• Large scale active measurement of broadband networks

• Hardware probes

• Began in 2008...
• Six regulator and twelve ISP deployments
• Thirty-four countries on four continents
• Eight languages directly supported
• Over 40,000 measurement probes deployed
Challenges
• **Technical Challenges**
  - Probe hardware and software
  - Measurement servers
  - Data collection and analysis

• **Operational Challenges**

• **Data Challenges**
Technical Challenges
Measurement Servers (>300)

Data Collection Infrastructure (3)

Measurement Probes (>40,000)

Management Traffic

Measurement Results
Measurement Servers (>300)

Data Collection Infrastructure (3)

MEASUREMENT TRAFFIC

Measurement Probes (>40,000)

MEASUREMENT RESULTS
Probe Software

- We required:
  - Small footprint
  - Resilient to infrastructure failure
  - Remotely upgradeable
  - Ability to run 24x7 and support scheduled testing
Measurement Servers

- We required:
  - Simple, ‘dumb’ software with minimal barriers
  - No data storage
  - Minimum technical specification
Data Collection
Measurement Servers (>300)

Data Collection Infrastructure (3)

Measurement Probes (>40,000)
Data Challenges

• More than 1 billion data points captured, processed and archived every month

• Service tier validation – critical!

• ISP collaboration

• Panelist privacy issues (including local legislation)
Operational Challenges

• Shipping challenges:
  - Local logistics for tens of thousands of devices
  - Technical integration and further challenges

• Localisation challenges:
  - Language support
  - Regulatory issues

• Infrastructure outages
Example
End-to-end downstream throughput for a single broadband product (200 probes)

Source: SamKnows
End-to-end downstream throughput for a single broadband product (200 probes)

Source: SamKnows
End-to-end downstream throughput for a single probe

Source: SamKnows
End-to-end downstream throughput for a single probe

Source: SamKnows
End-to-end downstream throughput for a single probe

Expected performance

Anomalous performance. Massive step changes.

Source: SamKnows
Diagnosis

• ISP found no capacity issues
• Investigation with users revealed:
  - Wired throughput intermittently dropped <1M
  - Wireless unaffected
• Ultimate cause: bug in ISP’s latest CPE
• Only visible through end-to-end measurements
What’s Next?
• Mobile measurement:
  - Smartphone apps
  - Mobile hardware probes
• IPv4 vs IPv6 measurements
• Standards contributions