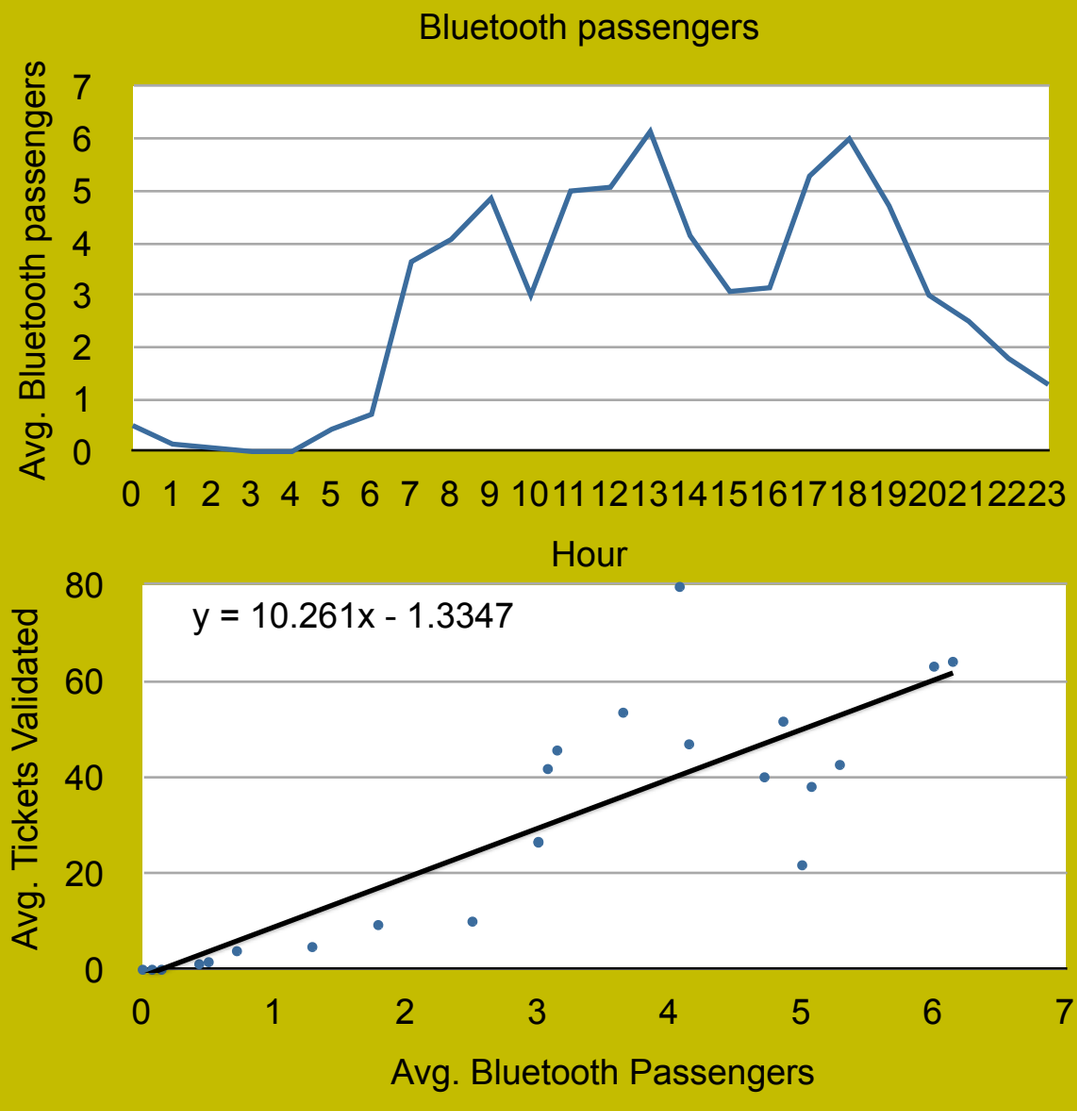
d

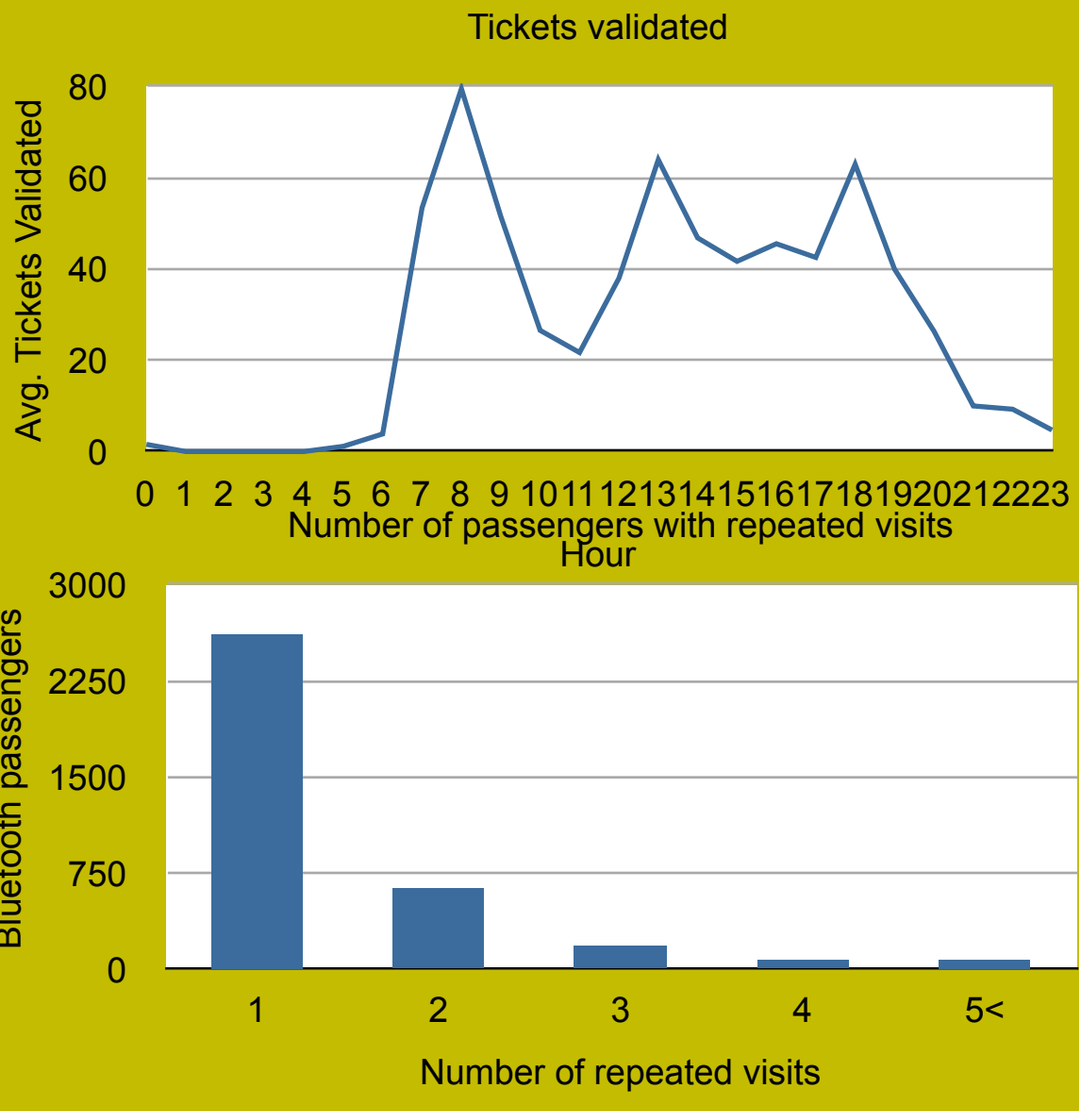
e

Results

- Identification of entry and exit points for individual devices
- Estimations suggest 10% of population have Bluetooth in discoverable mode
- System was deployed at a single bus for 4 weeks
- Bus covered 4 different routes at different times of day

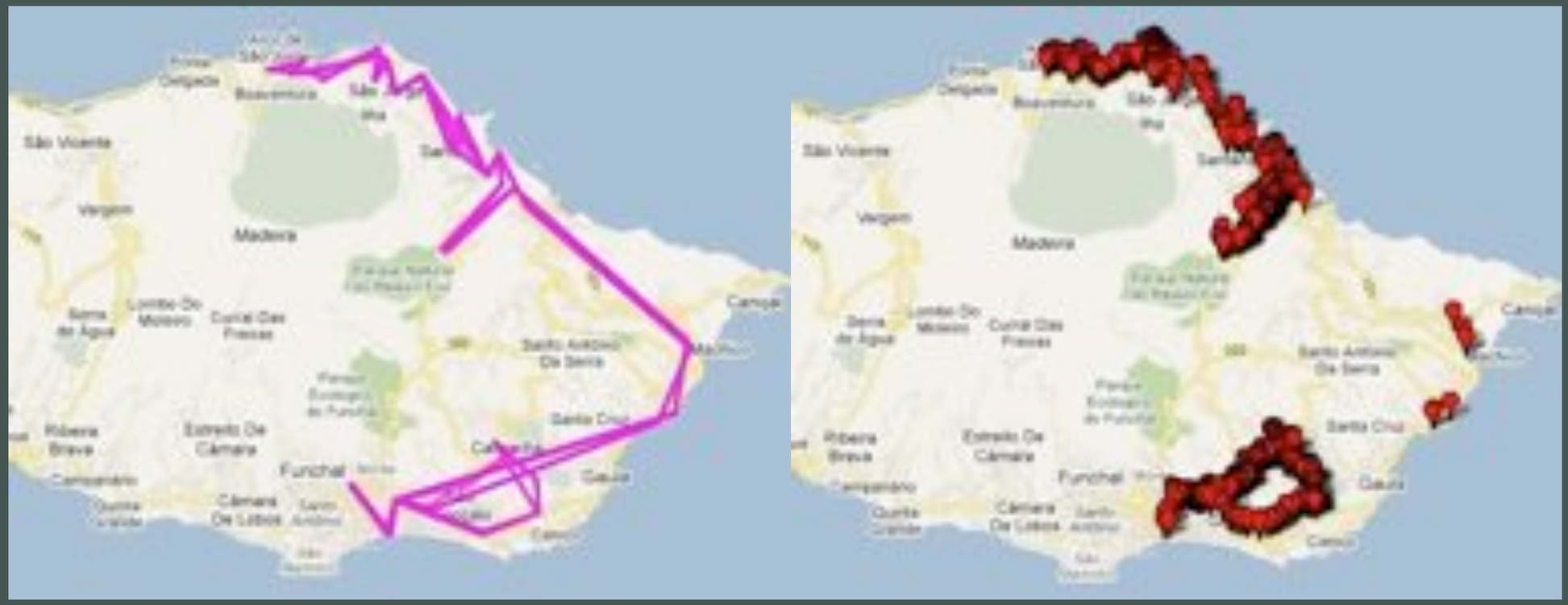

Localisation
Bluetooth
GPS
Odometer
Door sensor
GPRS
Datastore
Datastore
<DEVICE_ID> BOARD_TIME EXIT_TIME
BUS_ID TIME BUSSTOP_ID
<DEVICE_ID> BOARD BUSSTOP_ID
<DEVICE_ID> EXIT BUSSTOP_ID

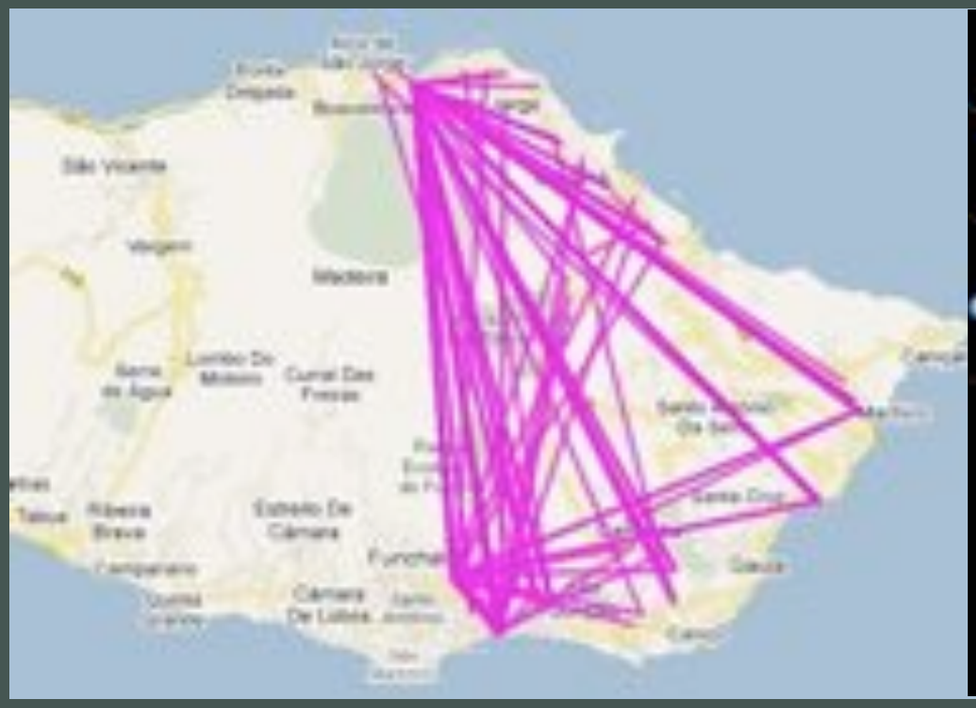

Bluetooth passengers
Avg. Bluetooth passengers
0 1 2 3 4 5 6 7
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Hour

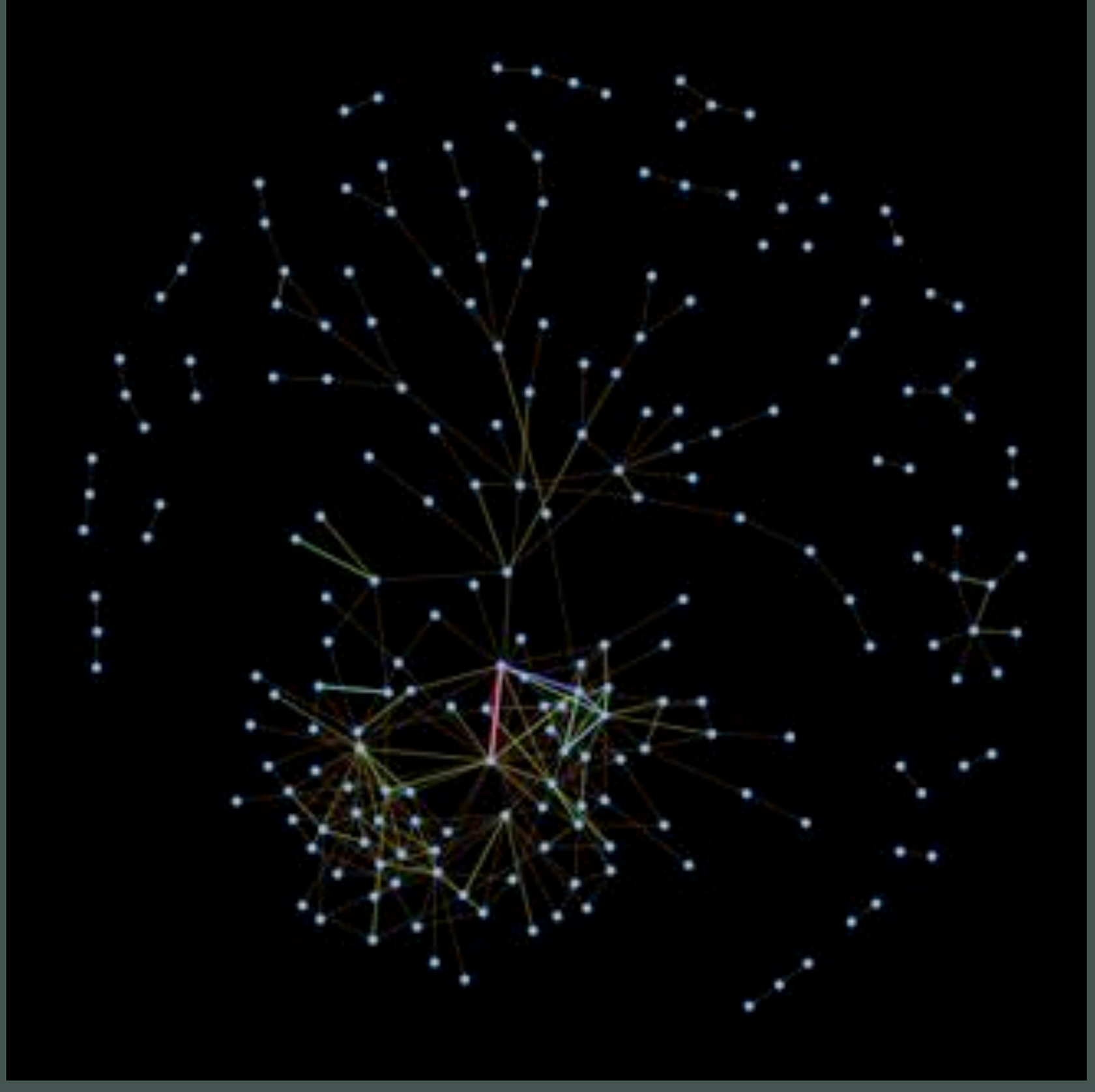

Tickets validated
Avg. Tickets Validated
0 20 40 60 80
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Number of passengers with repeated visits
Hour

y = 10.261x - 1.3347
Avg. Tickets Validated
0 20 40 60 80
0 1 2 3 4 5 6 7
Avg. Bluetooth Passengers

Bluetooth passengers
0 750 1500 2250 3000
1 2 3 4 5<
Number of repeated visits


São Vicente
Vargem
Madeira
Ribeira Brava
Estreito De Câmara
Funchal
Câmara De Lobos
Santa Cruz
Caniço


São Vicente
Vargem
Madeira
Ribeira Brava
Estreito De Câmara
Funchal
Câmara De Lobos
Santa Cruz
Caniço



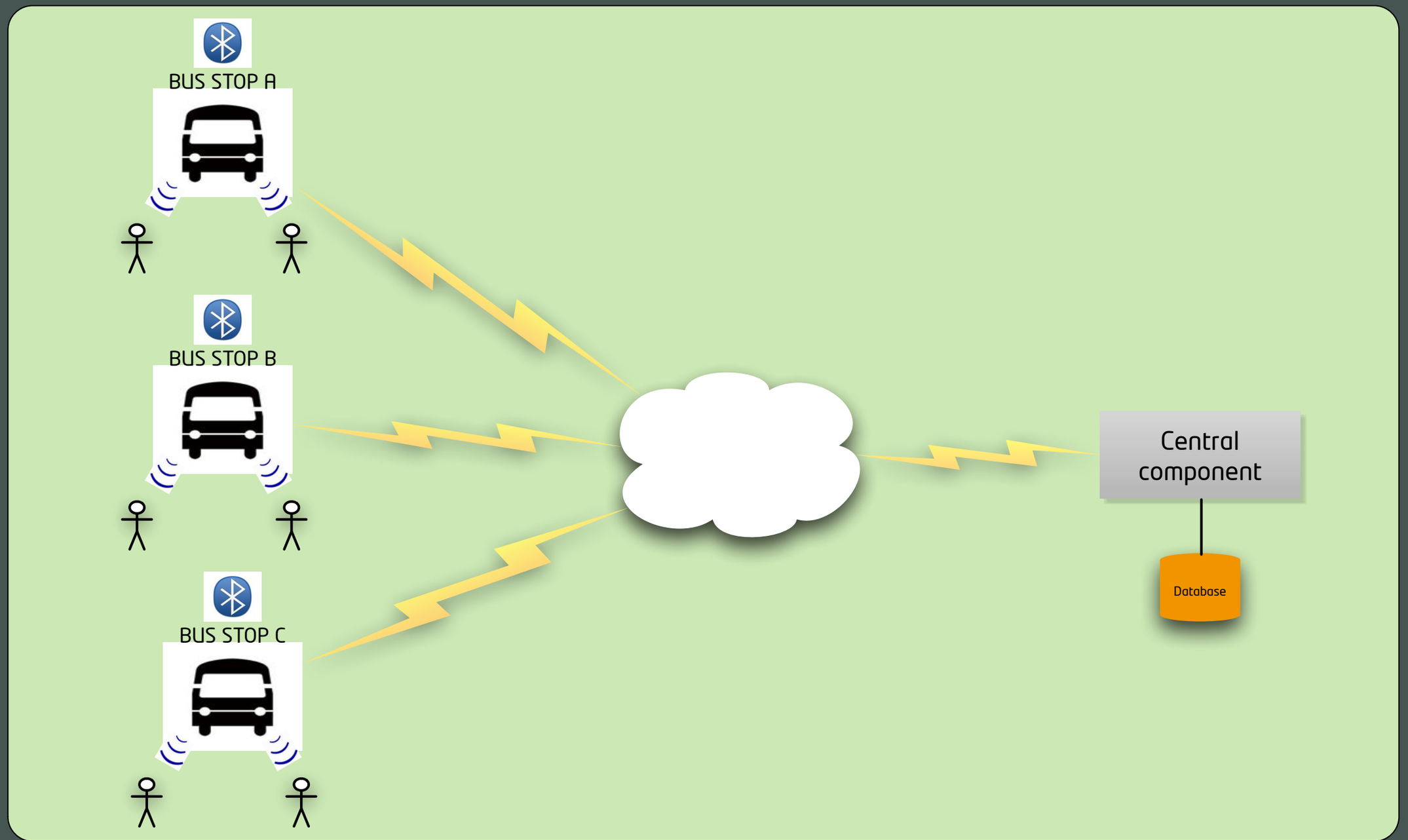
Contextual services for passengers

Proposed route

- Installation of 12 stations at/nearby public transit bus stops. Deployment at strategic locations

Proposed system

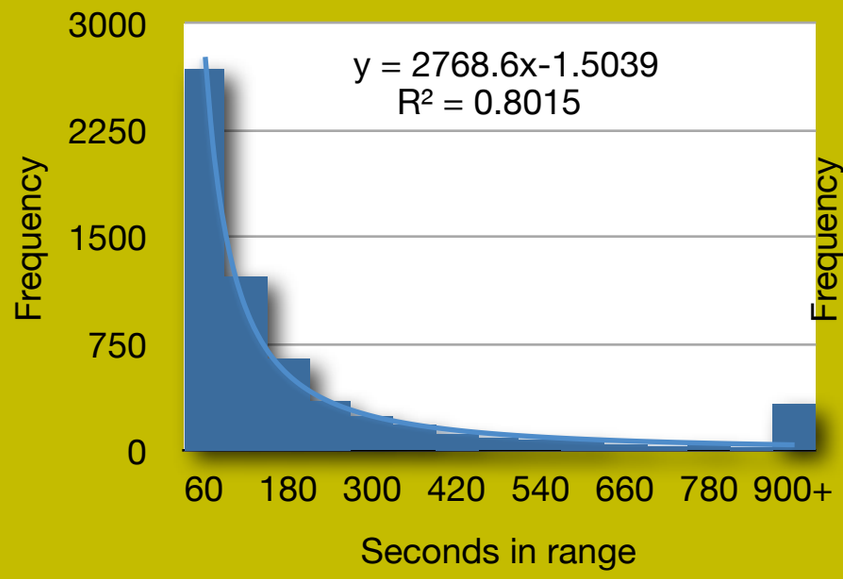
- Deploy equipment to collect data and provide services at bus stops
- Information is routed to the central server
- Provide both historical and (near) real-time perspective


BUS STOP A
BUS STOP B
BUS STOP C
Central component
Database

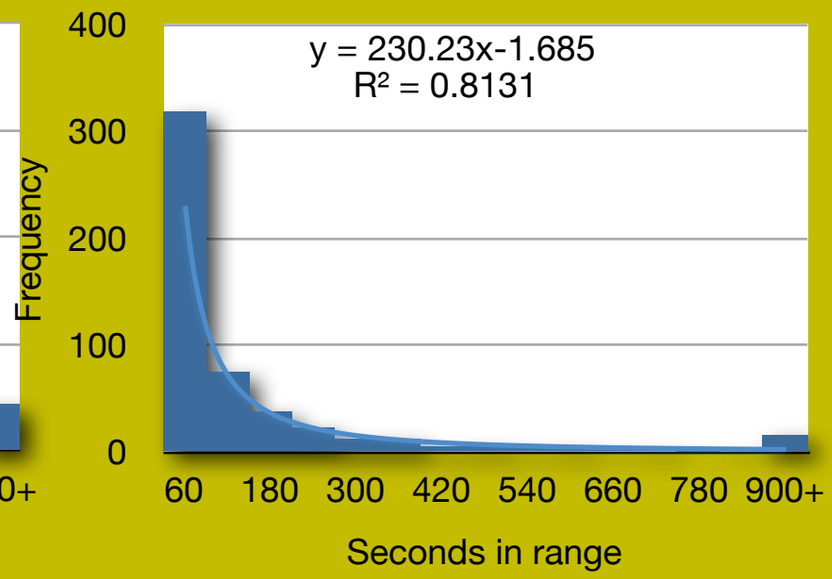
Service triggering

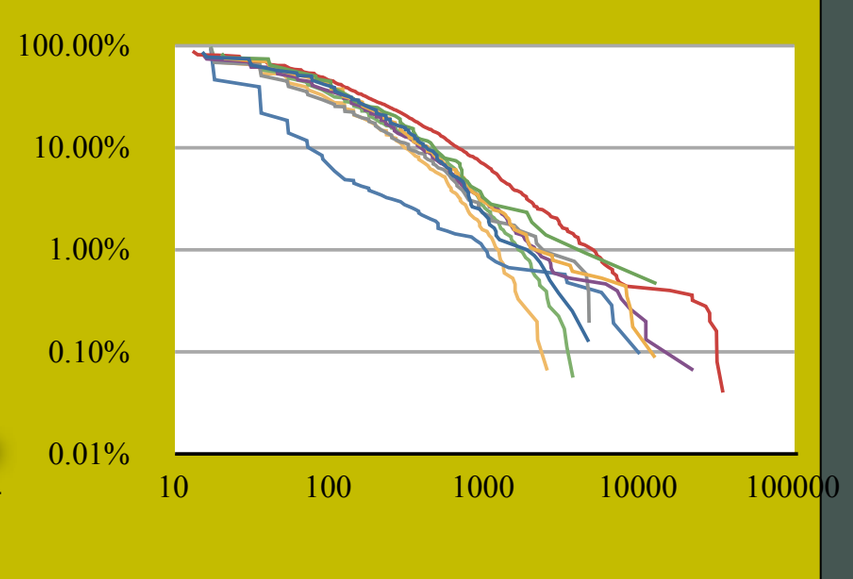
- Services are triggered when a device is detected
- Parameters / filters of a service
  - What to send (URL? Local file?)
  - To whom to send? (Specific device, broadcast)
  - At which location(s)?
  - At what time/date?
  - ...

University

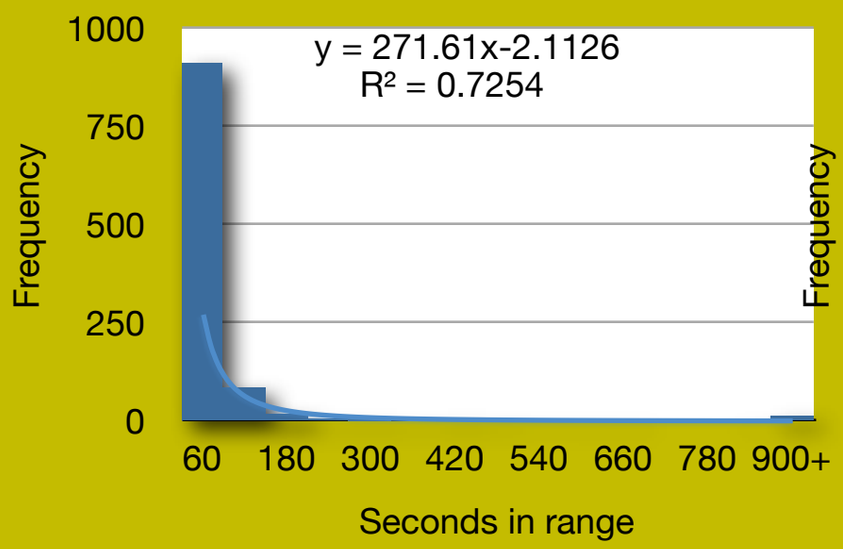


Festival

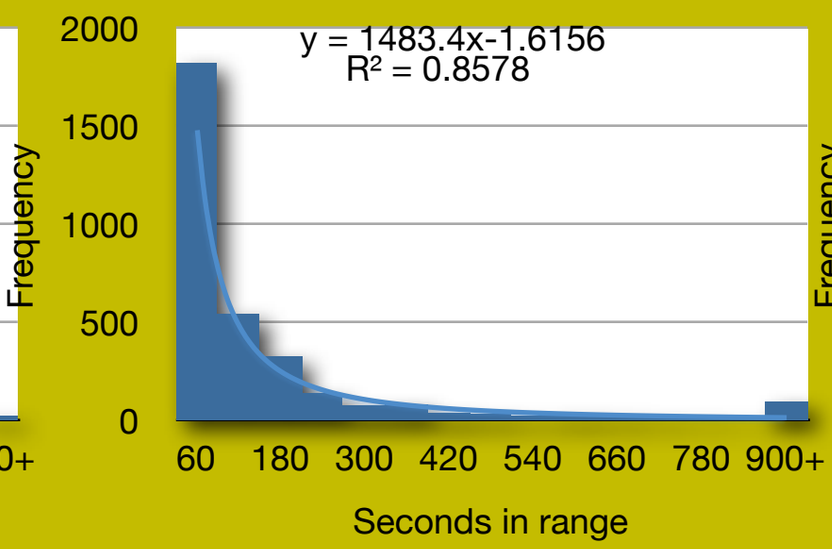




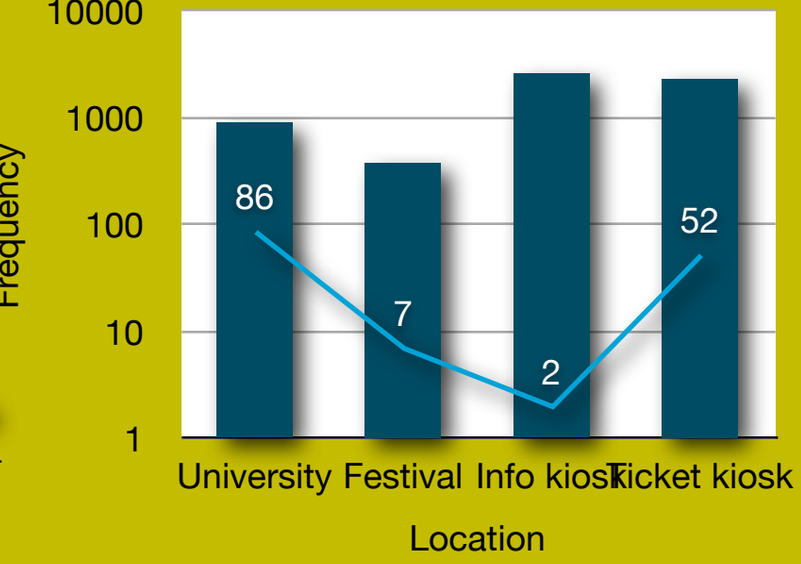
Info kiosk



Ticket kiosk



Content delivery for all locations



Successful Deliveries
Total Attempts

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Results

- Many passengers did not successfully receive the test file
  - We did not advertise the service!
  - People don't realise that their phone is trying to receive a file
  - Advertisement & increased awareness should resolve this
- New capabilities open up
  - Reward scheme based on how much time you wait
  - Personalised O/D matrix, predictions, better info

Summary

- By exploiting passengers' mobile bluetooth-capable phones we can
  - Collect rich data about travel behaviour
  - Provide rich, context-aware services
- The collected data are much richer than what current techniques can capture
- The provided services can be fully personalised

The end

- Thank you!
- Questions?
- http:// www. m-iti . org