

# Experiences with urban deployment of Bluetooth

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UCSD, California, 22 March 2007

# Overview

- Bluetooth scanning
- User-related
- Bluetooth CSI
- BlueVirus (ebola?!)



# Bluetooth scanning

# Requirements

- Capture BT address & BT name
- Static environments (pub)
- Dynamic environments (shopping street)

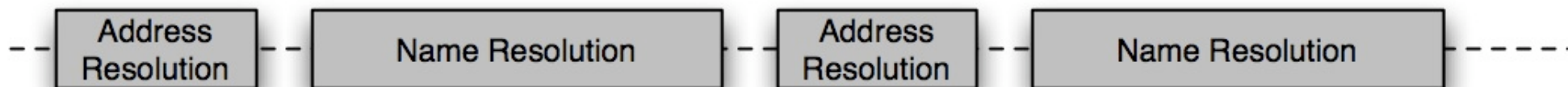


# Bluetooth protocol

- Get list of addresses (within range)
- Iterate on each address: request name
- Address resolution: multiples of 1.28s
- Name resolution: ???

# Single dongle

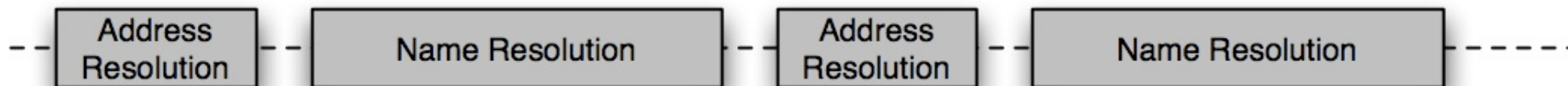
- Name resolution takes too long
  - >5sec per device
  - ~100sec timeout
- During name resolution, new devices are not recorded





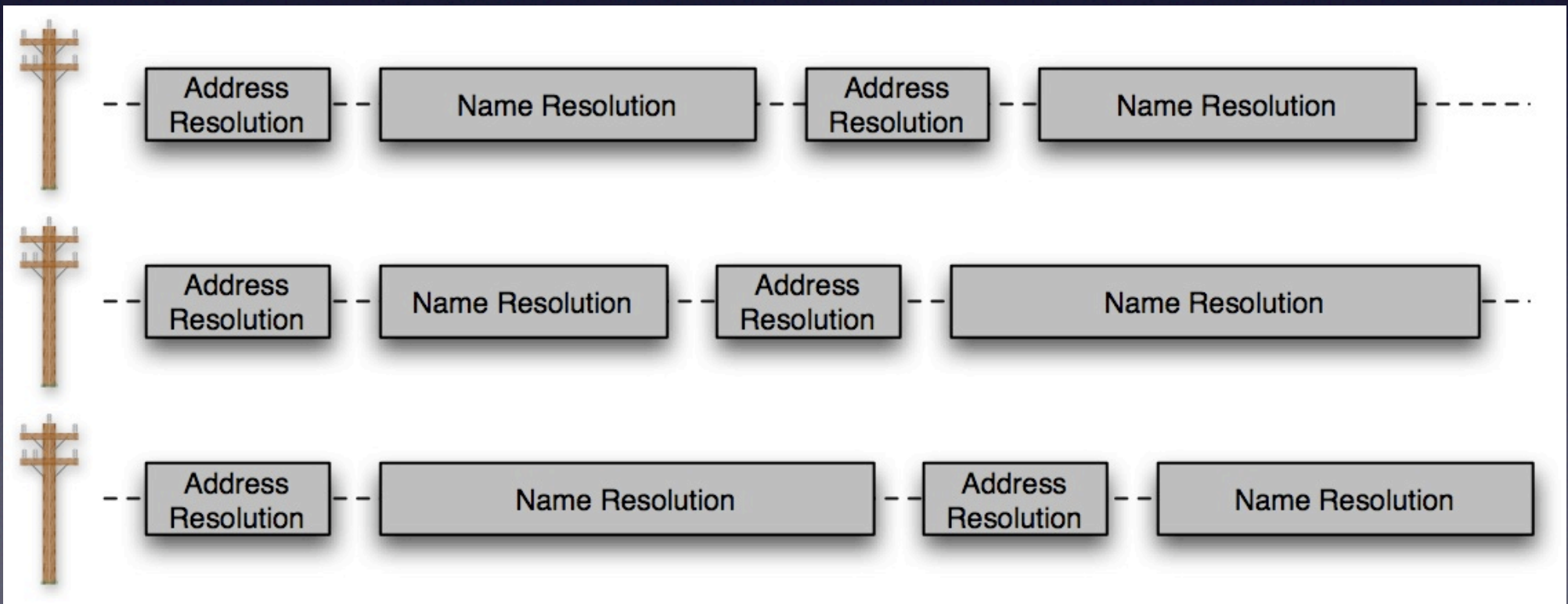
# Single dongle

- Optimisations
  - Name resolution timeout
  - Enable/disable name resolution
  - Address resolution interval



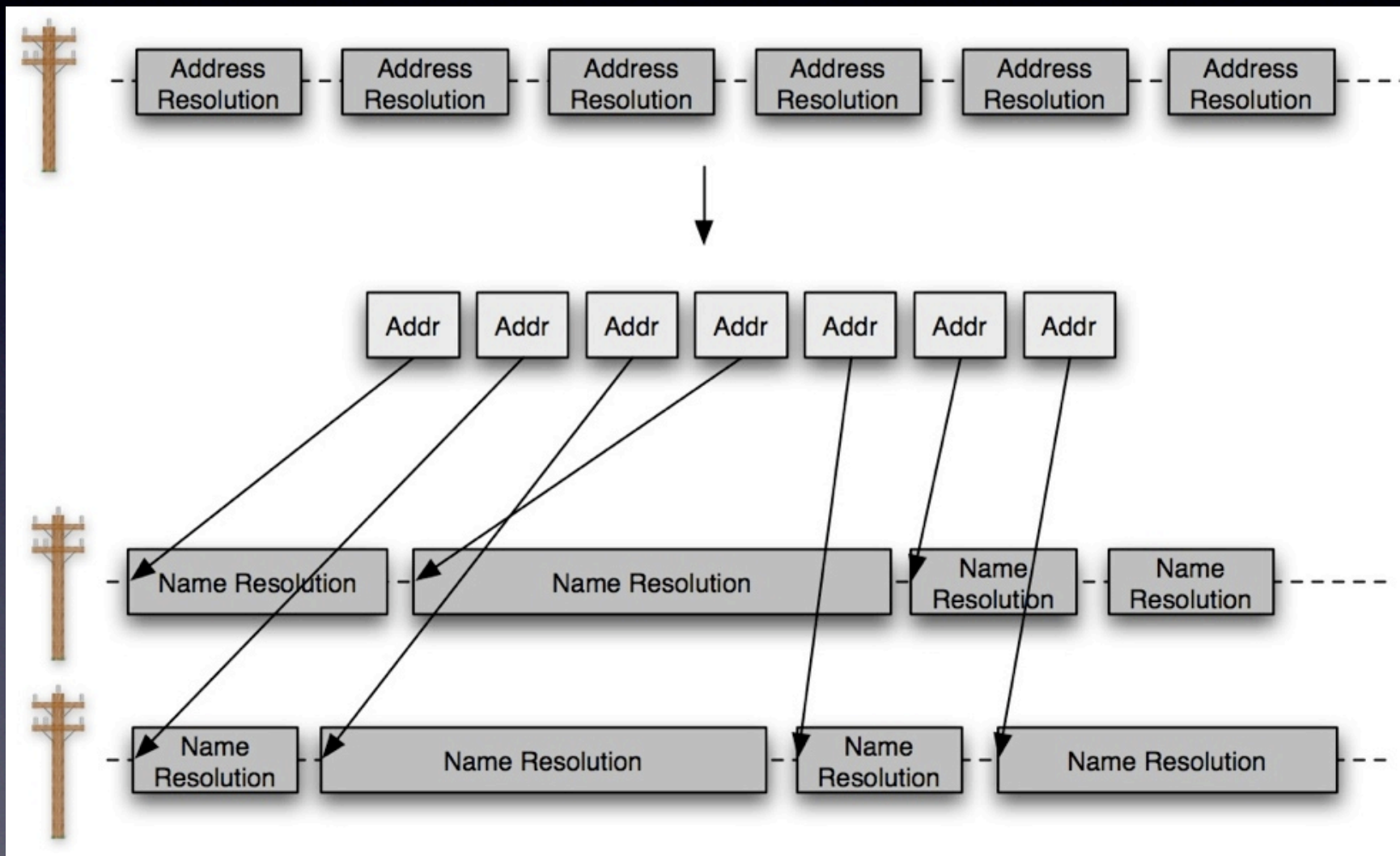
# Multiple dongle

- Some devices still missed
  - if all dongles are doing name resolution





# “Smart” multi-dongle



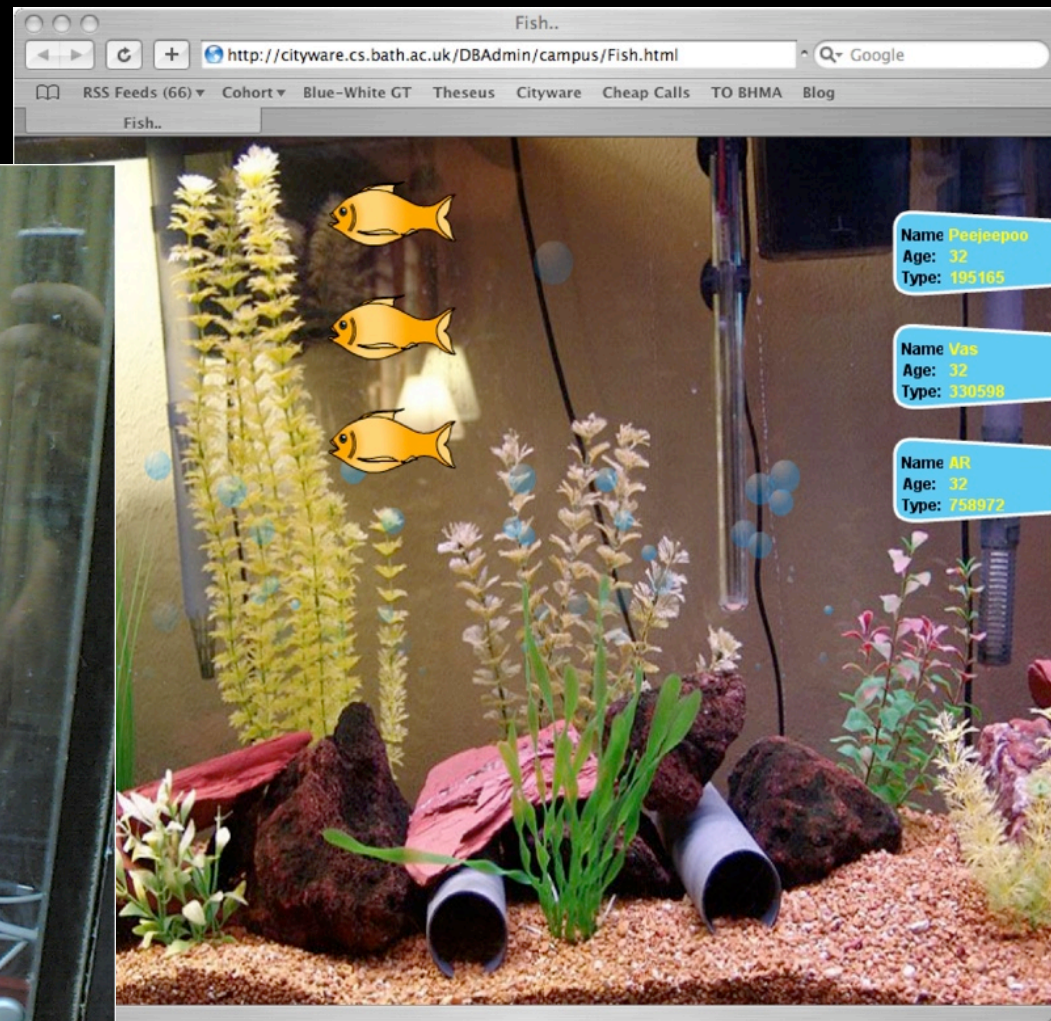
# Comparison

- Single dongle: OK for fairly static environments
- Mutli-dongle: Good for detecting changes in static environments
- Smart multi-dongle: Good for capturing high-speed flows



User-related





Bluefish





Bluefish



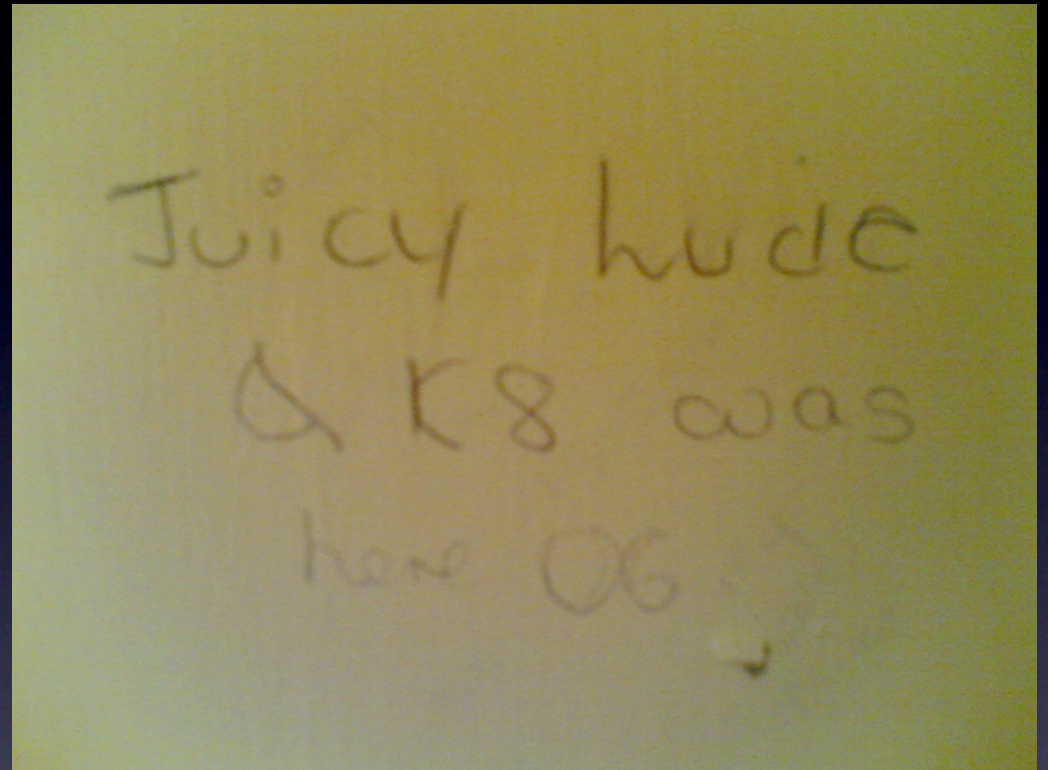
# What is your Bluetooth name?

- Name-changing patterns
  - Data is too noisy
- Intentional categories
  - Sexual, greeting, invitation, insult
- Lexical categories
  - Default, custom,
  - Identifiers, associations, t-shirt, graffiti



# Bluetooth & Graffiti

a.k.a. “Juicy Lucie”





Han  
waz  
ere.  
06

waz  
ere.  
06

Rosie  
waz  
ere  
06

Qna  
groovy

July had  
a 18 car  
line up

Sixty  
Rocky  
space.com/19144

George  
George  
Laura  
Don't  
Don't



# Do you ever send stuff? (Bluetooth honeypots)

- Bluetooth honeypot
- Various names
- Various device classes
- Are you the girl in the corner! :o);

# Do you receive stuff? (BlueSpamming)

- Hypothesis: name of sender affects recipient's reaction
- Issues in automating this process
  - Protocol behaviour, user prompts



# Bluetooth CSI

Bluetooth

# CSI:

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Research



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Early morning,  
November 29,  
2006

Detectives have launched an investigation after a teenag...last night fighting for his life in hospital after he...

http://www.thisisbath.com/displayNode.jsp?nodeId=163061&command=di... bath chronicle

VK Home movs Blue-White GT ODEON - Bath Google docs

Detectives have launched a...

**this is bath**  
in association with **Chronicle**

Sign up for the New Year and we'll help you keep your resolution.

Set your quit date now.

Hello Guest [Log In] JOBS | MOTORS | PROPERTY Tuesday, January 9, 2007

LATEST: Gay demo religious groups attacked

previous | back to list | next

**TEENAGER FIGHTS FOR LIFE AFTER FALL**

11:15 - 30 November 2006

Detectives have launched an investigation after a teenager fell from the top of a four-storey city centre building. The 18-year-old was last night fighting for his life in hospital after he apparently fell from the roof of Caffè Nero in the High Street.

Police were called at 1am yesterday following reports that a man had plunged from the roof.

The student was taken to the Royal United Hospital in Bath with serious head injuries.

His condition was described as critical but stable.

Detectives are now investigating the circumstances surrounding the fall.

Another 18-year-old man, who is also believed to be a student, has been arrested in connection with the incident and was yesterday in custody at Bath Police Station.

Staff arriving at Caffè Nero to open up yesterday morning found it sealed off with police officers and firefighters inside.

The front of the shop remained sealed off until 1pm yesterday, but it remained open for business as customers were able to enter through a side door.

Anyone who witnessed the incident or has any information is urged to call Bath CID on 0845 4567000 or Crimestoppers anonymously on 0800 555111.

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HGV Driver

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Assistant Manager

Team Members

Book-keeper / Administrator

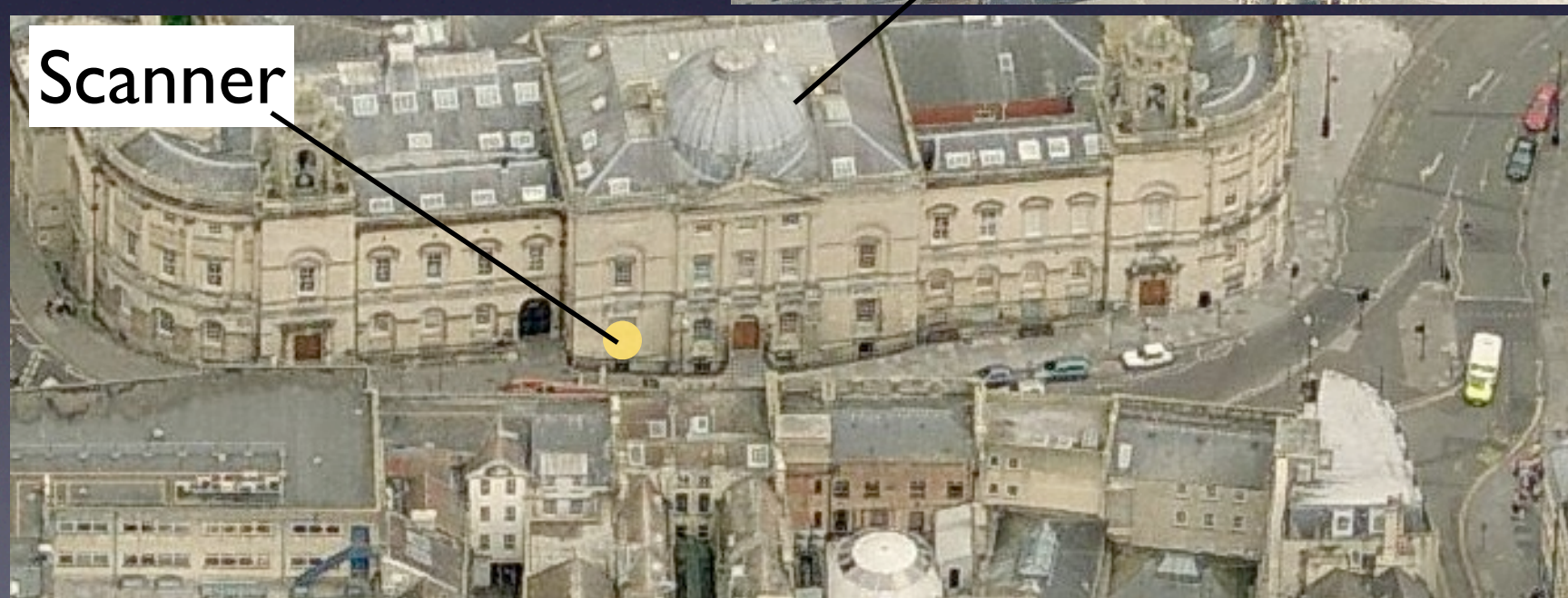
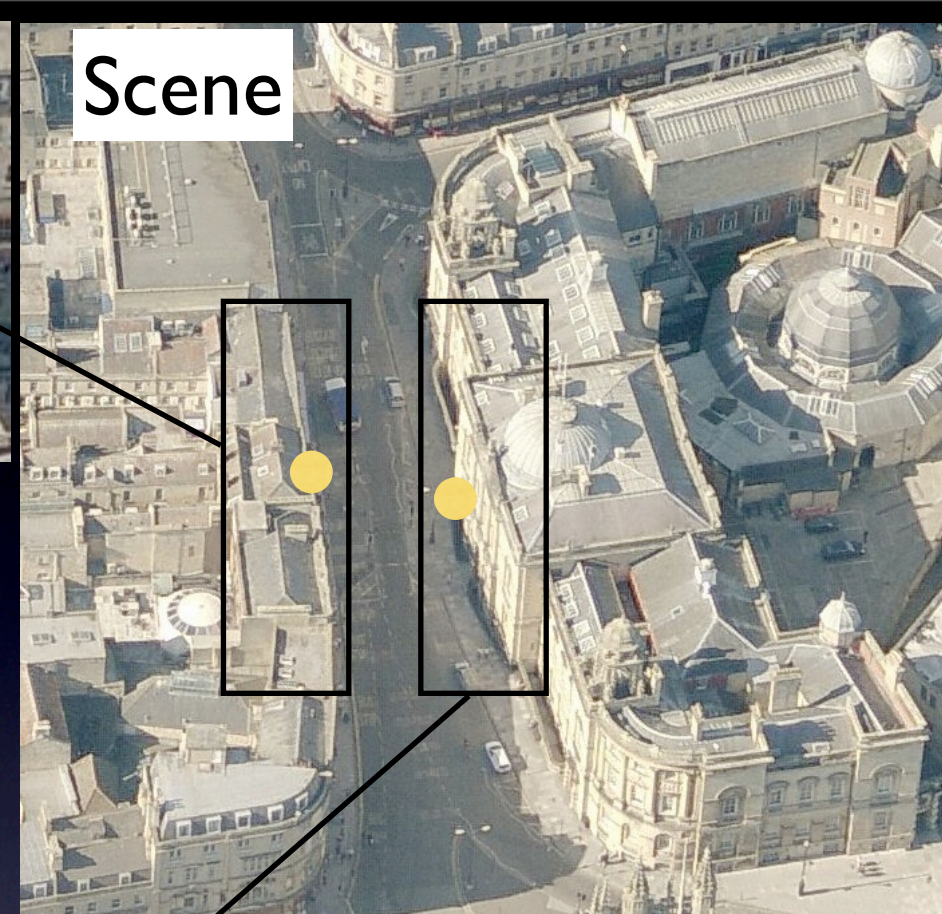
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click here for Bath's biggest selection

**this is**

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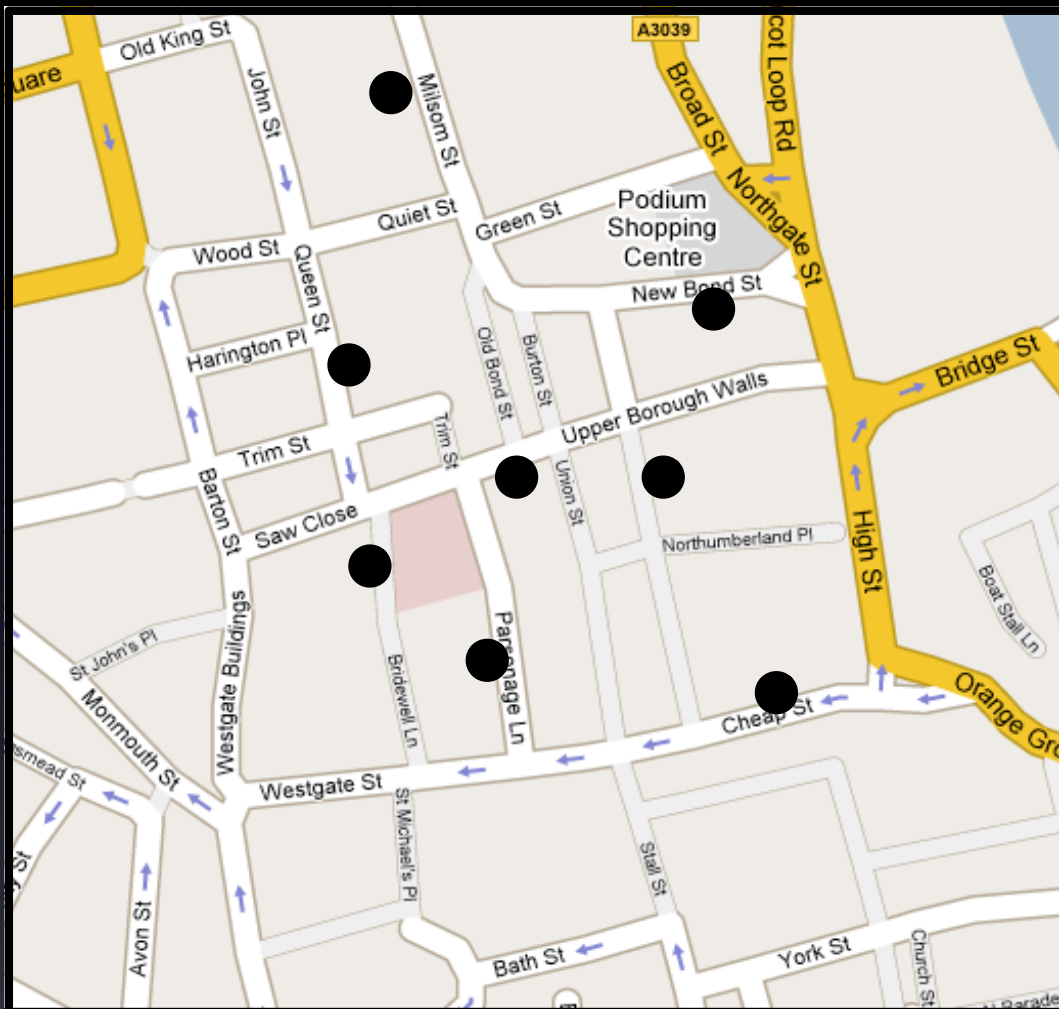


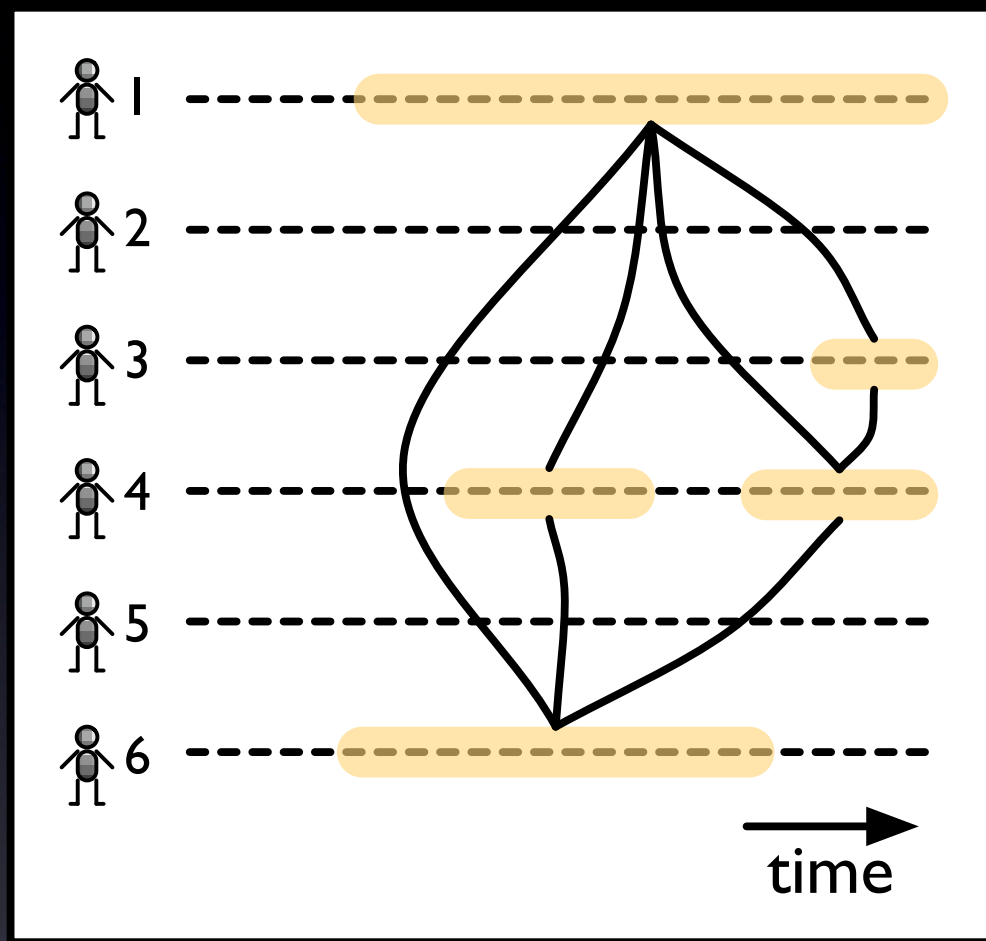
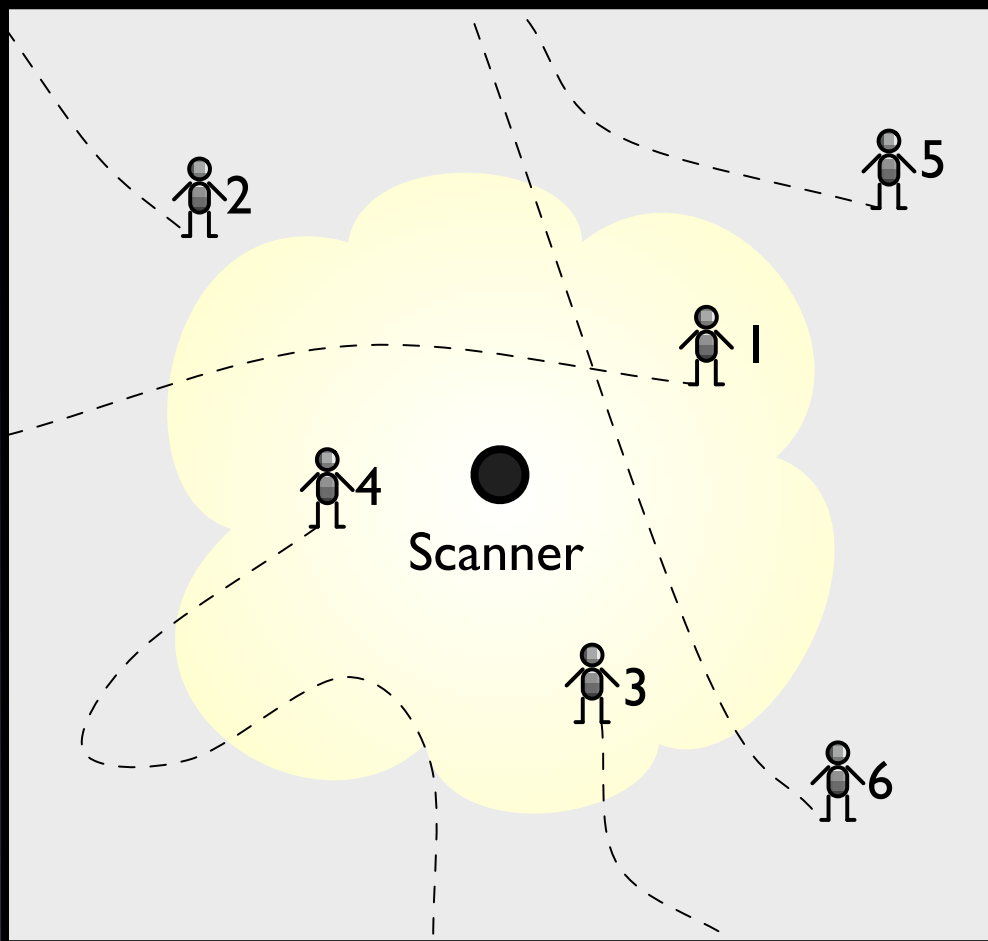
# Results

- Identify “suspects”
  - Taxi driver
  - Cleaner/security guard
  - One-off visitor
  - Return to the scene of the crime

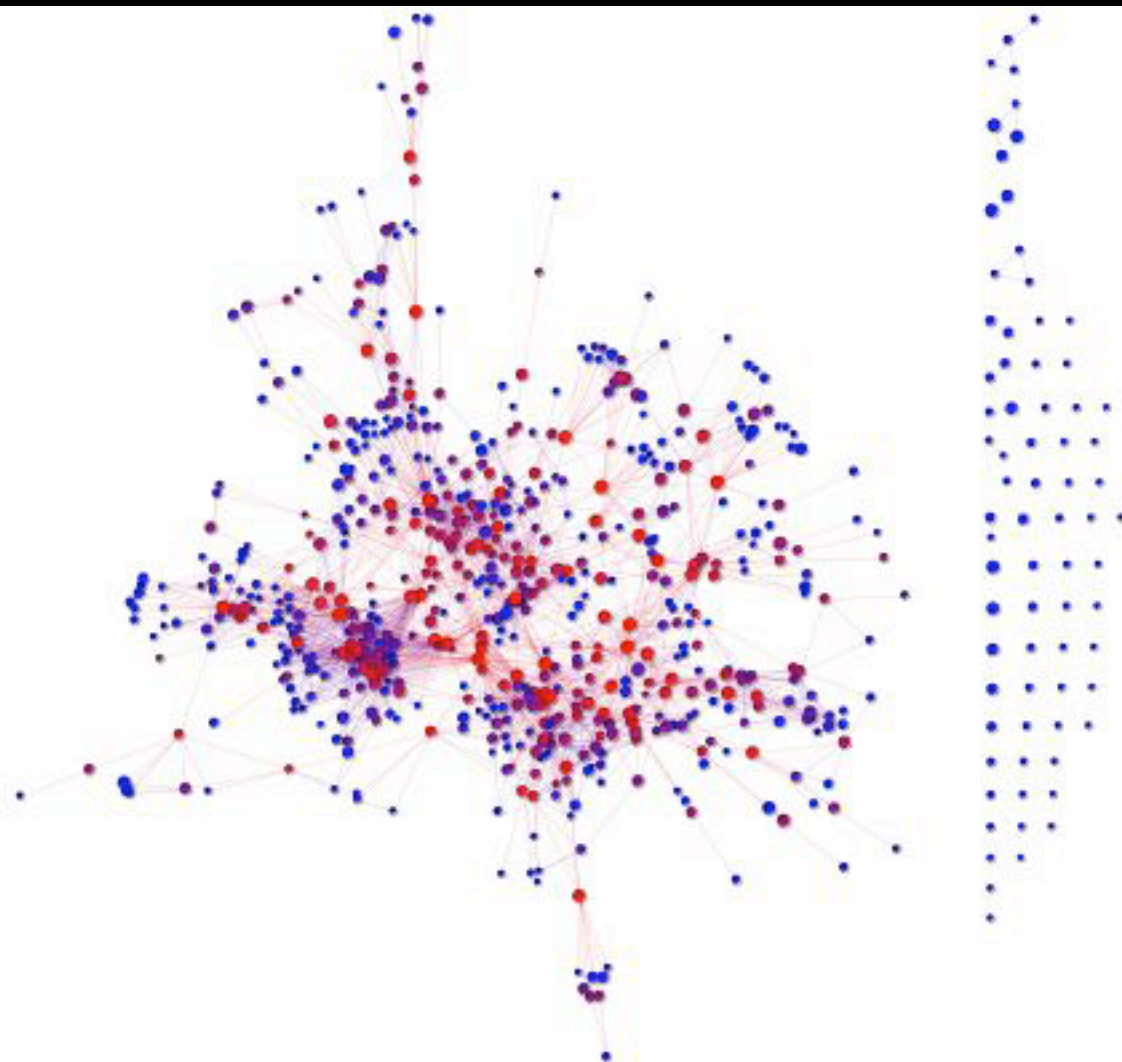
# Viruses, diffusion

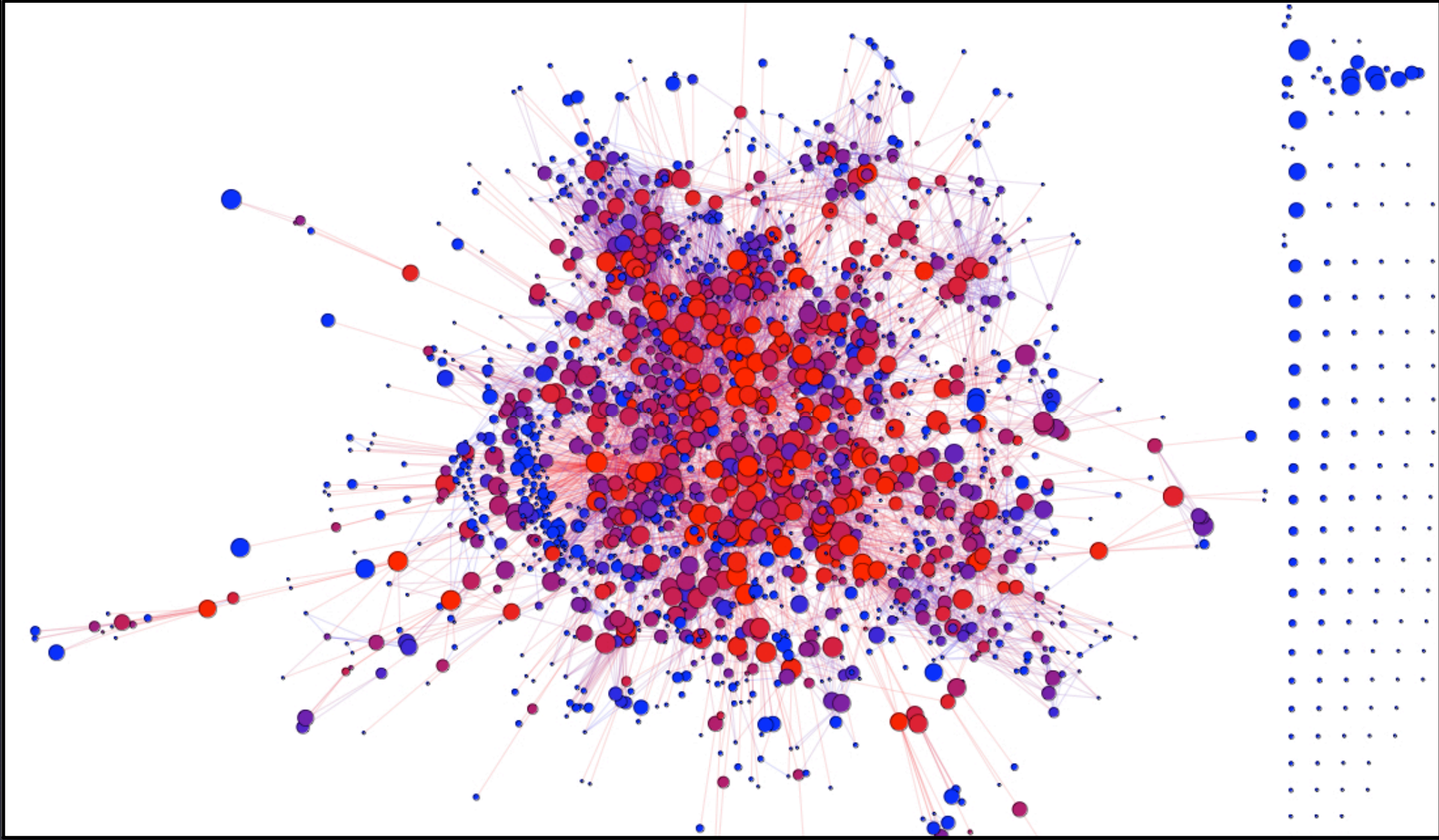






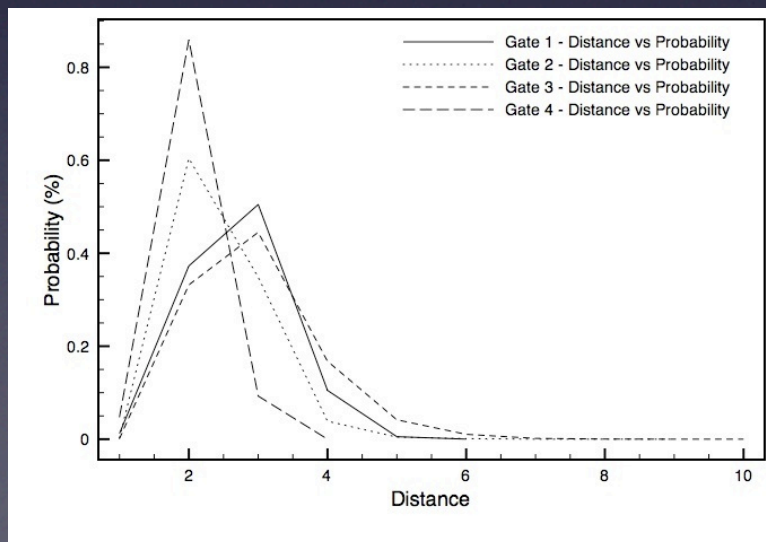
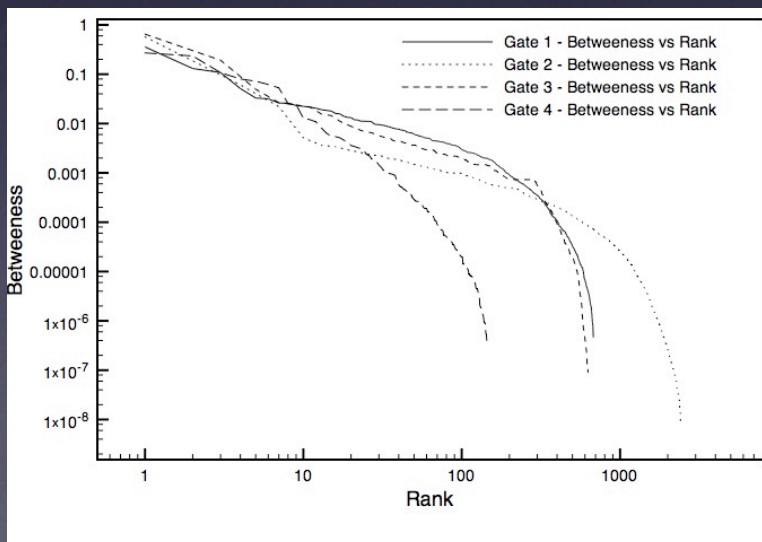
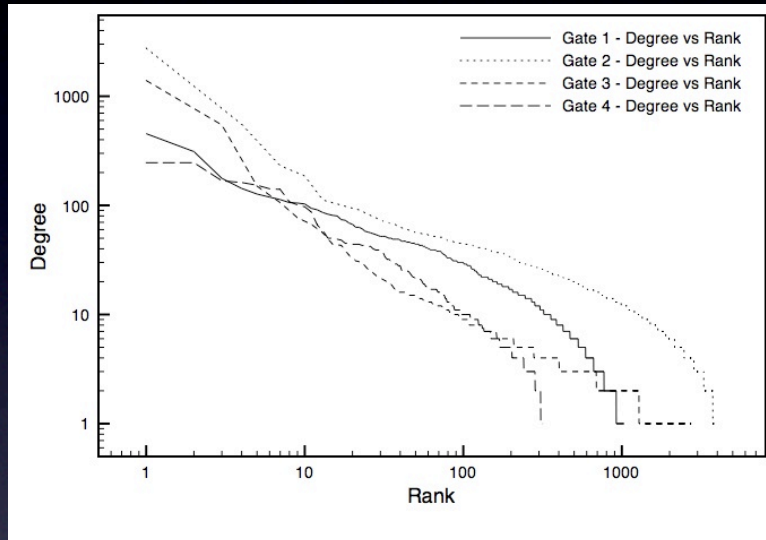
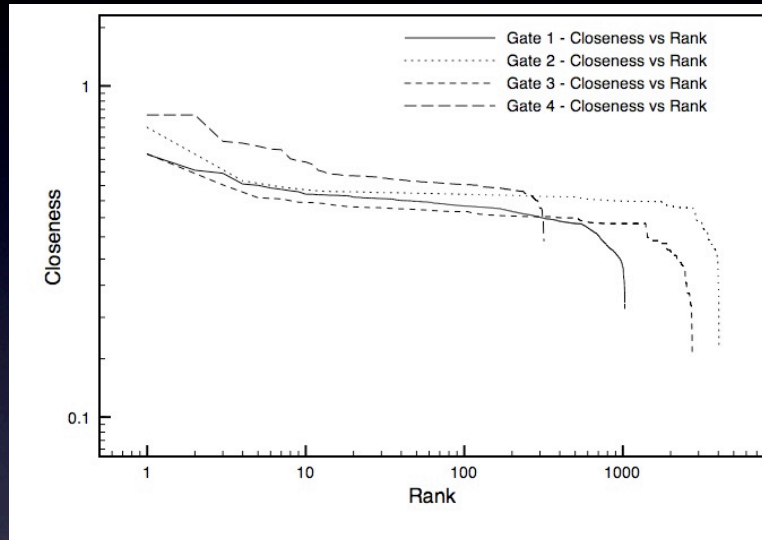








# Power laws and exponential decays





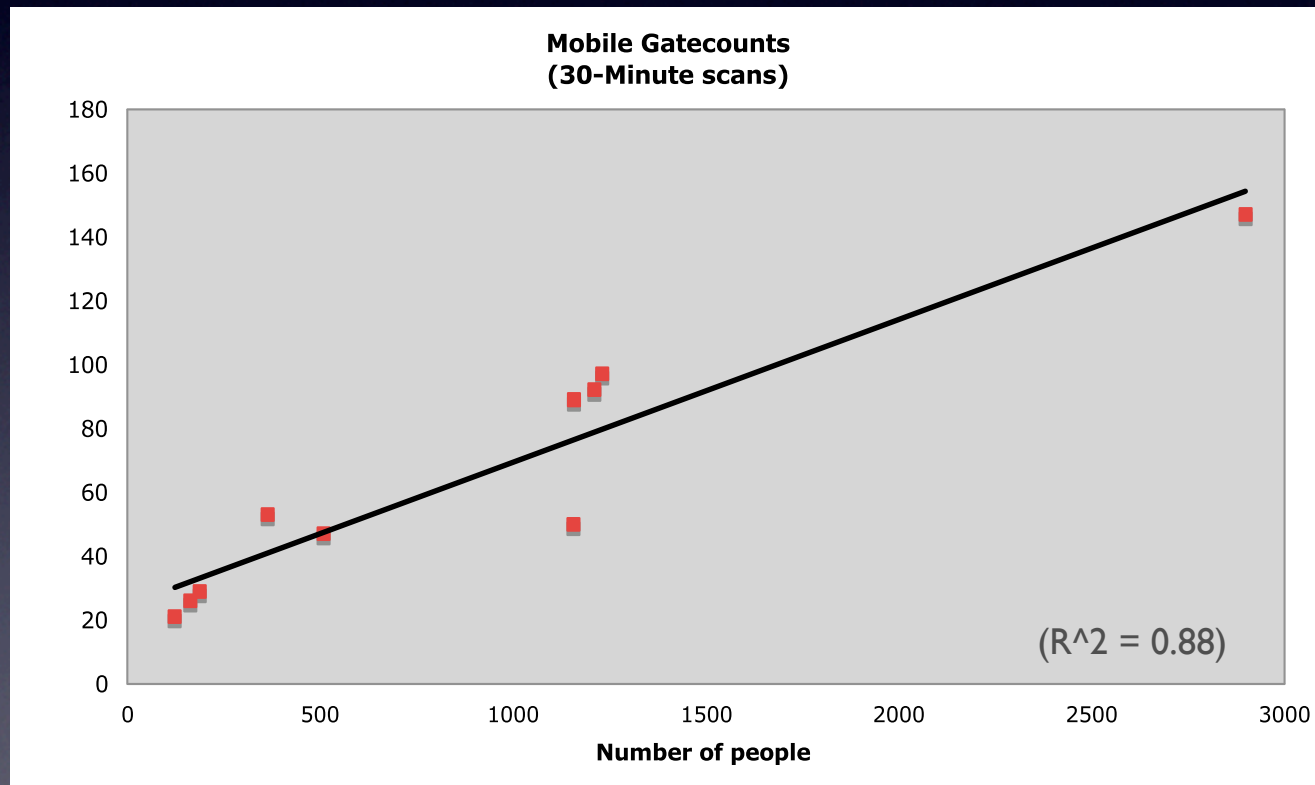
# Gatecounts





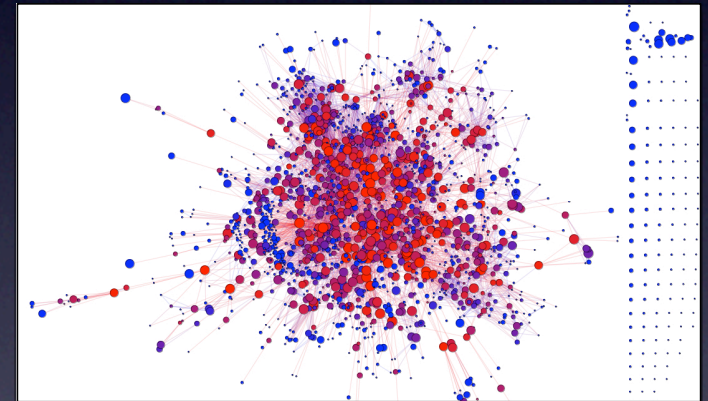
# Bluetooth visibility

- Around 7.5% of observed pedestrians had discoverable Bluetooth devices



# Dynamic properties

- Our data is not static
- 3D structure
- Chain of events





# Chain of events

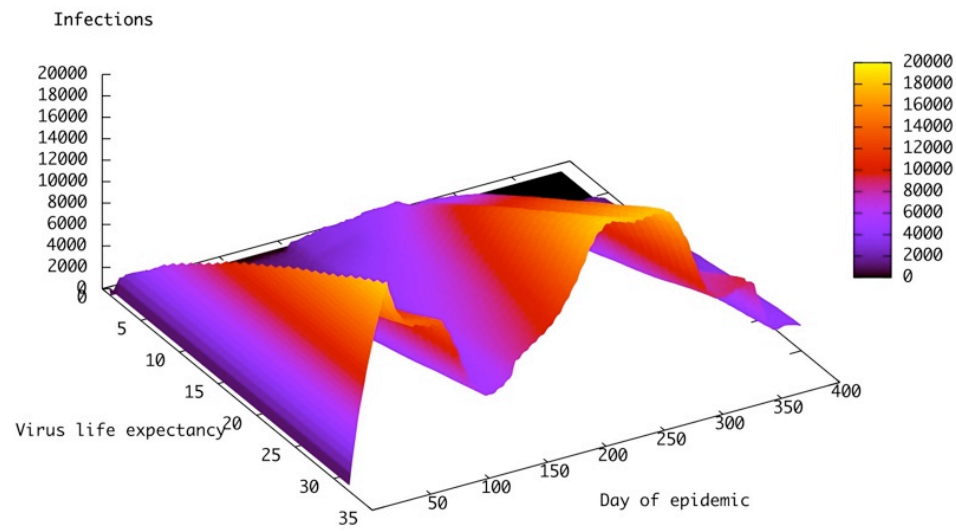
- John, Mary, 14:20:30
- John, Paul, 14:20:32
- Mary, Nick, 14:20:33
- ...

# Emulation

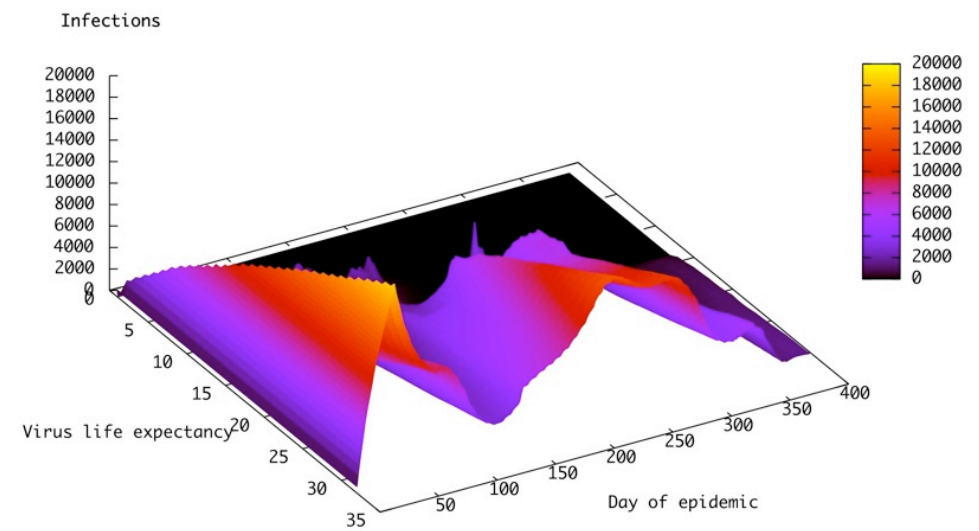
- Class “device”
- Class “virus”
- During encounter, virus is transmitted
- Device recovers (SIS) or dies (SIR)

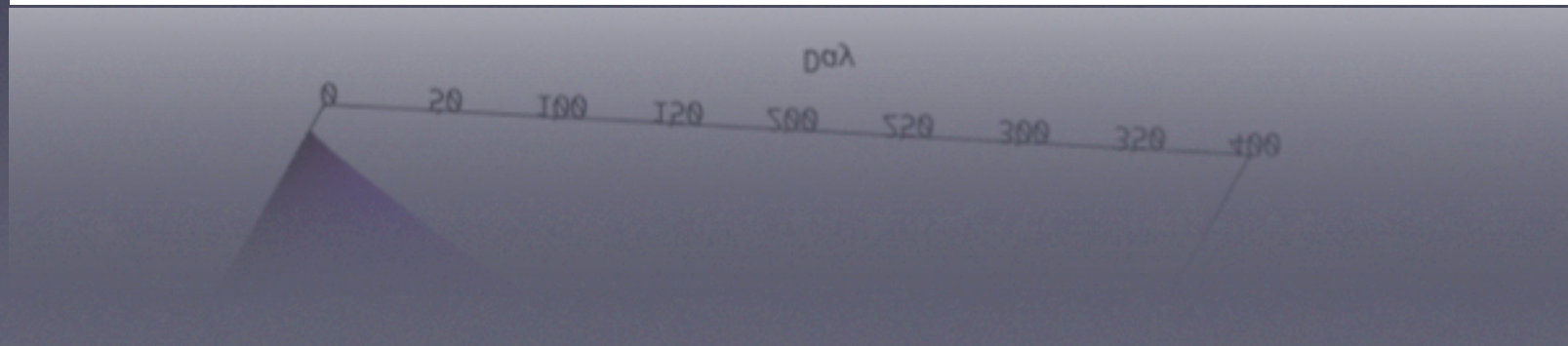
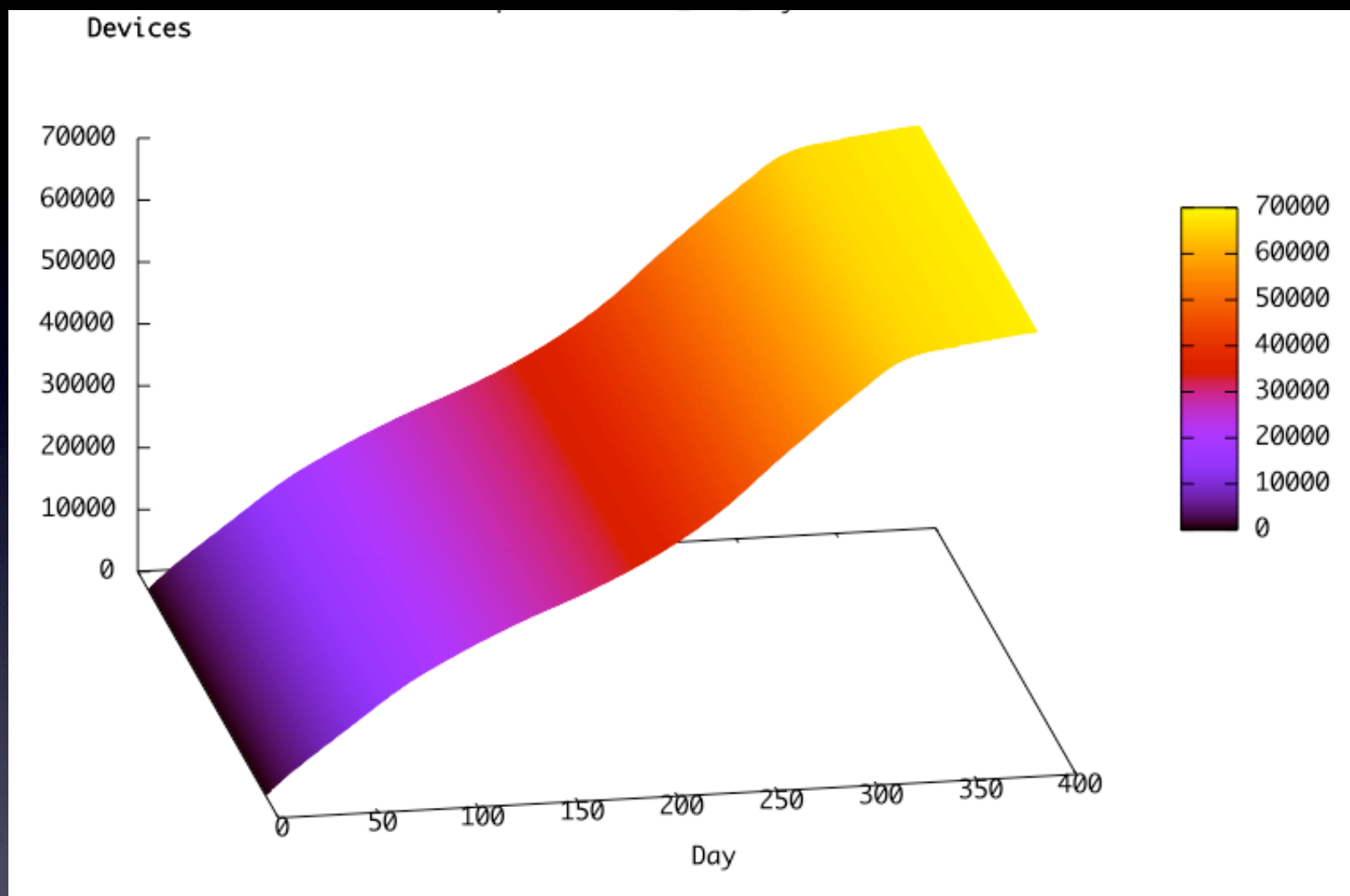


Virus spread - bath\_sis.txt



Virus spread - bath\_sir.txt



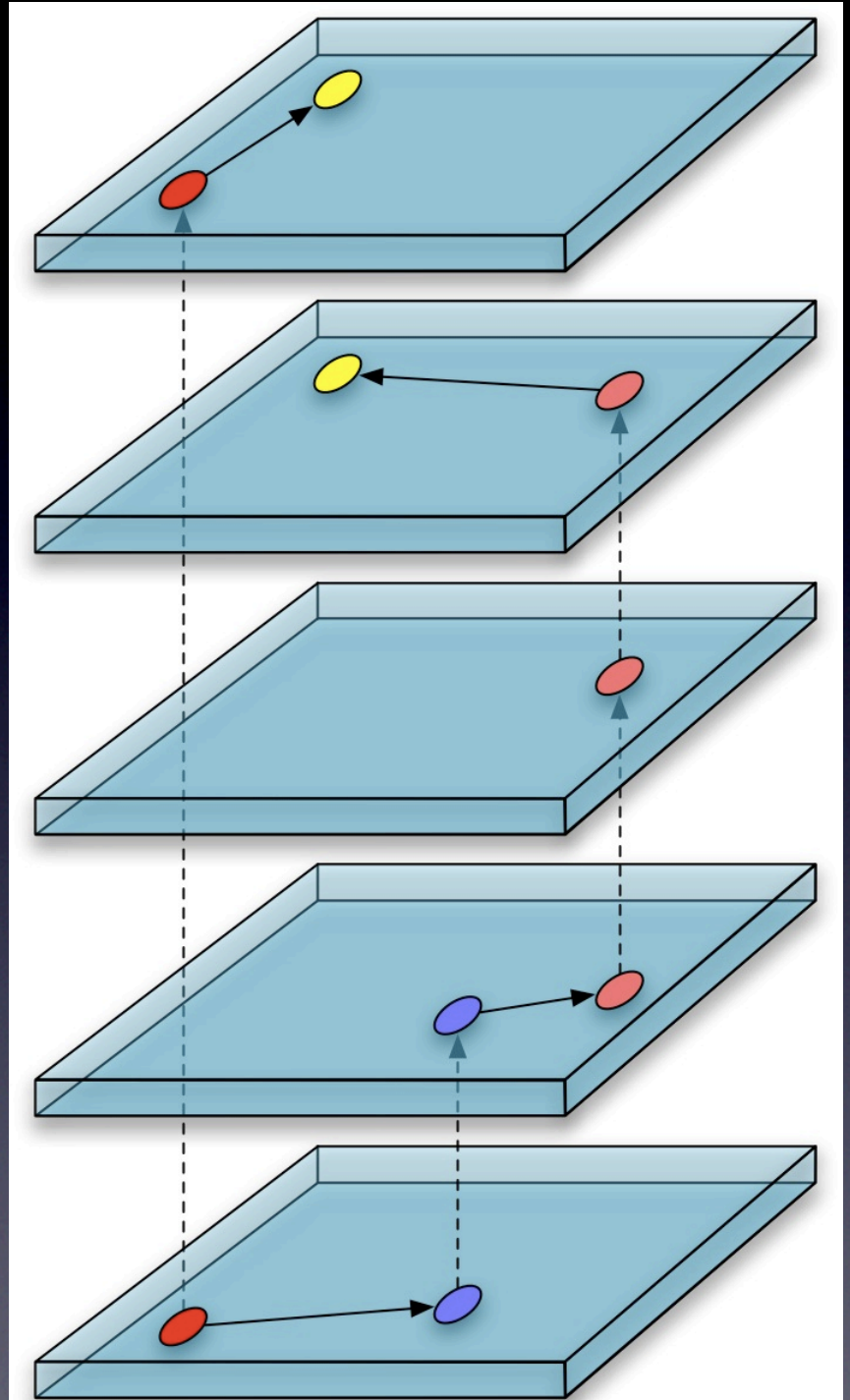




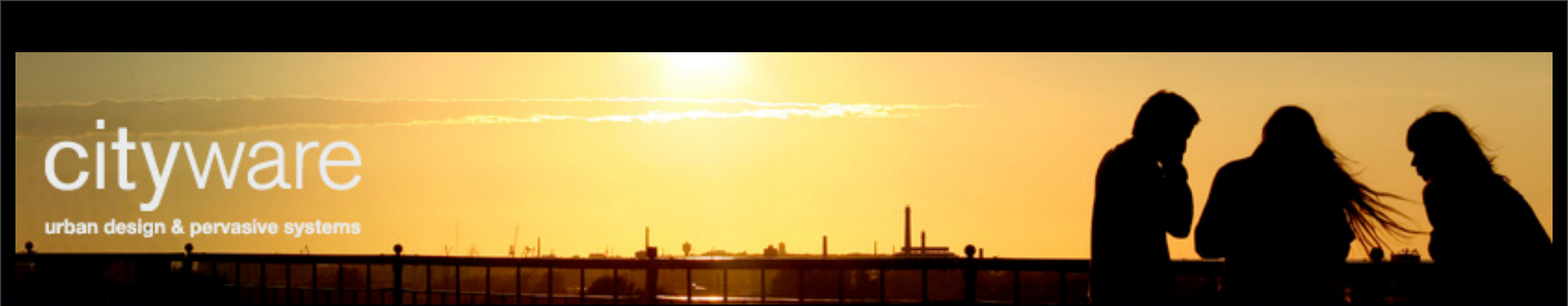
# DTN forwarding algorithm

- Static features
  - Node degree
  - Node betweenness
  - Node closeness
  - Average geodesic path (Bath = 3.3)
  - Community detection (21 using Newman)

# Considering time







cityware

urban design & pervasive systems

# Thank you

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<http://www.cityware.org.uk>