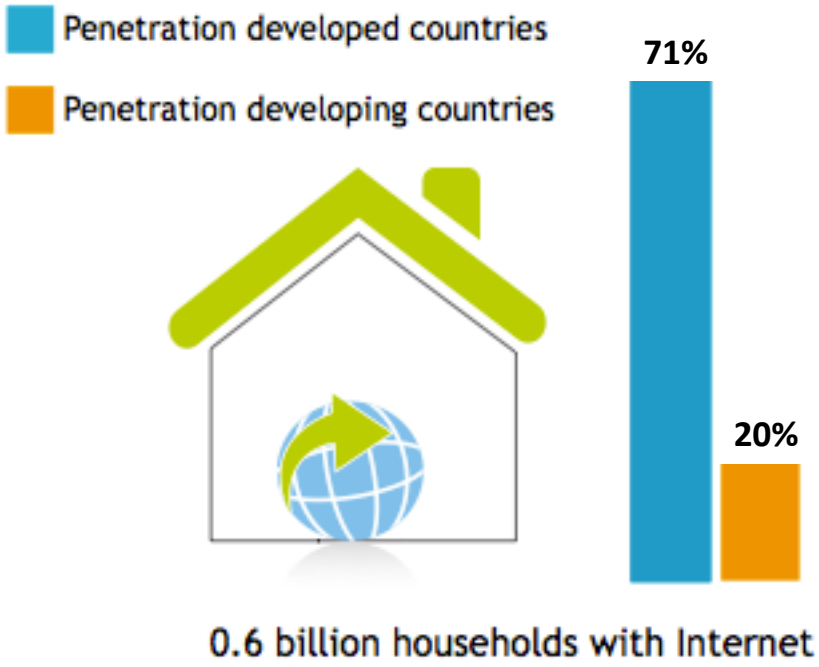
BISmark: A Testbed for Deploying Measurements and Applications in Broadband Access Networks

Srikanth Sundaresan, **Sam Burnett**, Nick Feamster
School of Computer Science, Georgia Tech

Walter de Donato
University of Napoli "Federico II"

http://projectbismark.net

The Internet is coming home



- 1/3 of the world's households had Internet access in 2011, compared to 1/5 in 2006. [ITU]
- About 200 million broadband access users in the U.S.

The Internet is coming home

Internet Of Things Goes Home

The "connected home" is becoming a reality thanks to improved broadband networks and mobile apps. Here's a rundown of how our homes are getting smarter.

Telstra taps internet of things with public broadband network

May 2014
ie Baker

tra is putting $100 million behind building a public
i network that would give customers and non-
tomers access to fast broadband outside of the
home.

Internet of Things market to hit $7.1 trillion by 2020: IDC

Summary: *The burgeoning global Internet of Things market is on track to hit $7.1 trillion in 2020, according to IT research agency, IDC.*

By Leon Spencer | June 5, 2014 -- 01:41 GMT (18:41 PDT)

Home networking research questions

Do ISPs perform as advertised?


guardian.co.uk

Money › Internet, phones & broadband

Ofcom: Broadband ISPs are pulling a fast one

- Average speed 46% below that promised by ISPs
- Mandatory code and clear penalties vital, experts say

Does home network usage vary across the globe?


Comcast plans data caps for all customers in 5 years, could be 500GB

Cable company already enforces 300GB limit in seven states.

How can we improve home network troubleshooting?


PC PCMAG.COM

12 Tips for Troubleshooting Your Internet Connection

Quick fixes to your most common wireless Internet and router problems.

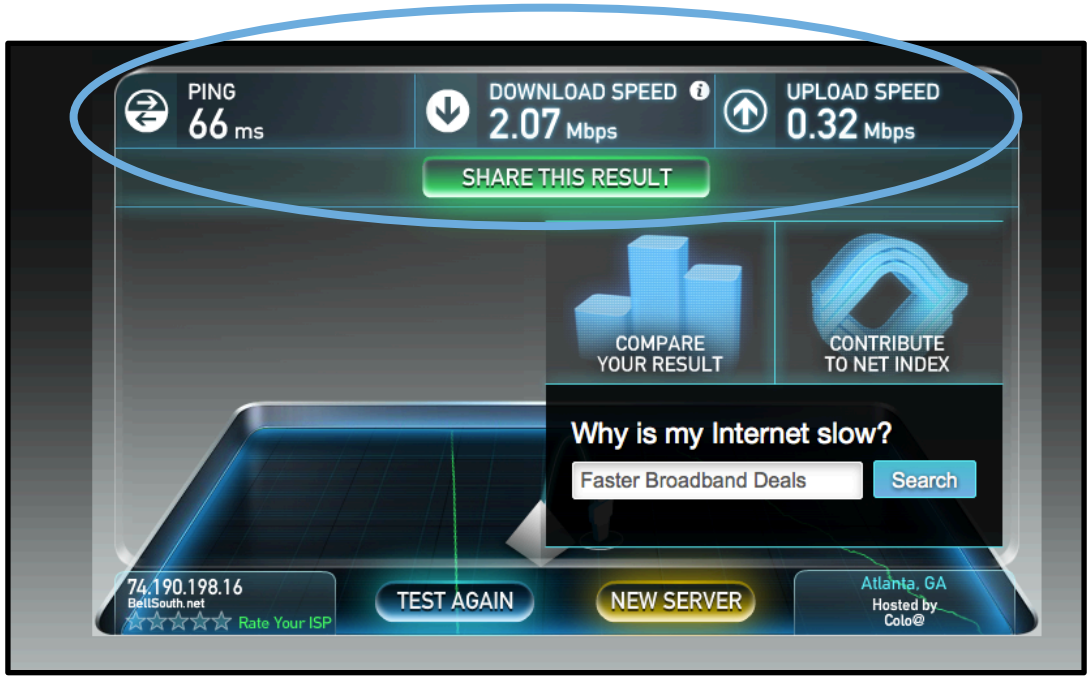
Answering these questions is hard in practice

Why is studying home networks difficult?

1. Every home behind its own NAT
2. Largely unmanaged and unmonitored
3. Real people

Difficult to experiment with and collect data from many home networks

Where we started: How fast is my ISP?

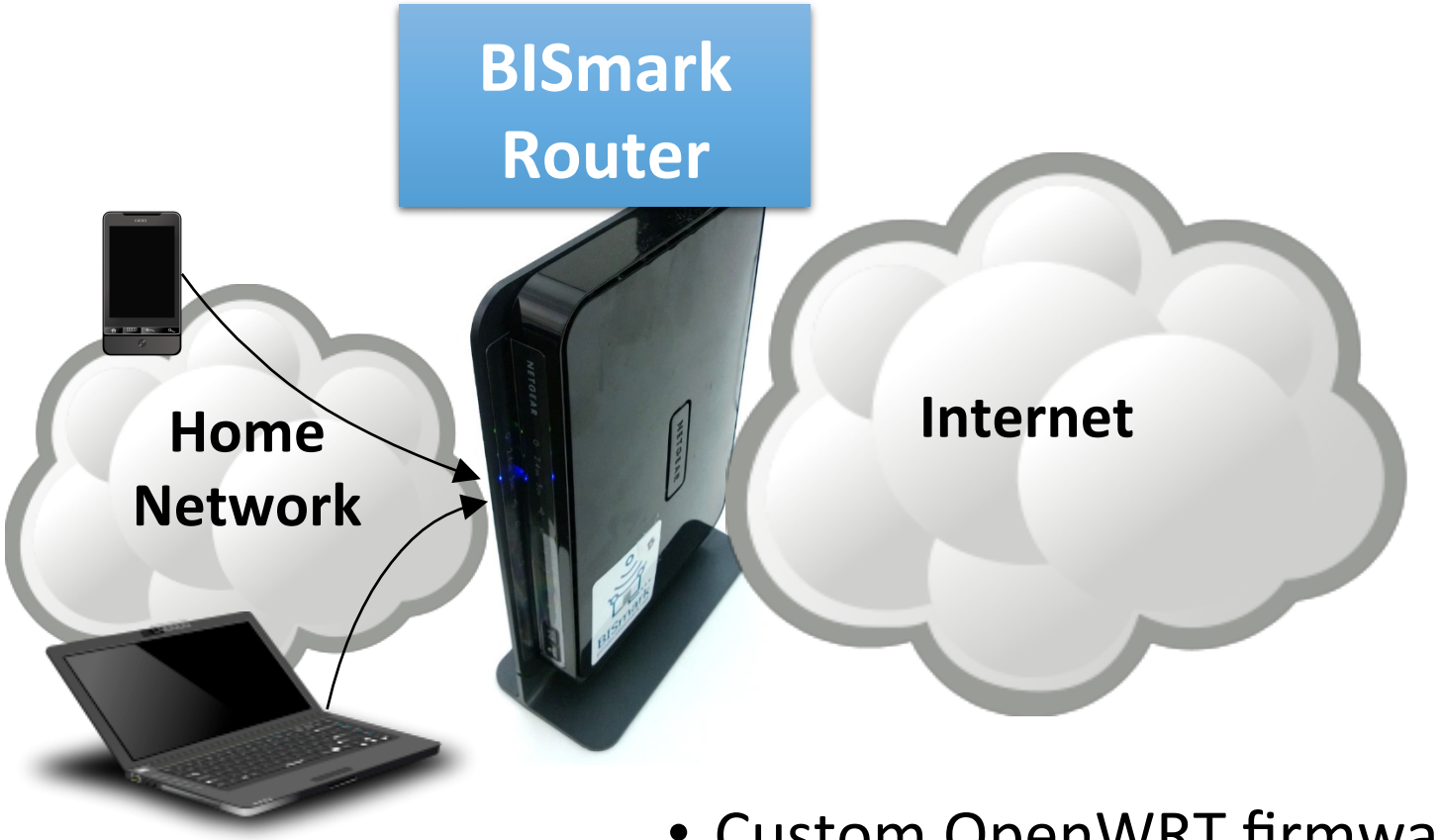


- Can I trust this measurement?
- Is performance consistent?
- How does wireless affect performance?

Our approach: modify the home router

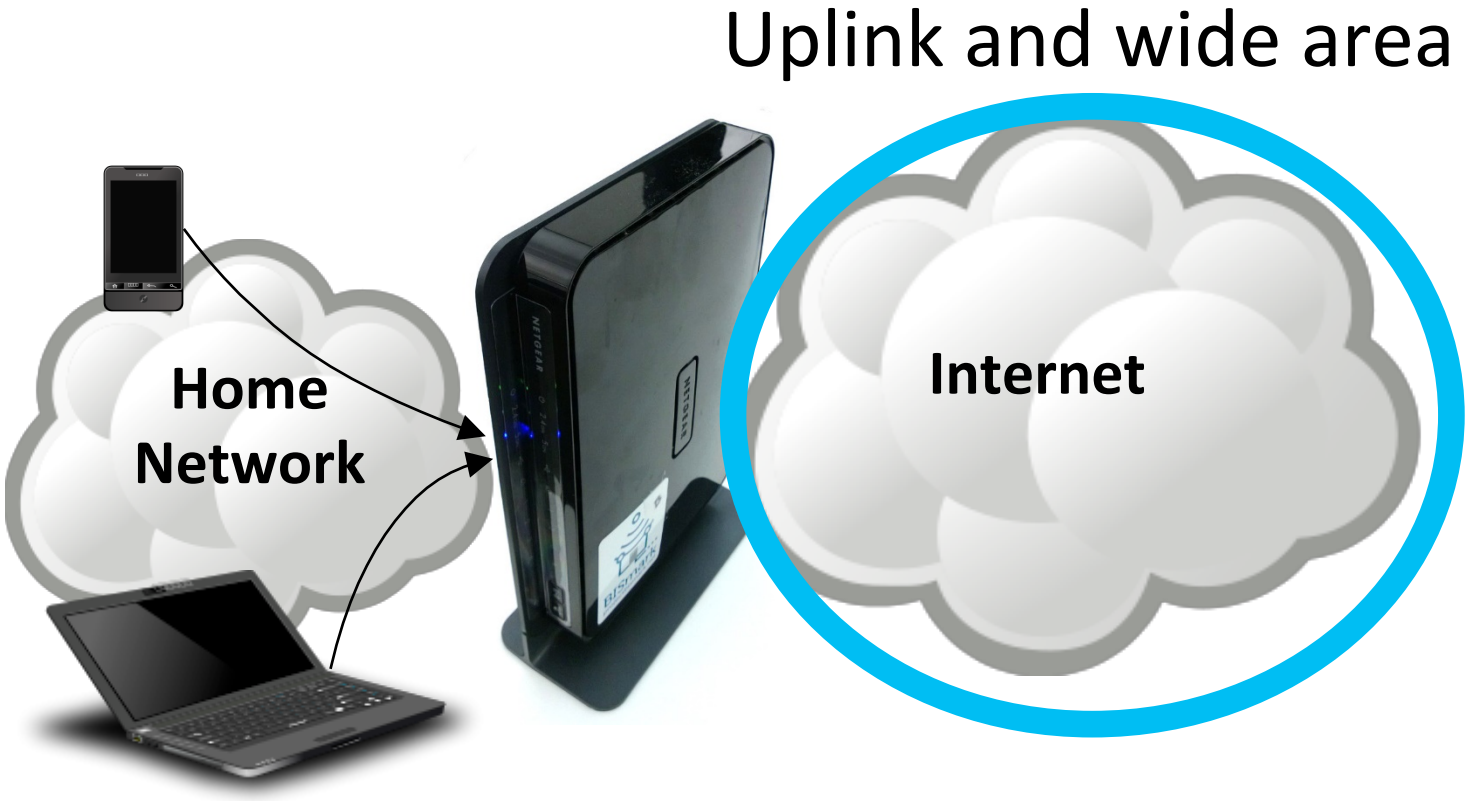
The home router sits at the center of the home network

Our approach: modify the home router



- Custom OpenWRT firmware
- Netgear WNDR3800
  - 650 MHz processor, 128 MB RAM, 16 MB flash

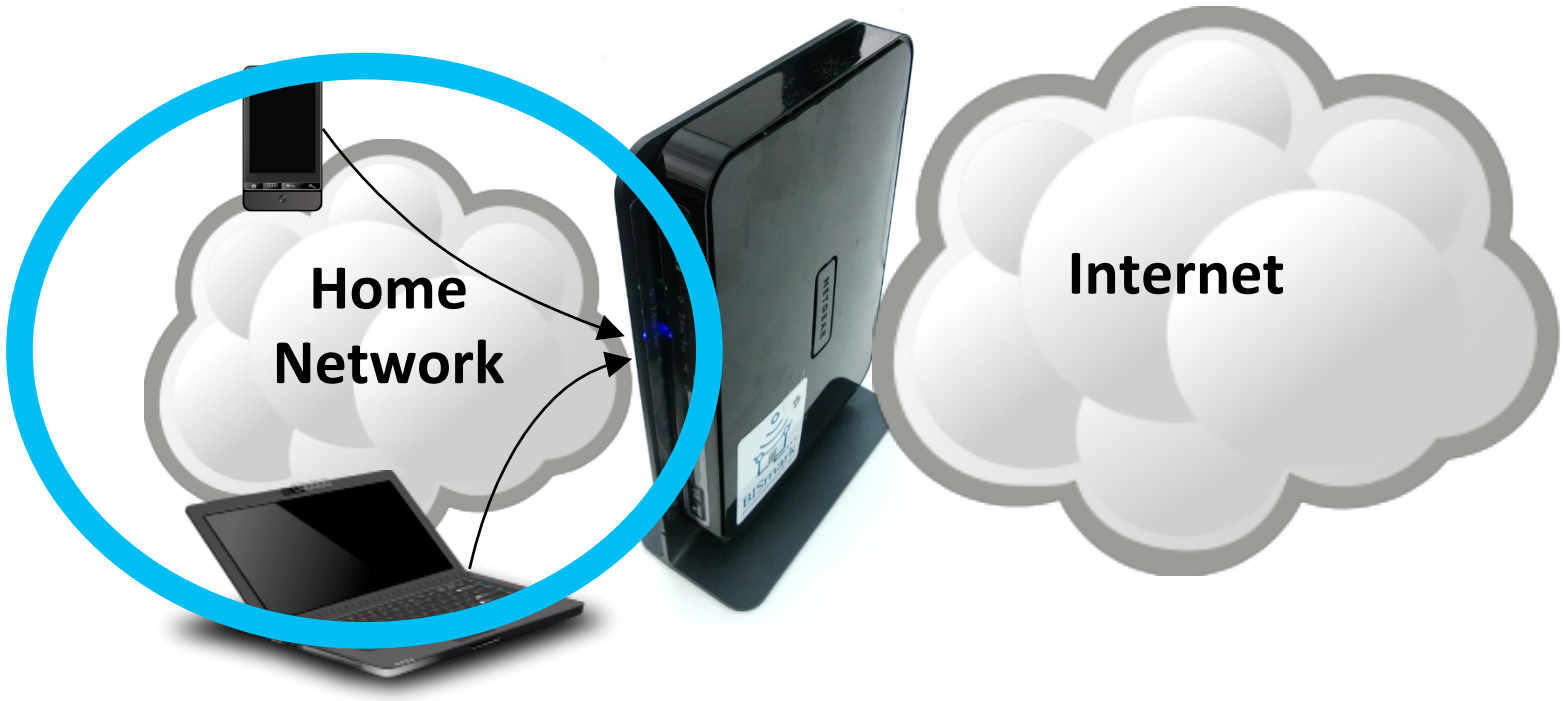
Home routers enable many kinds of research



Examples: Performance, reliability, accessibility

Home routers enable many kinds of research

Home network behind the NAT



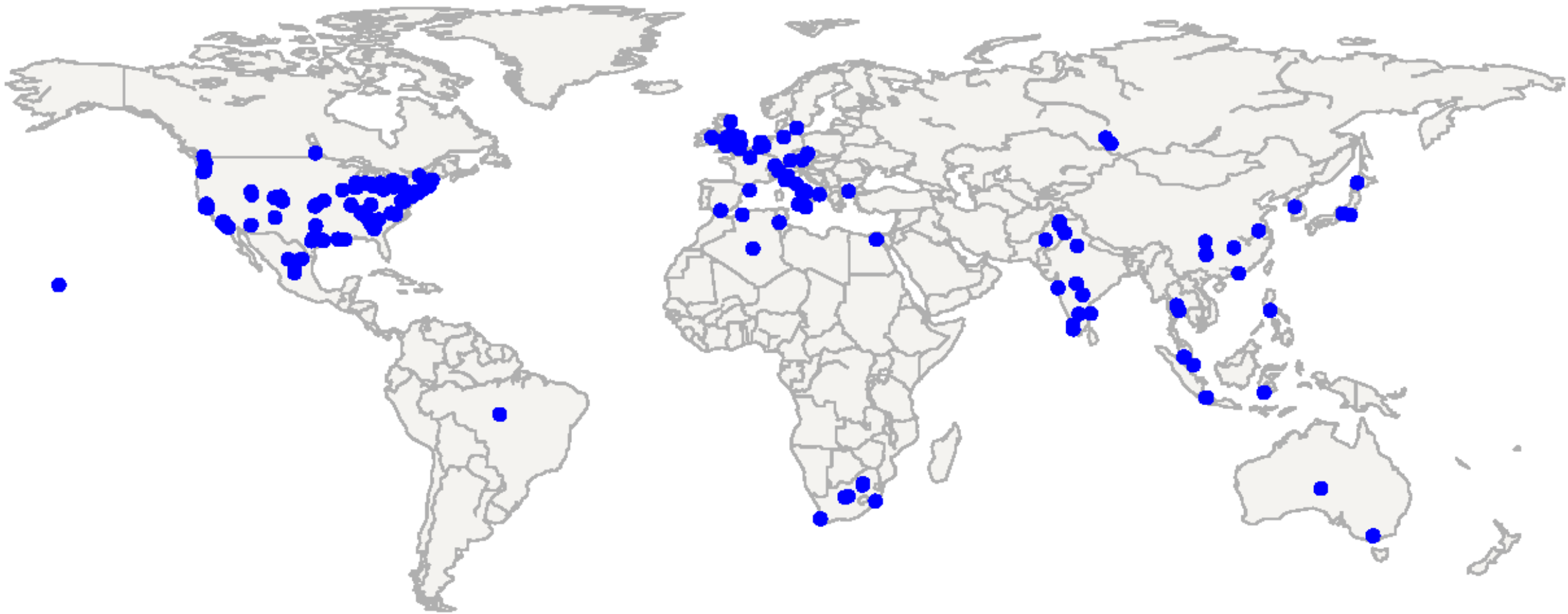
Examples: Home network characterization, troubleshooting

Home routers enable many kinds of research

Traffic that passes through the router

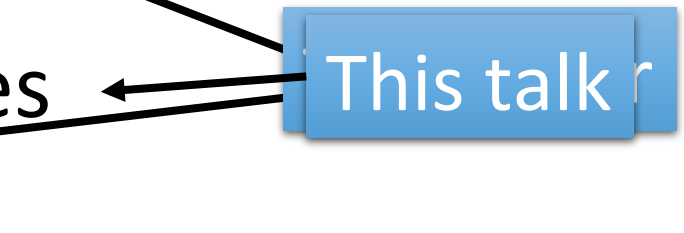
Examples: Security, caching, bottleneck isolation

175+ routers in 20+ countries



How to conduct research using BISmark

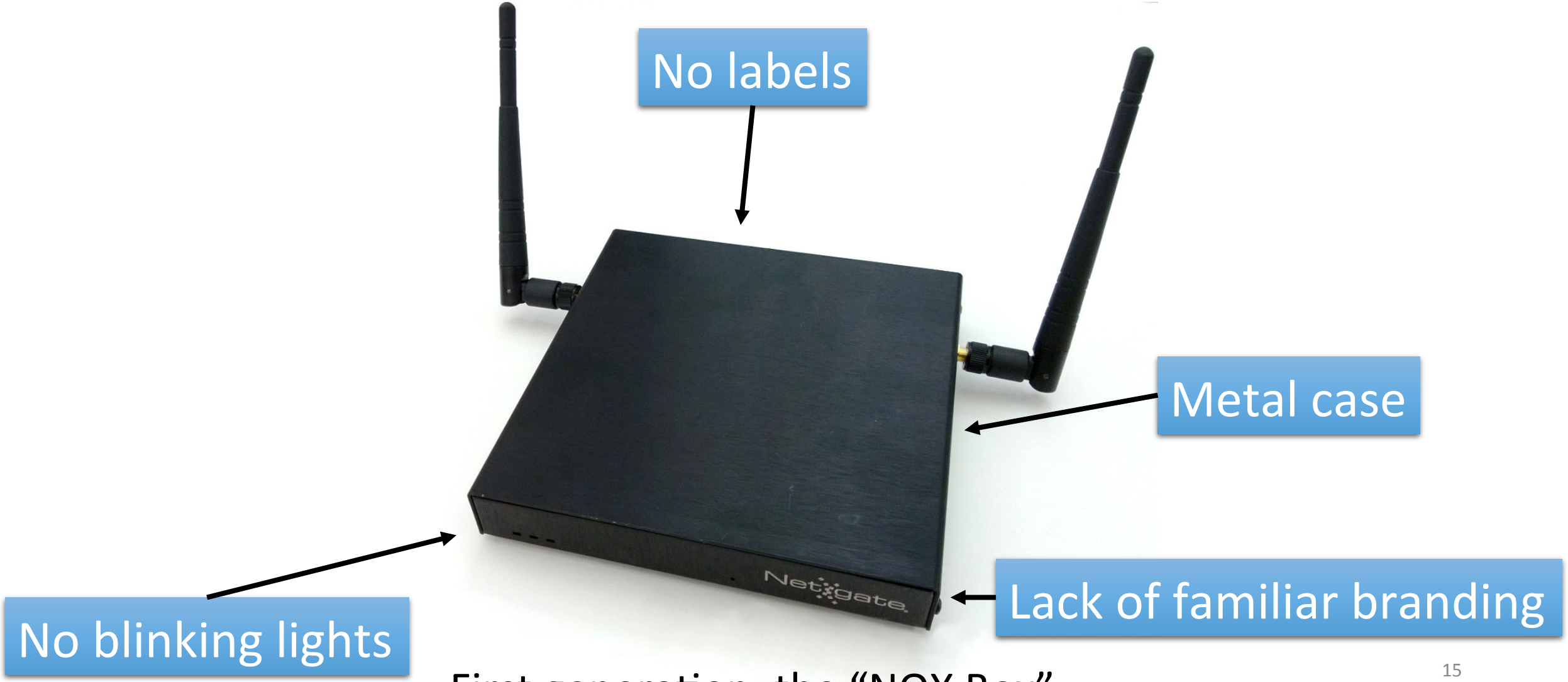
1. Write software
2. Make it work on the router
3. Deploy routers in real homes
4. Repeat



Outline

- Motivation for customized home routers
- Lessons learned
  - **Form factor matters**
  - Hardware on the critical path is a double-edged sword
  - Deployment model shapes success
- How you can use BISmark

Users are wary of unfamiliar hardware



First generation: the “NOX Box”

Form factor matters

NOX Box

VS

Netgear WNDR3800

Once deployed, users still only *marginally* trust familiar-looking hardware and blame it at the first sign of trouble.

Outline

- Motivation for customized home routers
- Lessons learned
  1. Form factor matters
  2. **Hardware on the critical path is a double-edged sword**
  3. Deployment model shapes success
- How you can use BISmark

BISmark is on the critical path

BISmark is on the critical path

Advantages

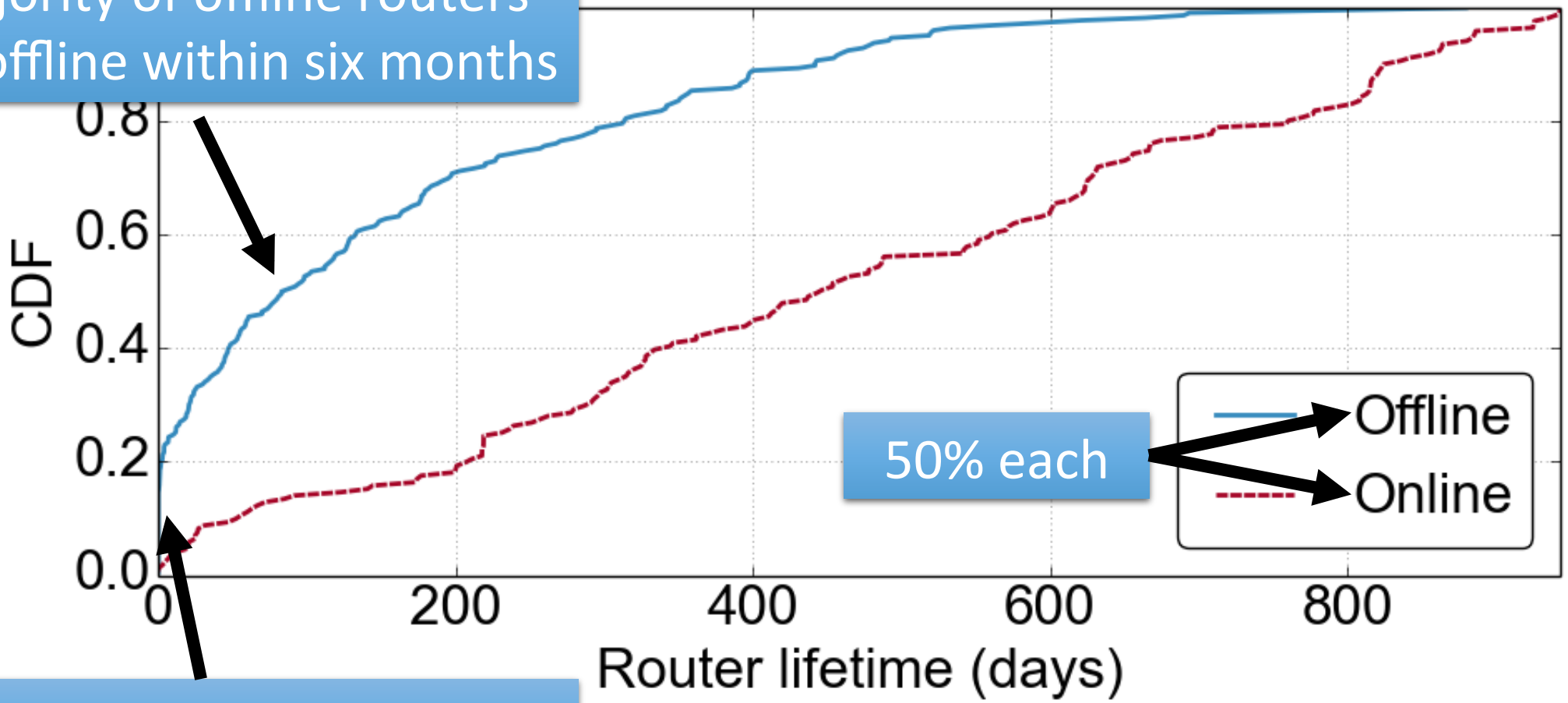
1. We get a complete view, for:
   - Measuring access networks
   - Characterizing home devices
   - Identifying bottlenecks
2. Users notice if hardware goes offline

Disadvantages

1. Privacy concerns
   - User consent?
2. Users do not tolerate failure

Attrition is high

A majority of offline routers went offline within six months



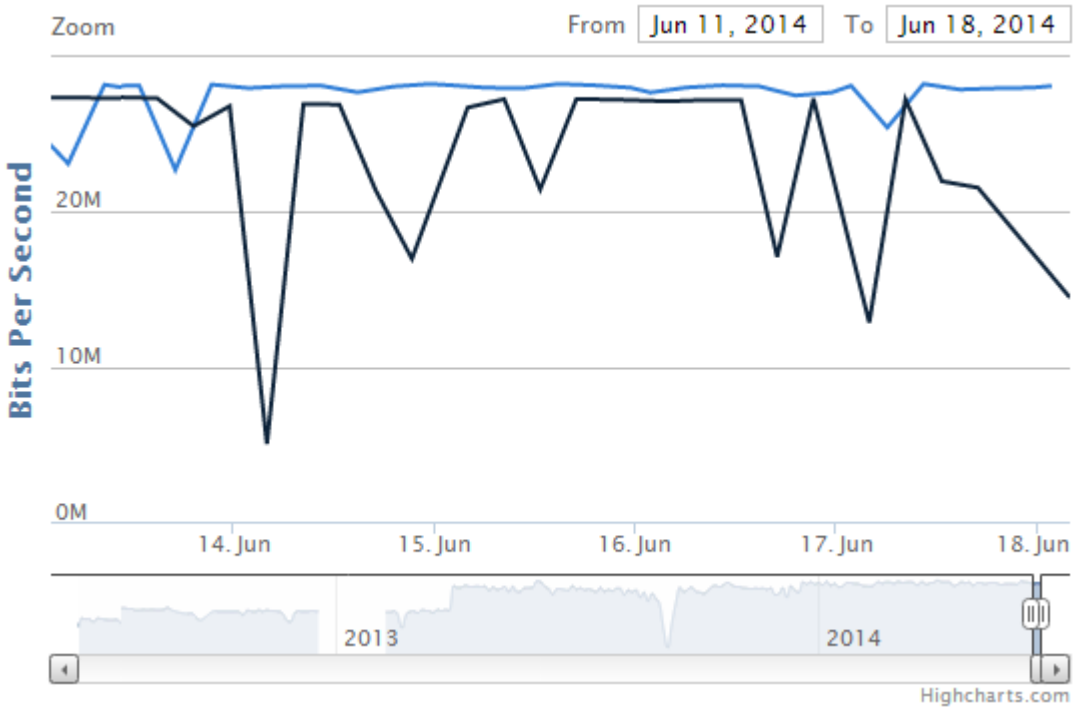
50% each

~10% never turned on at all!

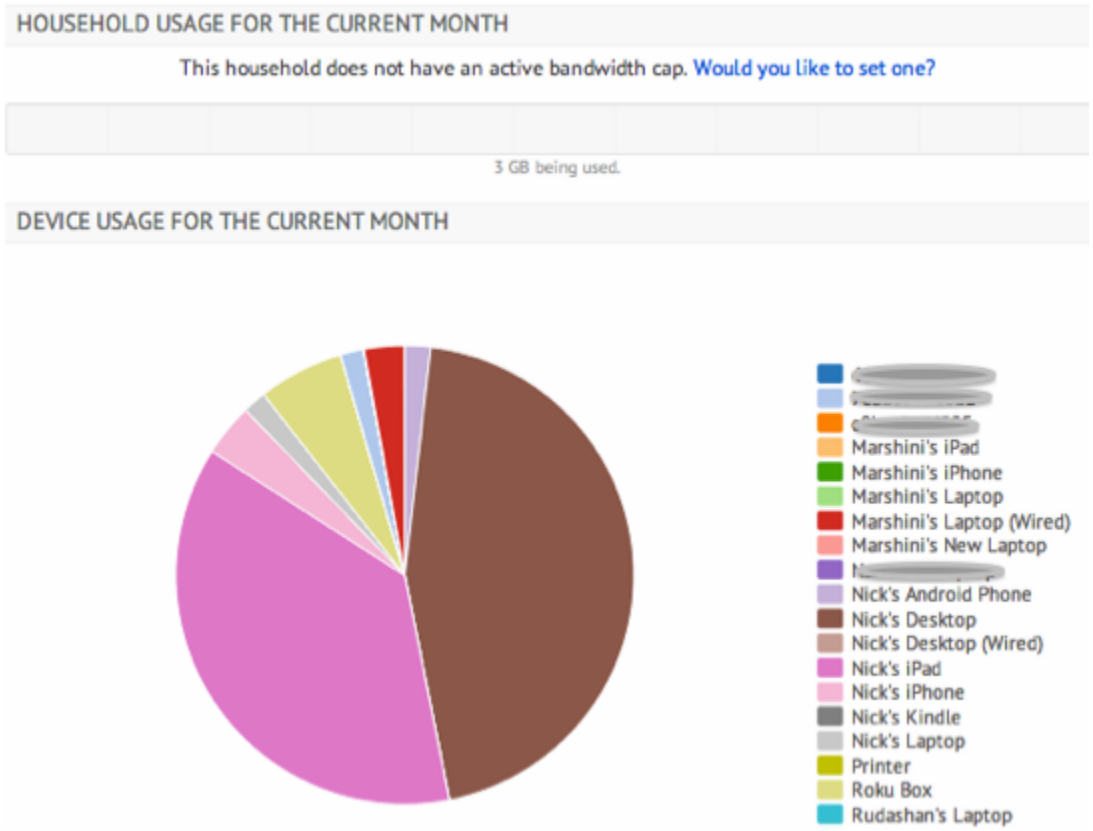
Incentives to counteract attrition

Network dashboard

http://networkdashboard.org



uCap



Some users find visualizations useful, and miss them if they stop working

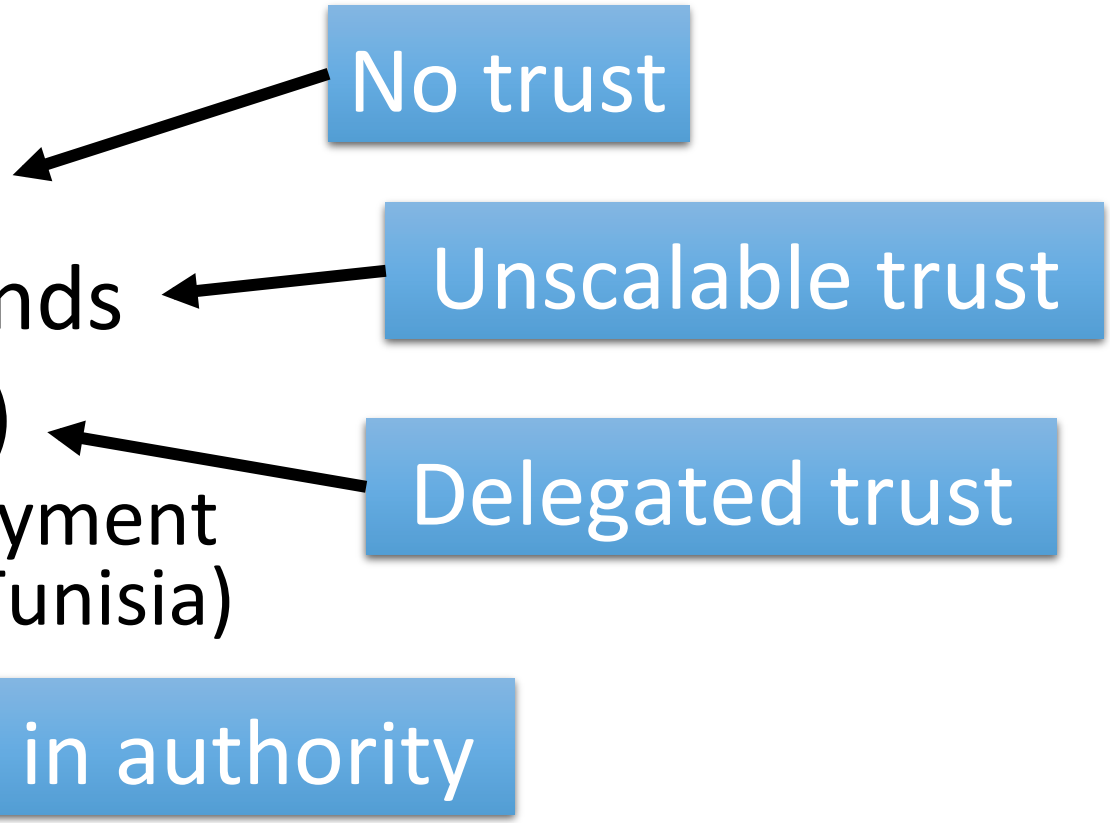
Outline

- Motivation for customized home routers
- Lessons learned
  1. Form factor matters
  2. Hardware on the critical path is a double-edged sword
  3. **Deployment model shapes success**
- How you can use BISmark

Trust relationships are essential for success

Four deployment models:

1. Volunteers with hardware
2. Friends and friends-of-friends
3. Franchising (like Planetlab)
   - Good for international deployment (UK, Pakistan, South Africa, Tunisia)
4. Driven by ISPs
   - Trial with Comcast



More isn’t always better

Large deployment

- Good for drawing general conclusions
- Good for comparing between regions, ISPs, devices, etc.
- Harder to maintain

Small deployment

- We know the users
  - Easier to get consent
  - Greater tolerance for failures
- Easier to conduct in-depth experiments
- Harder to draw general conclusions

Outline

- Motivation for customized home routers
- Lessons learned
  1. Form factor matters
  2. Hardware on the critical path is a double-edged sword
  3. Deployment model shapes success
- **How you can use BISmark**

How you can use BISmark

- In your home
  - Flash your own Netgear WNDR3700v2, Netgear WNDR3800, or TP-Link WDR3600
    - http://downloads.projectbismark.net
  - We can mail you a free router
- As a researcher
  - Open source and open data whenever possible
    - http://uploads.projectbismark.net
  - Can you host a deployment?

Conclusion

- Home routers are a good vantage point for conducting research in home networks
- BISmark is a global testbed for deploying measurements and applications in home networks

Contact us if you are interested in using BISmark for your own research

Visit http://projectbismark.net for more information

Acknowledgements

- BISmark could not exist without the help of many people
- Many thanks to Adam Allred, Marshini Chetty, Thomas Copeland, Abhishek Jain, Aman Jain, Hyojoon Kim, Guilherme Grillo Martins, Brian Poole, Alfred Roberts, Paul Royal, Boris de Souza, Dave Täht, Steve Woodrow, and many others
- Special thanks to the many hundreds of volunteers who host BISmark routers in their homes

Visit http://projectbismark.net for more information