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

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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.

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?
- Does home network usage vary across the globe?
- How can we improve home network troubleshooting?

- Comcast plans data caps for all customers in 5 years, could be 500GB
  Cable company already enforces 300GB limit in seven states.

- Ofcom: Broadband ISPs are pulling a fast one
  - Average speed 46% below that promised by ISPs
  - Mandatory code and clear penalties vital, experts say

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

This talk
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

- No labels
- Metal case
- Lack of familiar branding
- No blinking lights

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.
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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

~10% never turned on at all!
Some users find visualizations useful, and miss them if they stop working.

Network dashboard
http://networkdashboard.org

uCap

This household does not have an active bandwidth cap. Would you like to set one?

DEVICE USAGE FOR THE CURRENT MONTH

- Marshan's iPad
- Marshan's iPhone
- Marshan's Laptop
- Marshan's Laptop (Wired)
- Marshan's New Laptop
- Nick's Android Phone
- Nick's Desktop
- Nick's Desktop (Wired)
- Nick's iPad
- Nick's iPhone
- Nick's Kindle
- Nick's Laptop
- Printer
- Roku Box
- Rudashan's Laptop

3 GB being used.
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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

- No trust
- Unscalable trust
- Delegated trust
- Trust in authority
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
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• 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](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