# Public Access WiFi Service (PAWS)

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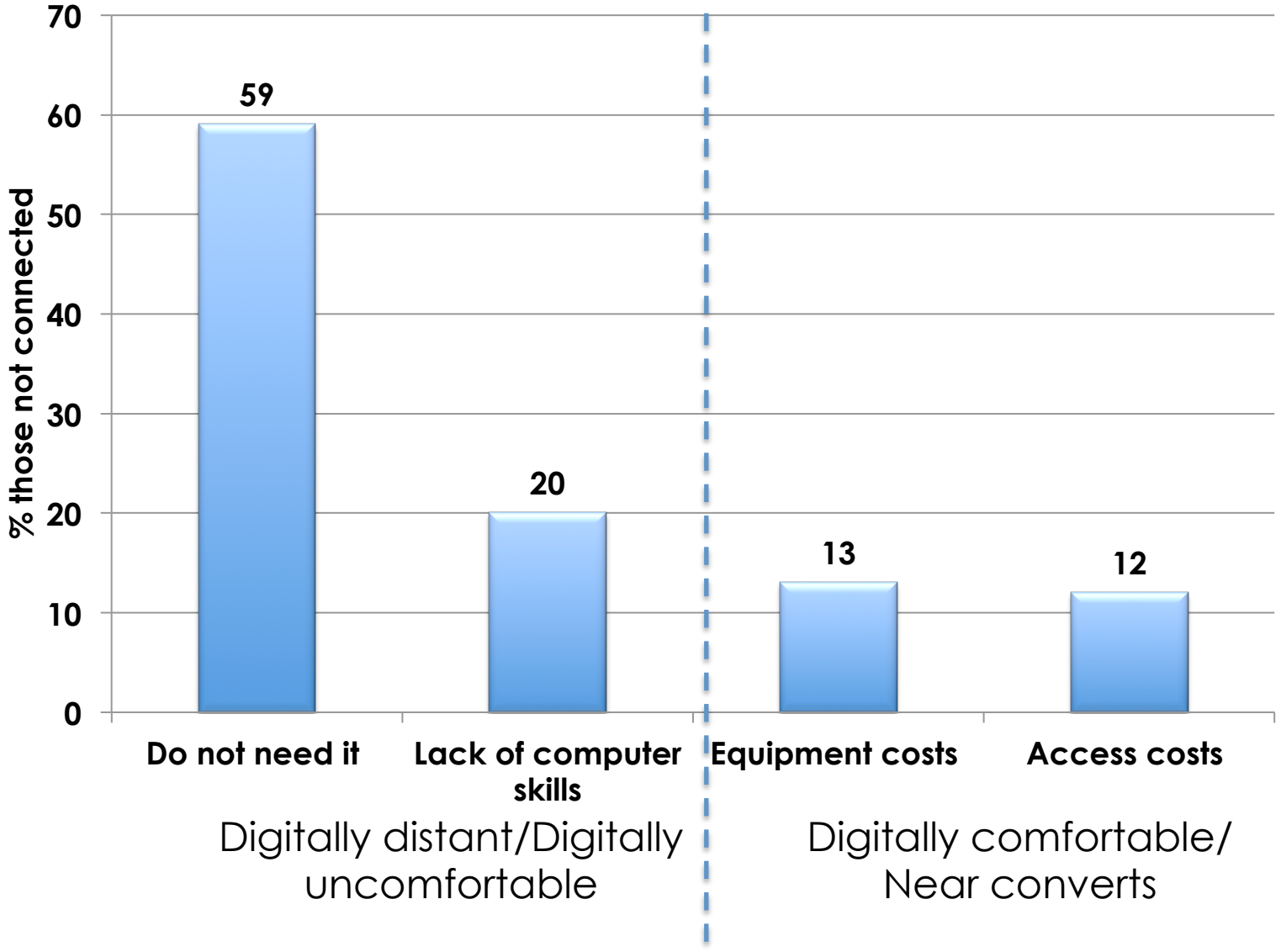
# Internet access is challenged

- **Geographic**
  - Conventional Internet access has physical limitations
  - Not economically feasible for a network operator to provide coverage
- **Economic**
  - Access to fixed broadband in some developing countries costs almost 40x-100x the national average income
  - In developed countries, affordability limits broadband access in impoverished communities
- Regulatory, Social & Capacity building challenges

# Mandatory to solve the Socio-Economic Problem




ONS 2013: 4 million households without internet access

# Lowest Cost Denominator Networking (LCDNet) VIsion

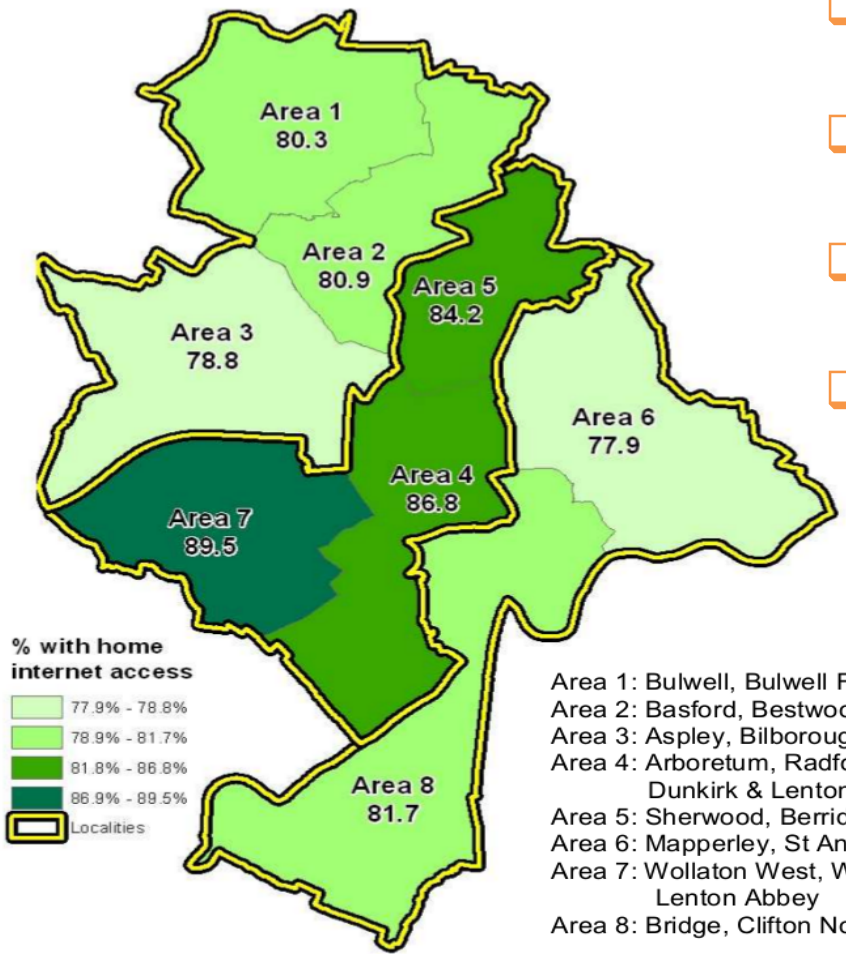
- How do we make Internet access free at the point of use
- Solve the problem of digitally comfortable/near converts
- Provide opportunities for digitally distant/digitally uncomfortable to explore the benefits of Internet
- "An environment that stimulates curiosity can cause learning through self-instruction and peer-shared knowledge" - Sugata Mitra
  (Hole in the Wall)

# Public Access WiFi Service (PAWS)

- An in-the-wild attempt to explore a solution to solve the urban broadband affordability problem
- Funded by the EPSRC - Cambridge (Lead), Nottingham, BISMark, BT, SamKnows, Nottingham City Council
- Can the "*have nots*" piggyback on existing home broadband of the "*haves*" for free and at lower quality?
- In-the-wild Research with real users:
  - Would this work?
  - What are the challenges?
  - What are we going to learn in the process?

# Study Context: Social

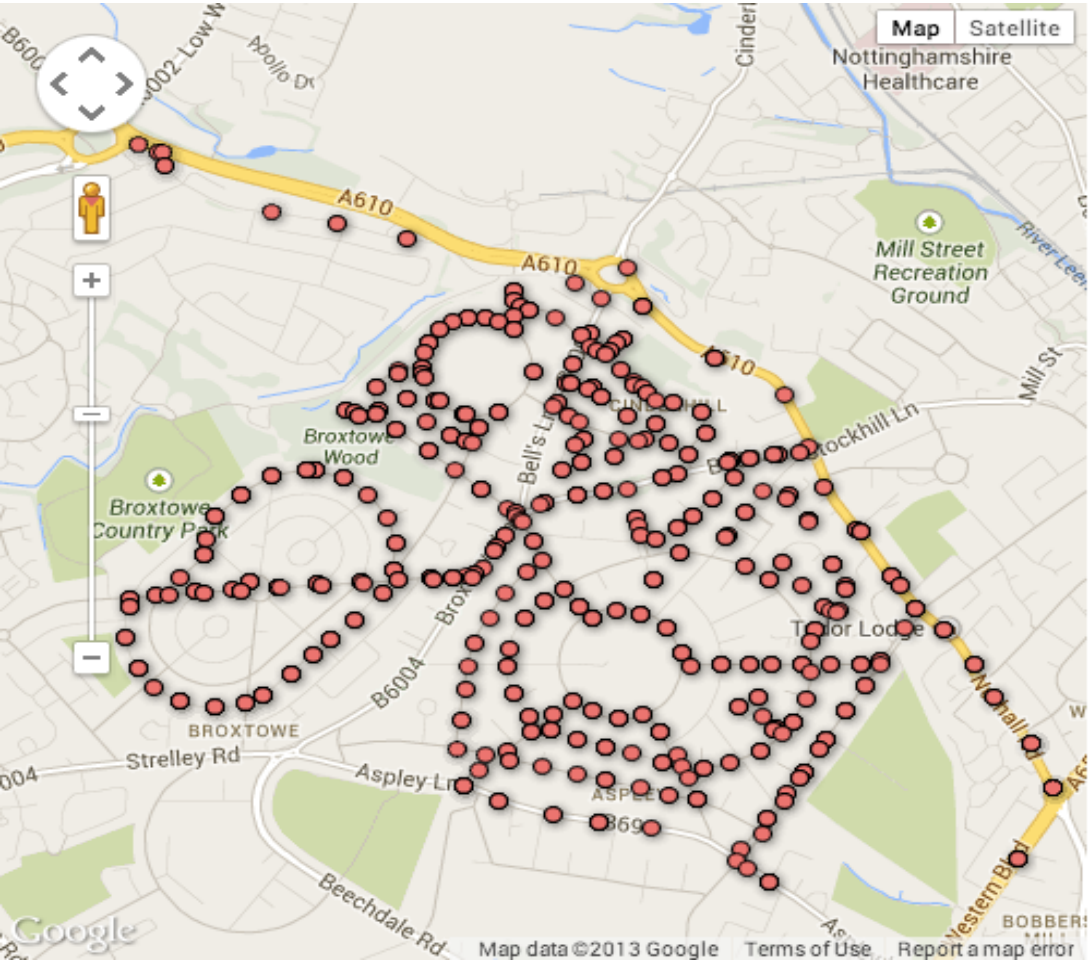
- Nottingham: Medium sized city with a population ~300,000
- Aspley: population of >16,000 in ~6280 households (2004 estimate)
- Ranked bottom 10% nationally for deprivation
- Highest teenage pregnancy in Europe
- Unemployment rate of over 10% (3x national average and 2x city)
- 28.5% are digitally excluded




Area 1: Bulwell, Bulwell Forest
Area 2: Basford, Bestwood
Area 3: Aspley, Bilborough, Leen Valley
Area 4: Arboretum, Radford & Park, Dunkirk & Lenton
Area 5: Sherwood, Berridge
Area 6: Mapperley, St Ann's, Dales
Area 7: Wollaton West, Wollaton East & Lenton Abbey
Area 8: Bridge, Clifton North, Clifton South

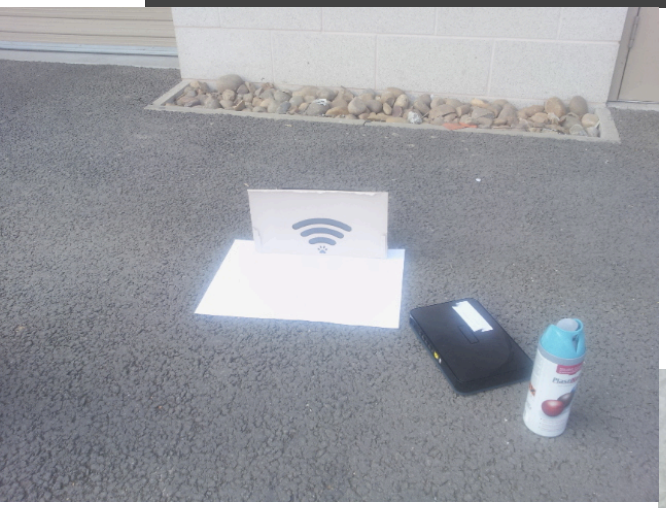
# Study Context: Technical

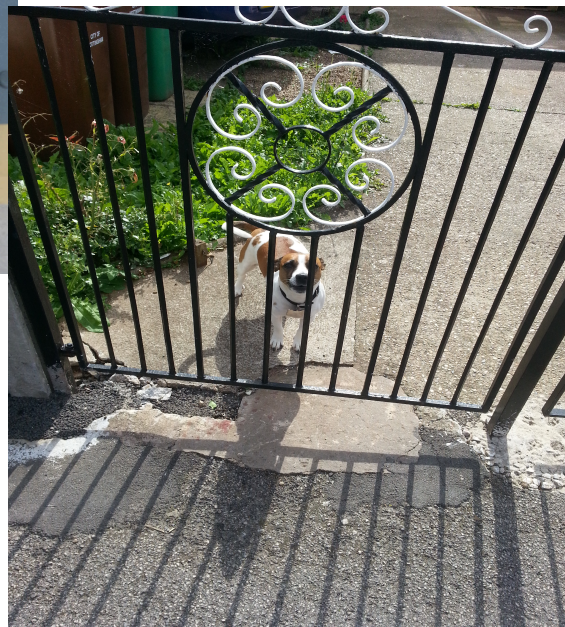
- 52% of 16-24 and 23% of skilled working class, working class and non-working class have smartphones (2011 estimates)
- Wardrive sampled 40% of the streets
- Found 1067 unique APs




| Provider | Percentage |
|---|---|
| SKY | 23% |
| Virgin | 21% |
| BT | 23% |
| FON | 61% of BT |
| Unspecified | 33% |

# Recruitment unravels



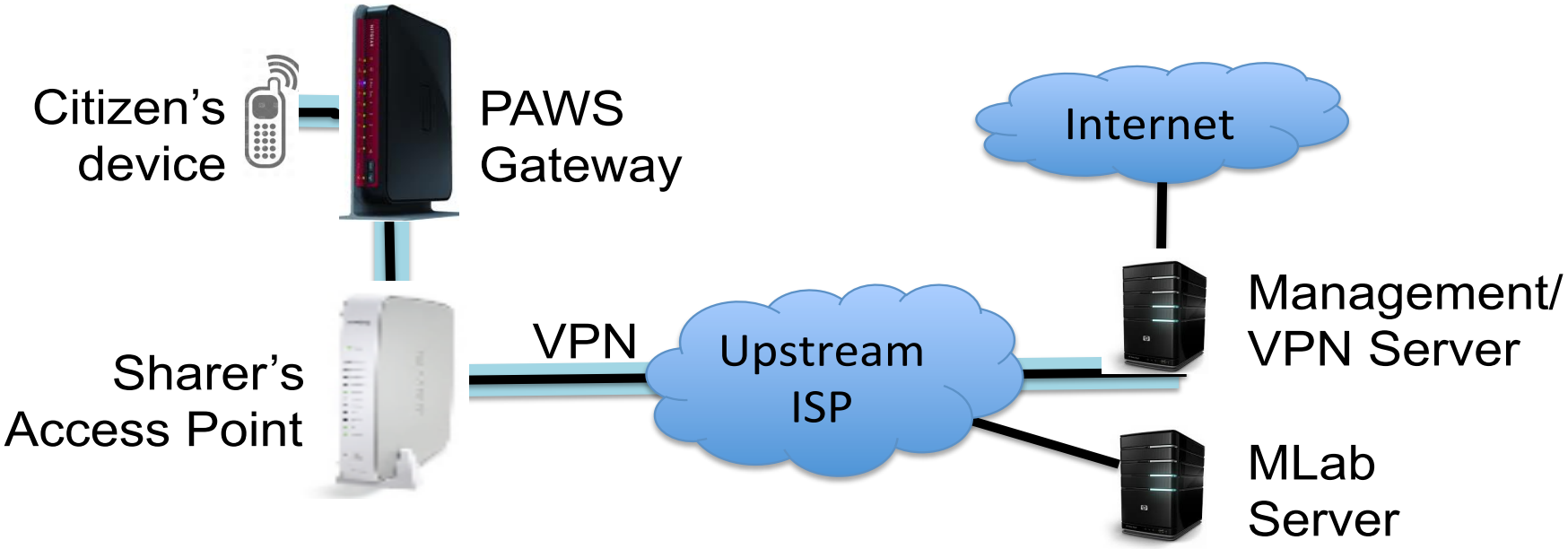


# Recruitment

- Recruitment specifically targeted the "near converts" and the "digital hopefuls" where cost is the main barrier to adoption (Horrigan, 2011)
  - Not the "digitally uncomfortable" and "digitally distant"

| Doors Knocked | ~2158 |
|---|---|
| Recorded responses | 730 |
| Potential Sharers | 98 (18.3%) |
| Potential Citizens | 36(4.9%) |
| Sharers (PAWS installed) | 20 |
| Citizens (via self signup) | 54 |
| Active Citizens | 18 (two from recruited, others via self signup) |

# PAWS: Technical Architecture




- VPN (PPTP and L2TP support)
- Firewall policies (DHCP, ICMP, DNS, management, VPN, measurement server, HTTP/HTTPS redirected to self signup page)
- Enabling Less than Best Effort (LBE) access
  - WiFi access points : lack of QoS (both upstream and wireless)
  - DSLAM/MSAN: Need L2 QoS differentiation
  - PAWS: We throttle at 2Mbps downstream/512Kbps upstream

# # of PAWS routers

| ISP | Total | Measured |
|---|---|---|
| SKY | 6 | 5 |
| Virgin | 10 | 8 |
| Orange | 1 | 1 |
| TalkTalk | 1 | 1 |
| Tiscali/PIPEX | 1 | 0 |
| Griffin | 1 | 0 |

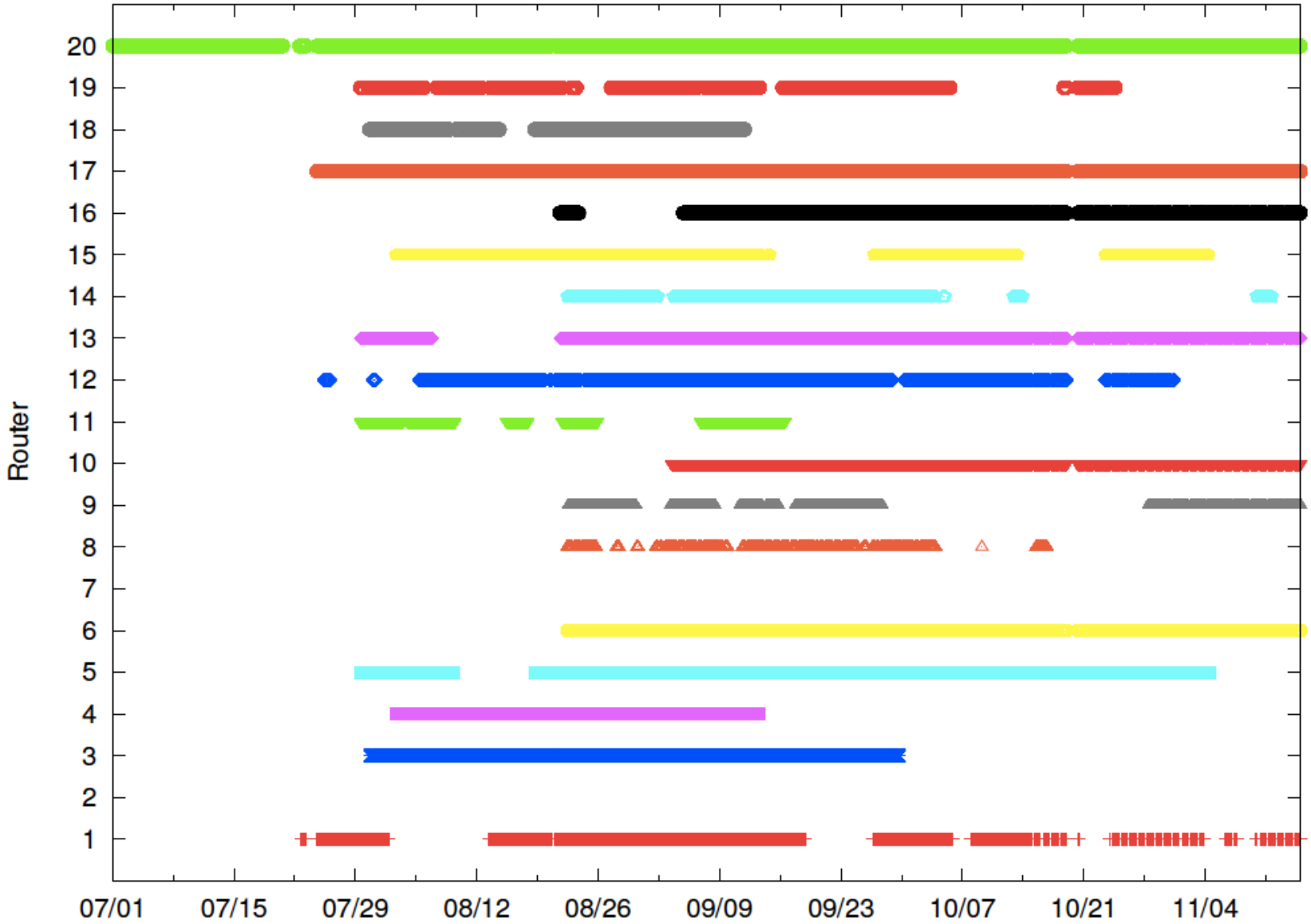
- 20 PAWS routers deployed between July 2013-March 2014
- 8 were used by 18 citizens: two was deployed in a public space
- Remaining 12 served as measurement points

# PAWS: Measurements

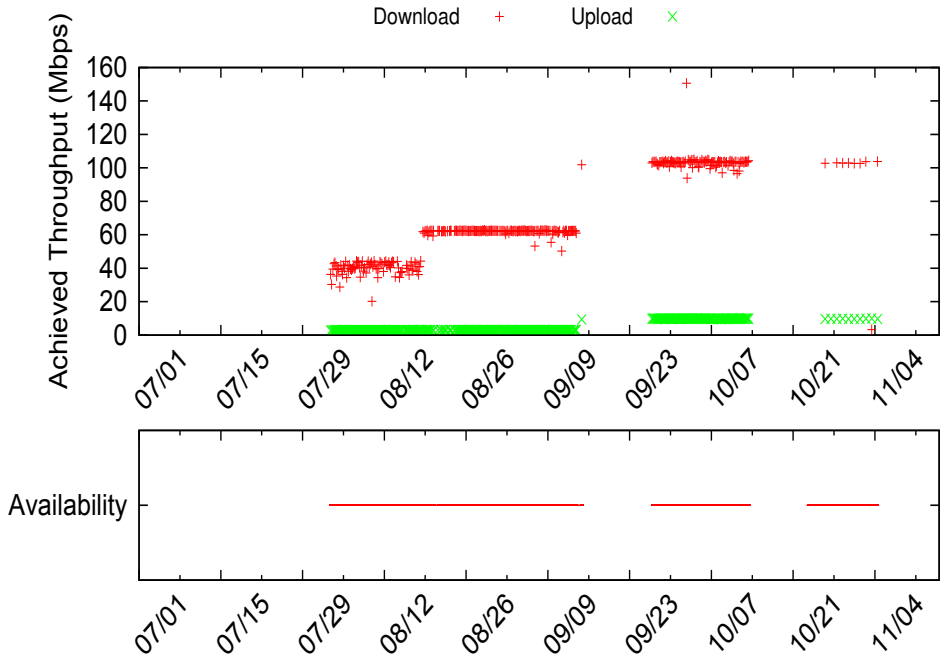
- Availability
- How much unused capacity is actually available
- Citizen Usage

| Metric | Method | Frequency |
|---|---|---|
| Availability | UDP Probe (60 B) | Every min |
| Throughput | NETPERF (3 Parallel TCP) | 6 hours |
| Last Mile Latency | Traceroute/Ping to first non-NATed IP | Every 10 mins |
| E2E RTT | Ping to different servers | Every 10 mins |
| Loss | D-ITG | Every 15 mins |

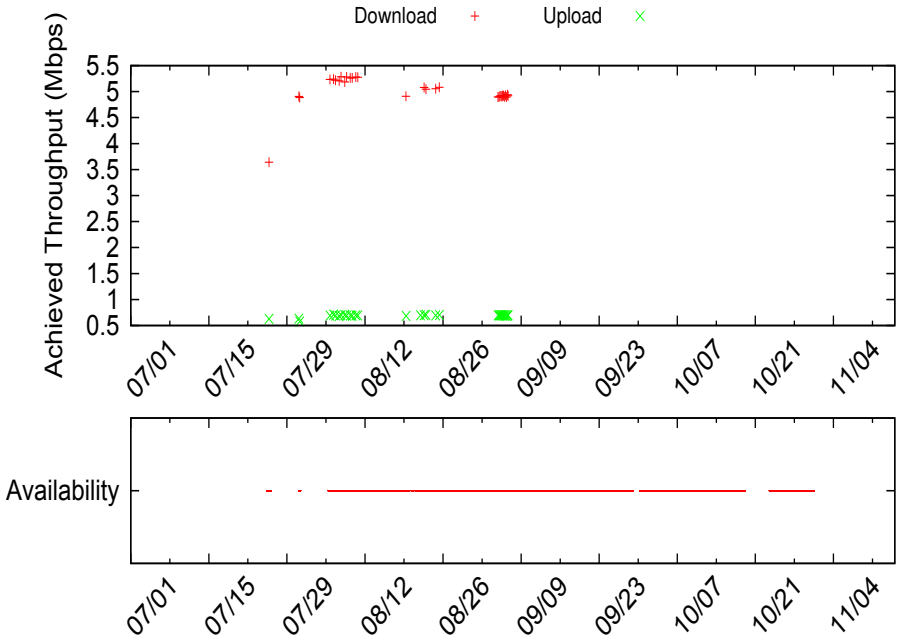
# PAWS: Availability



# Understanding the Broadband Performance Measurements

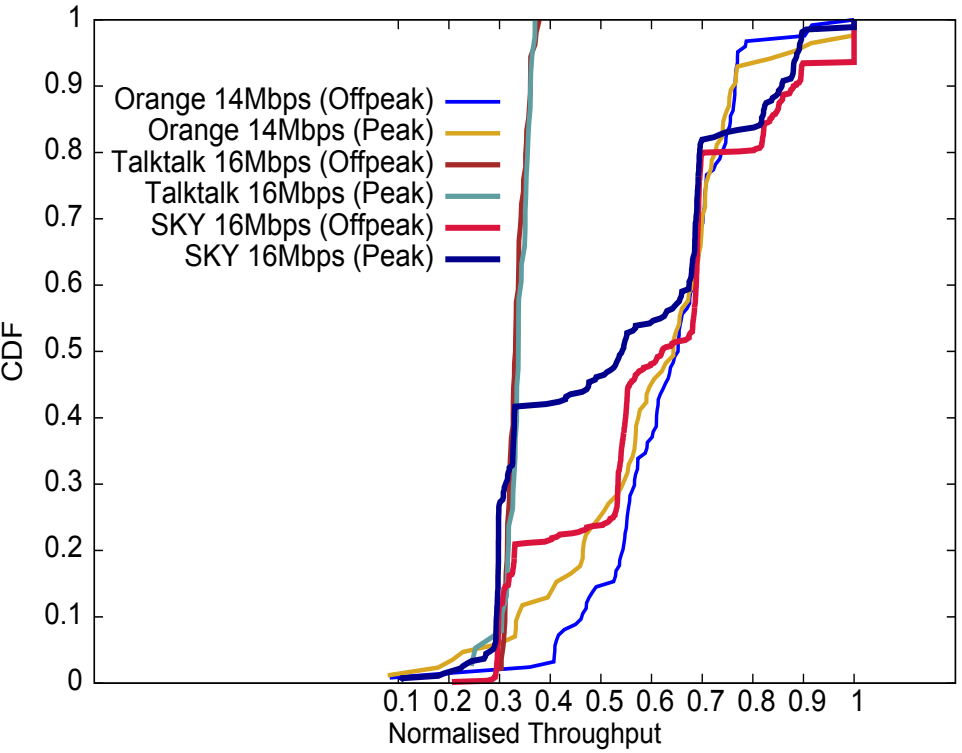



Virgin Fiber
(60/100Mbps)

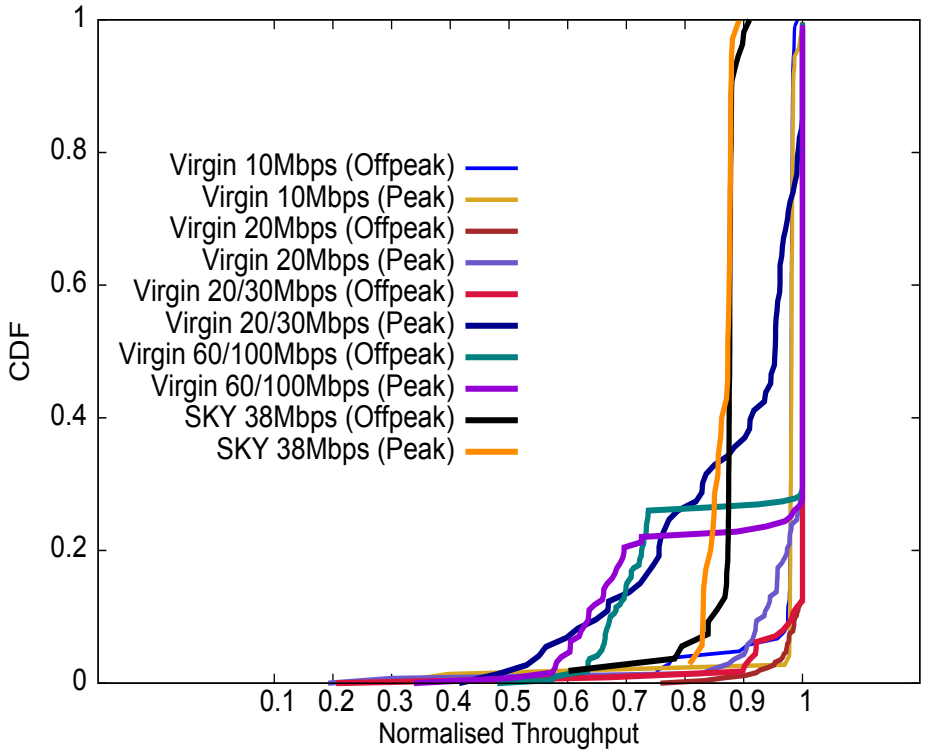



SKY ADSL
(16Mbps)

# Capacity (download)




ADSL




Fiber

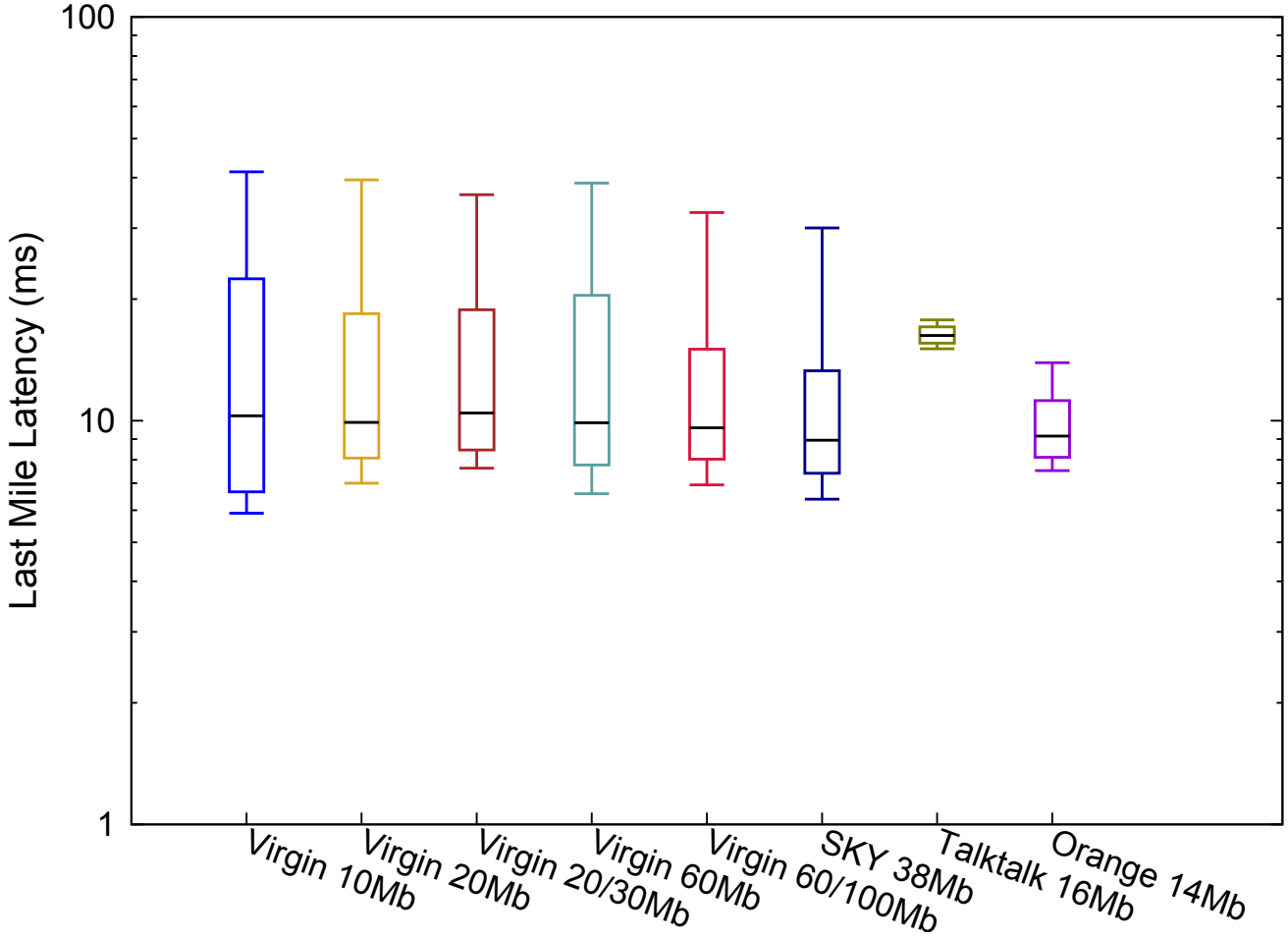
- **Fiber has sufficient capacity to share 2Mbps 100% of the time**

# Capacity(upload)

| ISP | Min (Mbps) | Max (Mbps) | Average (Mbps) |
|---|---|---|---|
| Virgin 10 | 0.33 | 1.00 | 0.68 |
| Virgin 20 | 1.01 | 1.18 | 1.12 |
| Virgin 20/30 | 1.05 | 2.01 | 1.23 |
| Virgin 60 | 2.45 | 3.00 | 2.94 |
| Virgin 60/100 | 2.5 | 9.95 | 5.15 |
| SKY 38 | 1.05 | 2.33 | 1.97 |
| SKY 16 | 0.47 | 1.31 | 0.91 |
| TalkTalk 16 | 0.72 | 0.90 | 0.87 |
| Orange 14 | 0.03 | 1.31 | 0.60 |

- **Sharing 512 Kbps on upload needs AQM/QoS on home routers/BRAS**

# Last Mile Latency and Loss



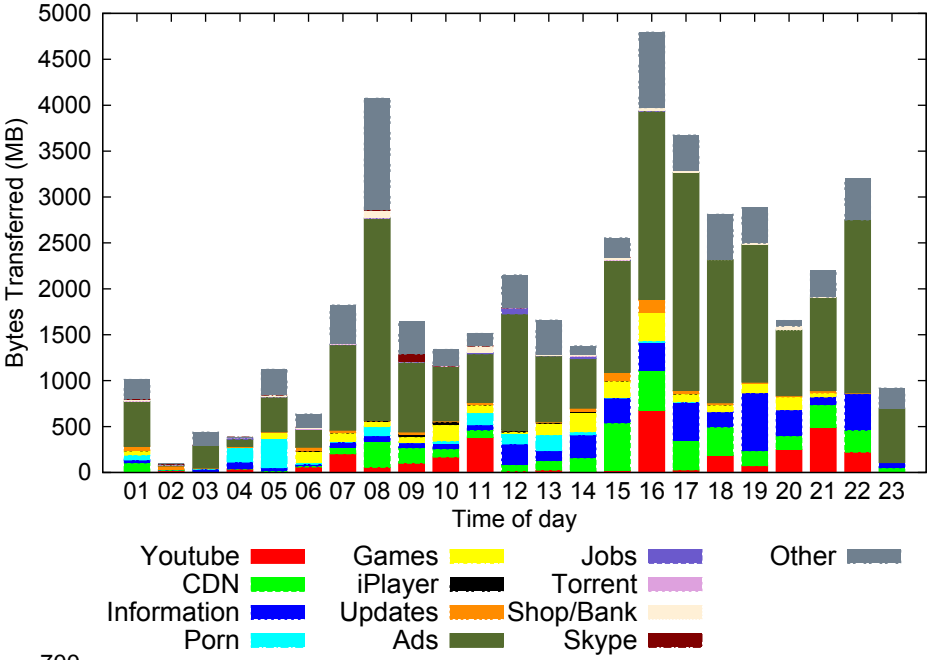

Loss was negligible < 0.07%

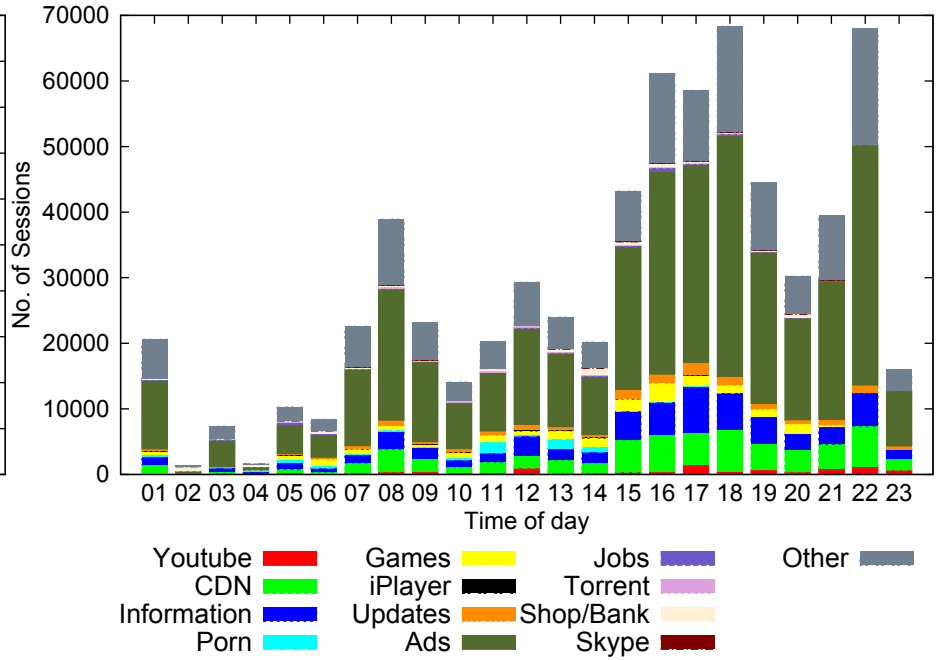
# Analysing Citizens Usage

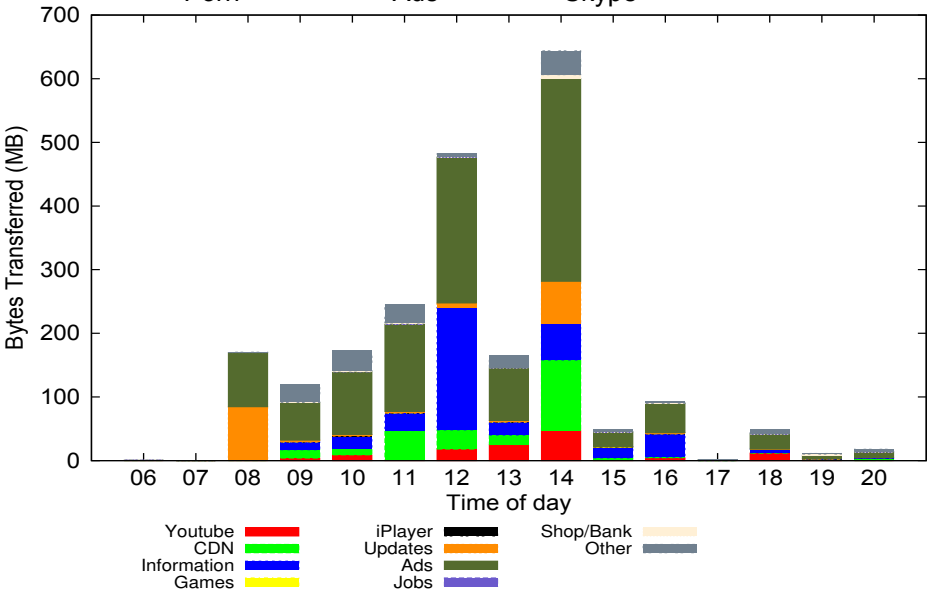
- Correlated tcpdump packet data with RADIUS logs
- Total 36GB traffic (15GB upload, 21GB download) by 18 citizens
- One citizen (primary citizen) stood out with 28GB
- Devices used: Primary citizen (Windows PC, iPhone), Six citizens connected via local community center (Windows PC), others (Android, iOS (iPad and iPhone)).

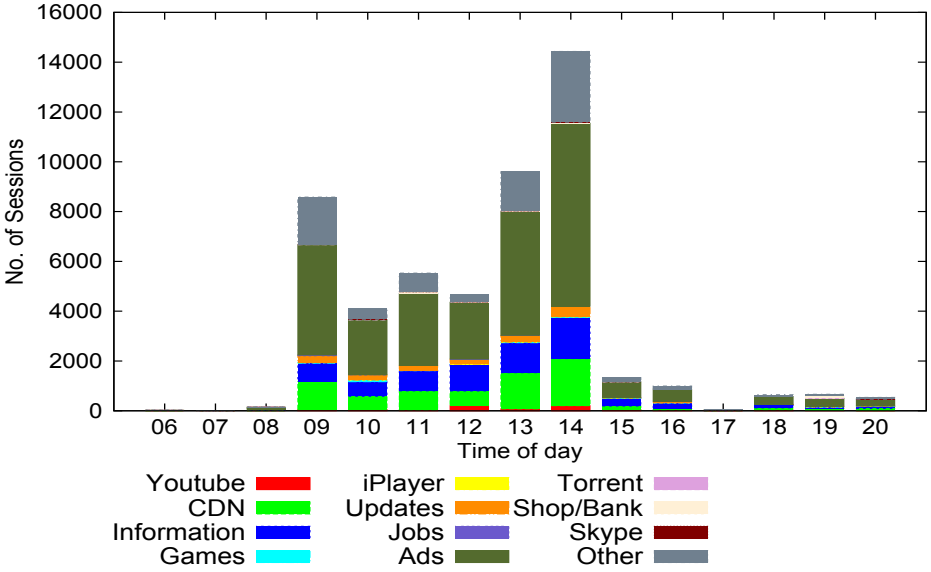
| Category | Sample keywords/netblocks |
|---|---|
| Ads | doubleclick, 2mdn, advert, analytics |
| BBC iPlayer | Iplayer, bbci |
| Jobs | job, reed, vacancy, career, work |
| CDN | edgecast, akamai, cdn |
| Games | game, mochi, nextgenhabbo, playfatal |
| Information | google, facebook, fbcdn, wiki, edu, .ac.uk, 173.194/16 |
| Updates | avast, mcafee, microsoft, apple, norton |
| Youtube | Youtube |
| Shop/Bank | tesco, asda, natwest, amazon, gumtree |
| Porn | xxx, porn, raunch, strip [others] |
| Other | [unmatched names, IP addresses] |

# Citizen Usage (by bytes and sessions)

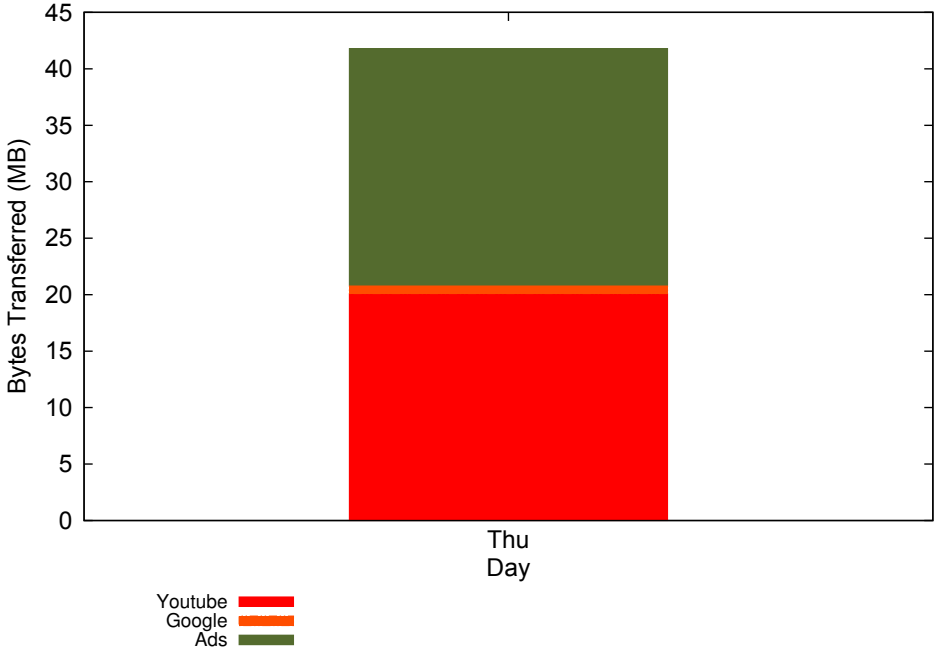


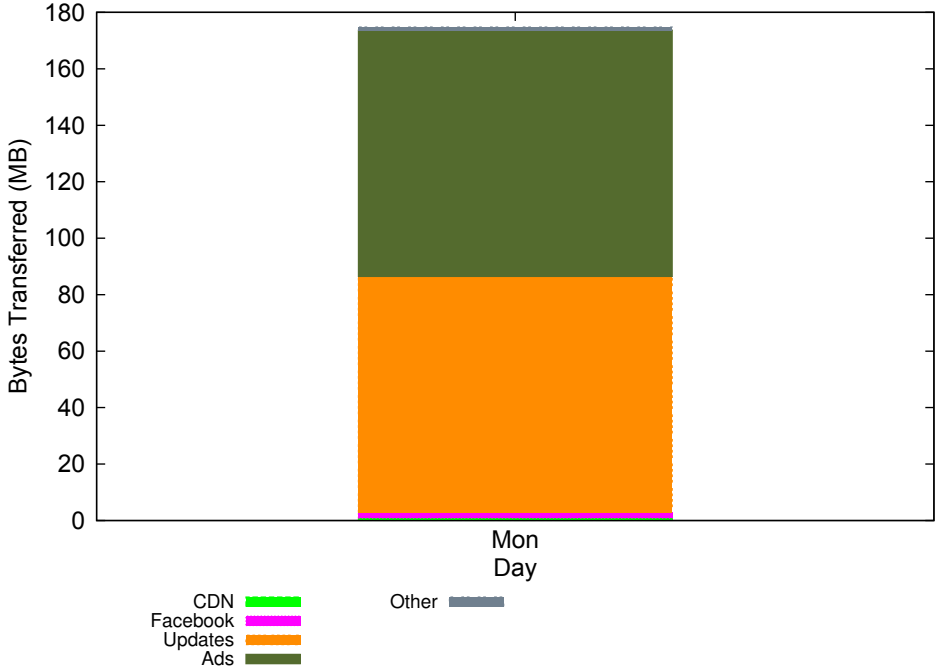



# The Internet is for ~~Porn~~ Ads




User A

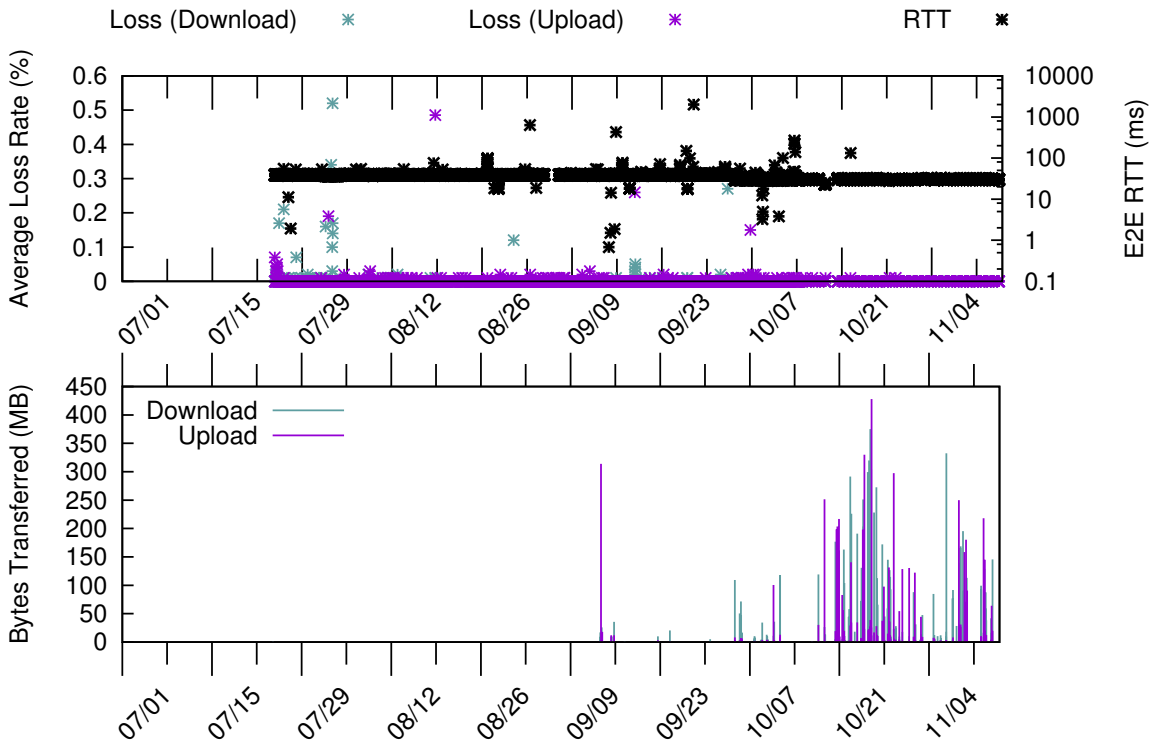



User B

# Citizen Usage

| Category | % |
|---|---|
| **Ads** | **60** |
| Legitimate Uses | 22 |
| Youtube | 8 |
| Games | 5 |
| Porn | 3 |
| Updates | 2 |

# Effect of Primary Citizen Usage on Sharer




- Sharer was on a 20/30 Mbps link
- Gateway was switched on for 89% of the time
- Throttling was sufficient

# Sustainability model

- Extend stakeholder value chain for incentivizing access by creating new Virtual Network Operators that have a socio-environmental objective (e.g. local government, NGO)
  - Digital by default programme could achieve savings of £2.2 bn/ year!
- Ads are a main driver of traffic
  - Can we get ad providers to pay for the extra traffic?
- Share costs: Decouple CAPEX and OPEX - NO can setup or use existing infrastructure while VNO can manage the infrastructure or vice versa
  - Software Defined Networking would facilitate such decoupling and enable flexible management

# Lessons Learnt through PAWS

- Deprived urban areas have network infrastructure with good capacity
  - Fibre networks ideal candidates for network sharing
  - ADSL is common - need better QoS to support
- It was easy to recruit sharers!
  - Sharers did not complain or perceive any performance issues while sharing
  - WiFi stack issues, usage caps
- It was harder to recruit the citizens!!
  - Quotes from an interview with a "*digitally distant*"
    - "Do you have the Internet?" "No"
    - "Would you like to?" "No, that's alright. I'm not interested."
    - "May I ask why not?" "Cos it's a load of fucking bullocks."
- Citizens had to overcome WiFi coverage, VPN issues (54 signed up, only 16 used!), Network availability
- However the primary citizen was able to use the network reasonably well

# Summing up..

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