

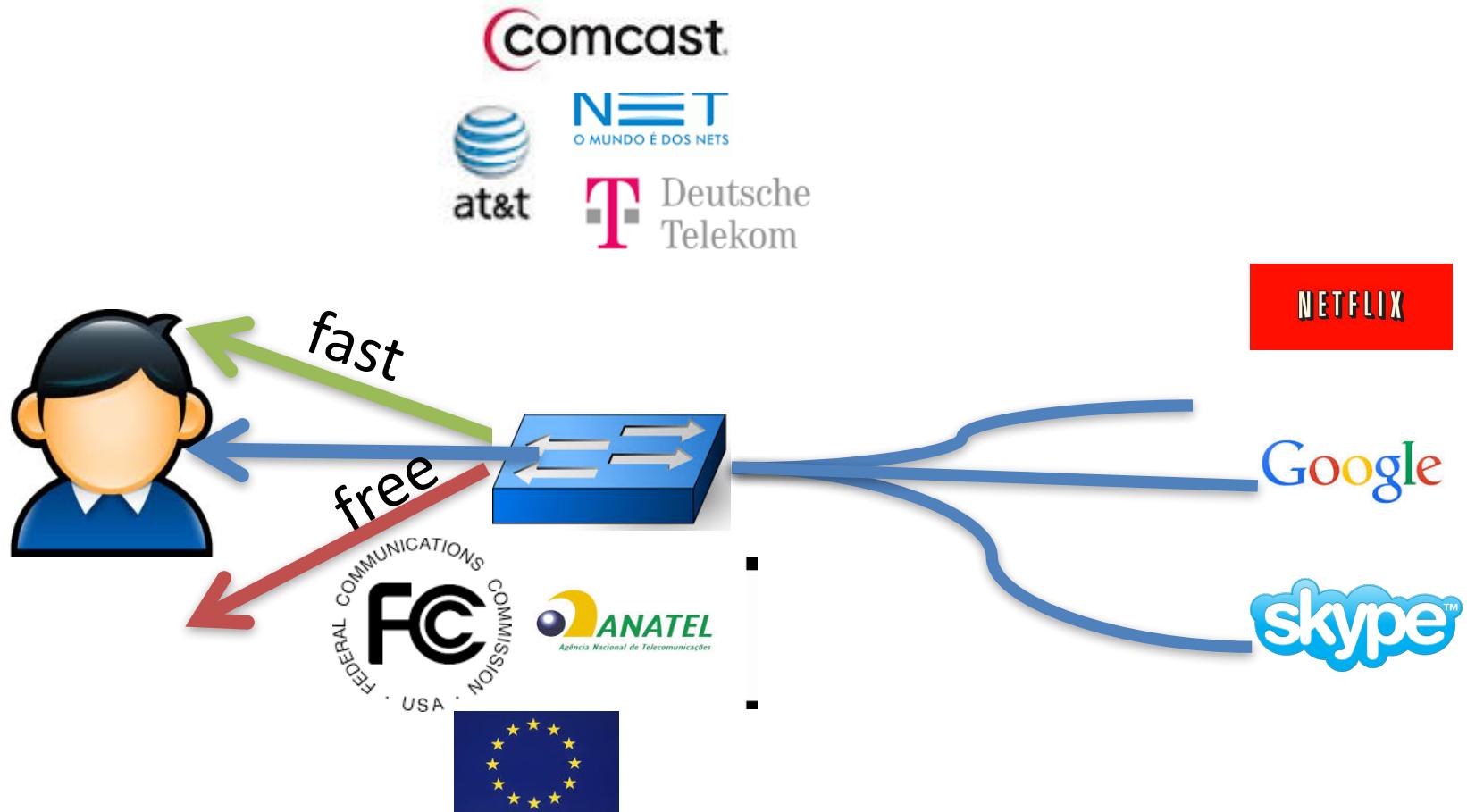


Neutral Net Neutrality

Expressing User Preferences with
Network Cookies

Yiannis Yiakoumis, Sachin Katti, Nick McKeown
Stanford University

Who controls your network access?



Who controls your network access?



WH
.GOV

Who controls **your** network access?



What about the users?

What if we let users decide?

Neutral
Network

ISP-defined
Fast Lanes

User-Driven



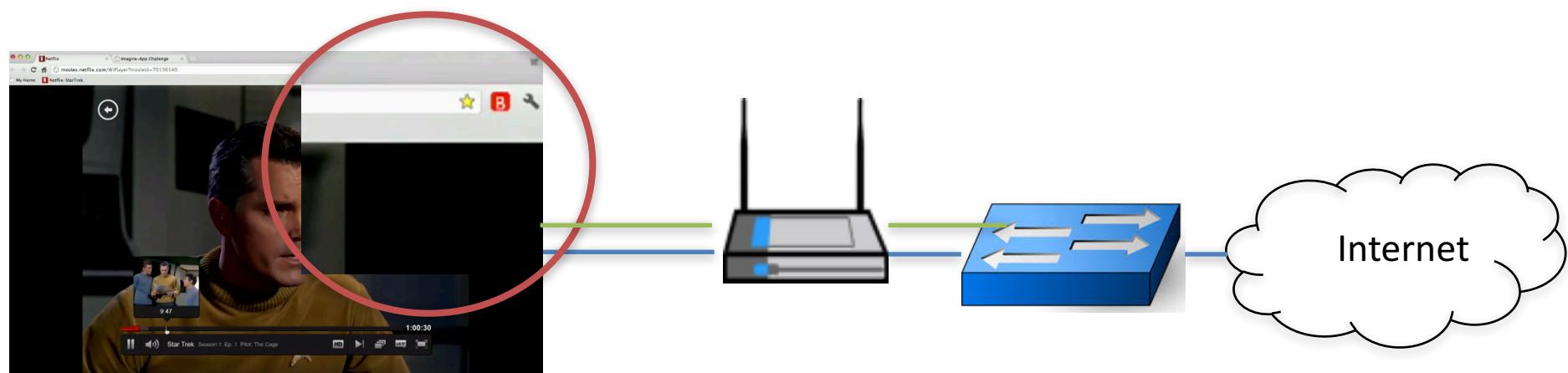
Outline

- Why user preferences matter
- Expressing user preferences to the network

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- **Why user preferences matter**
- Expressing user preferences to the network

1. Boost : User-driven Fast Lane



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- Deployed in ~300 homes (Google employees)
- One Boost lasts for one hour + Last Boost wins
- 44 websites in two weeks

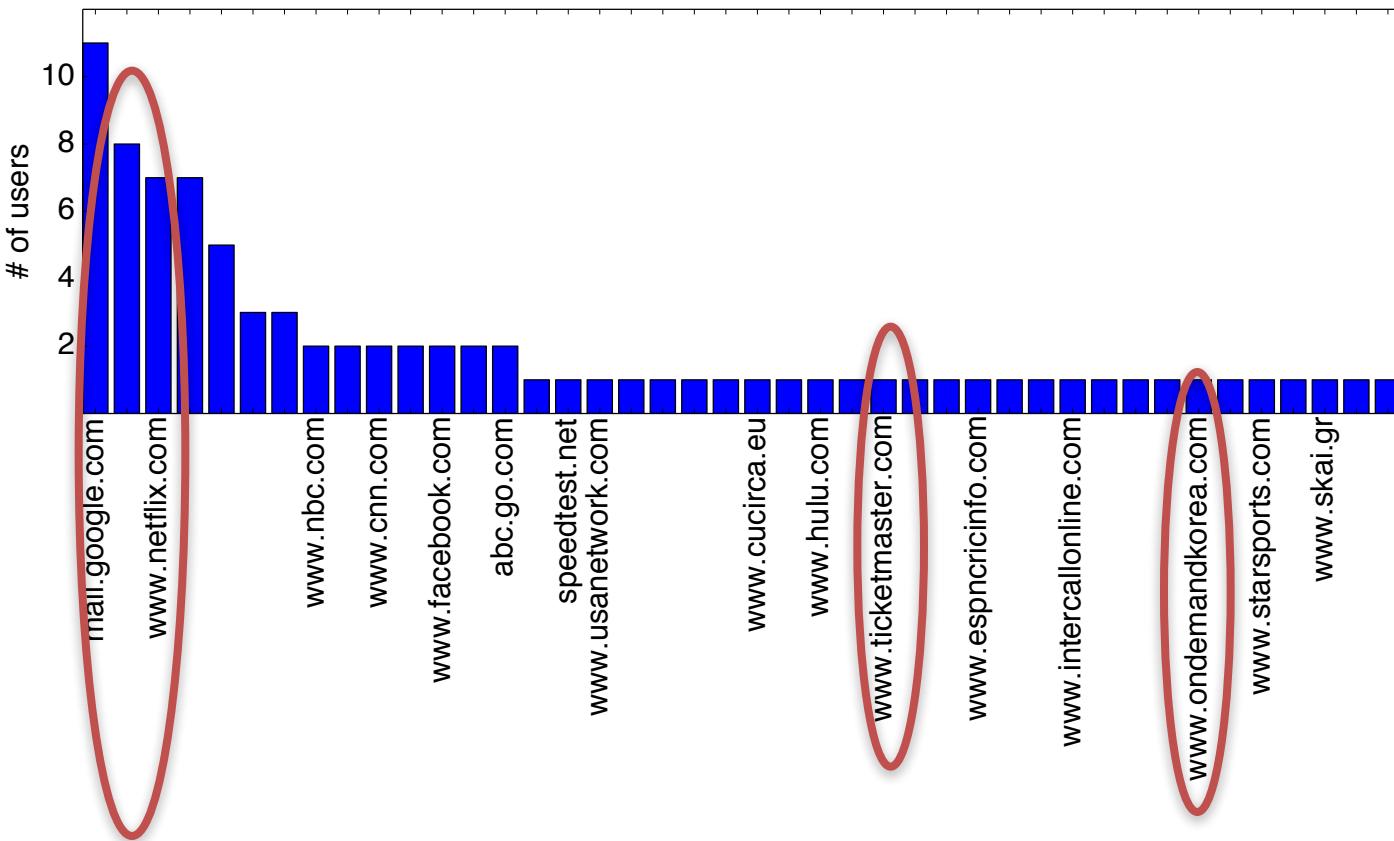
How do people use Boost?

- “*Business-related stuff should be faster (me or my partner)*”

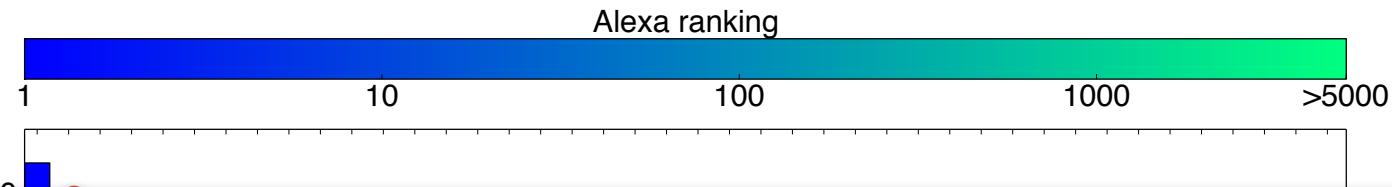
User context

~~Augmented reality~~

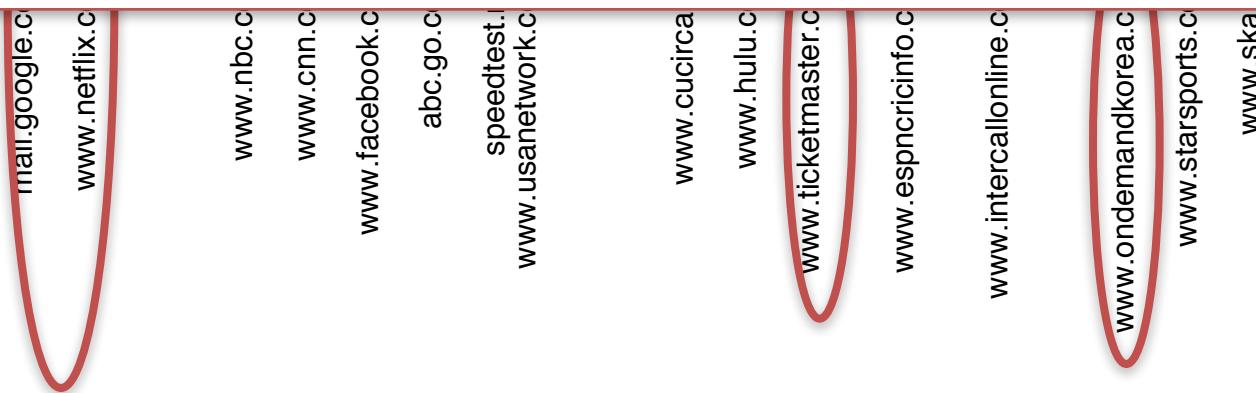
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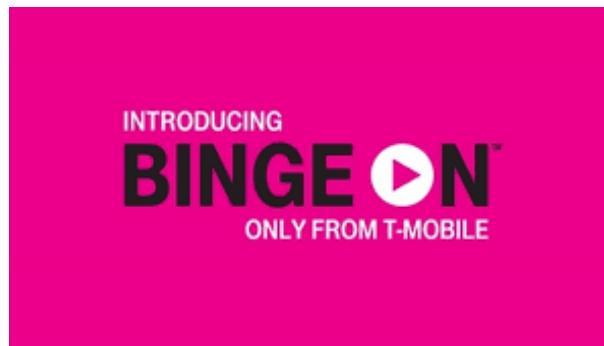
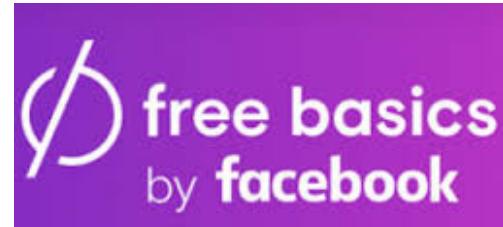
How do people use Boost?



Heavy-tail of user preferences

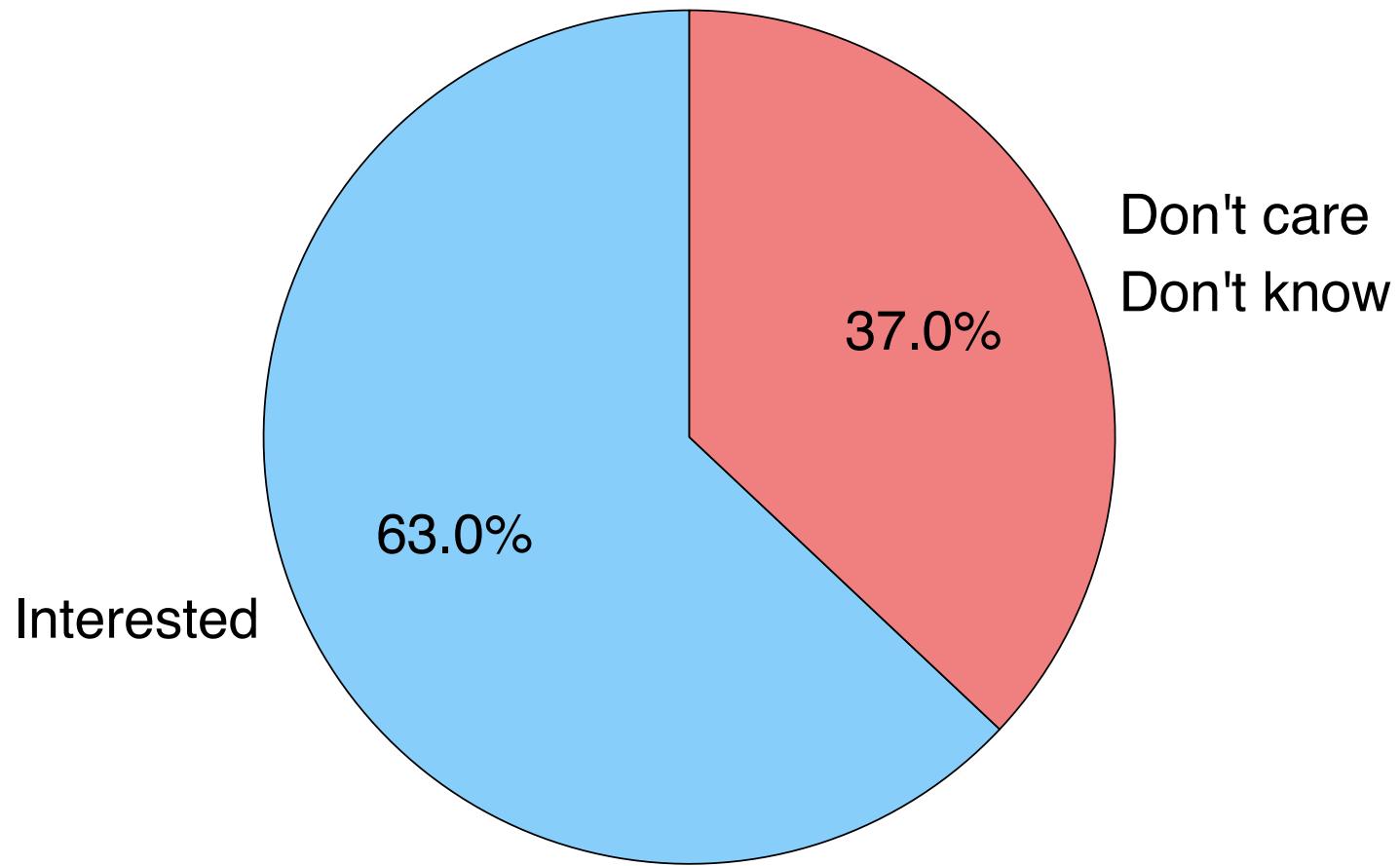


2. Zero-rating



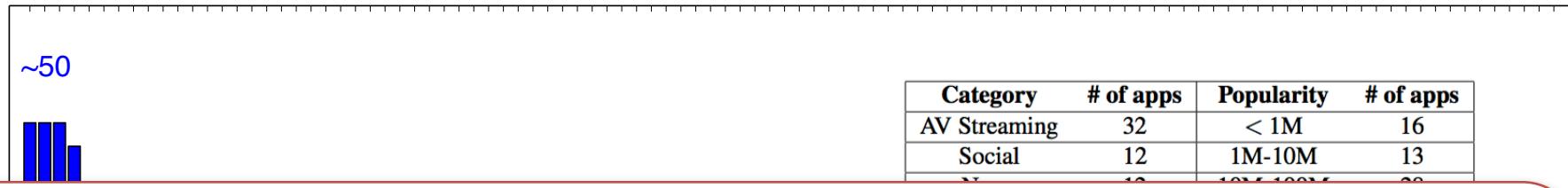
Do users want zero-rating?

1000 smartphone owners, US, 18-65 year old, SurveyMonkey Audience, 08/15

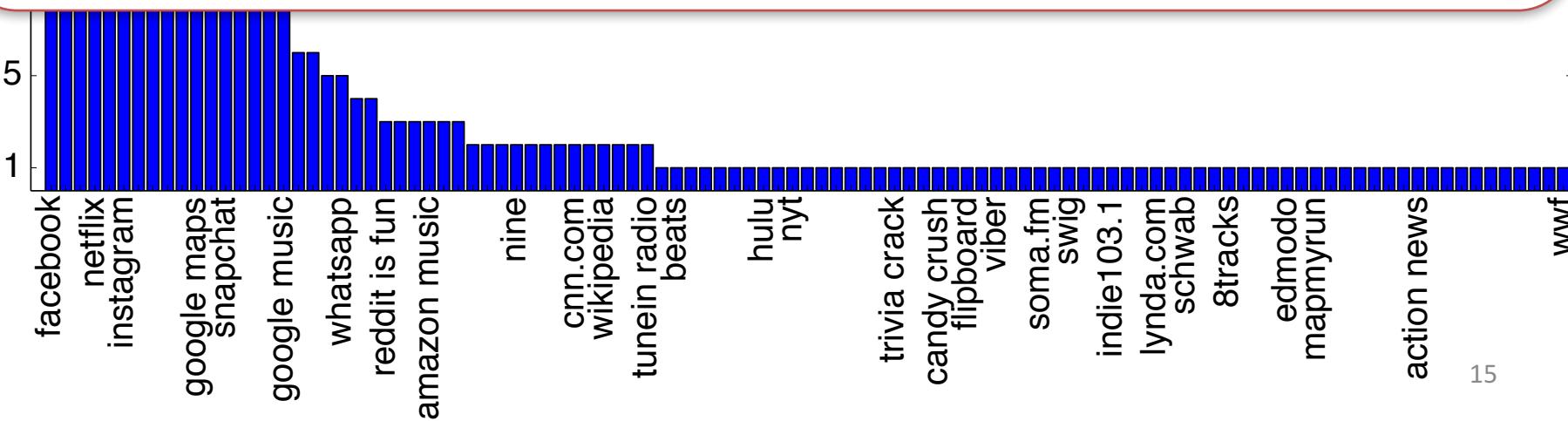


What do users really want to zero-rate?

Which application would you choose to zero-rate?

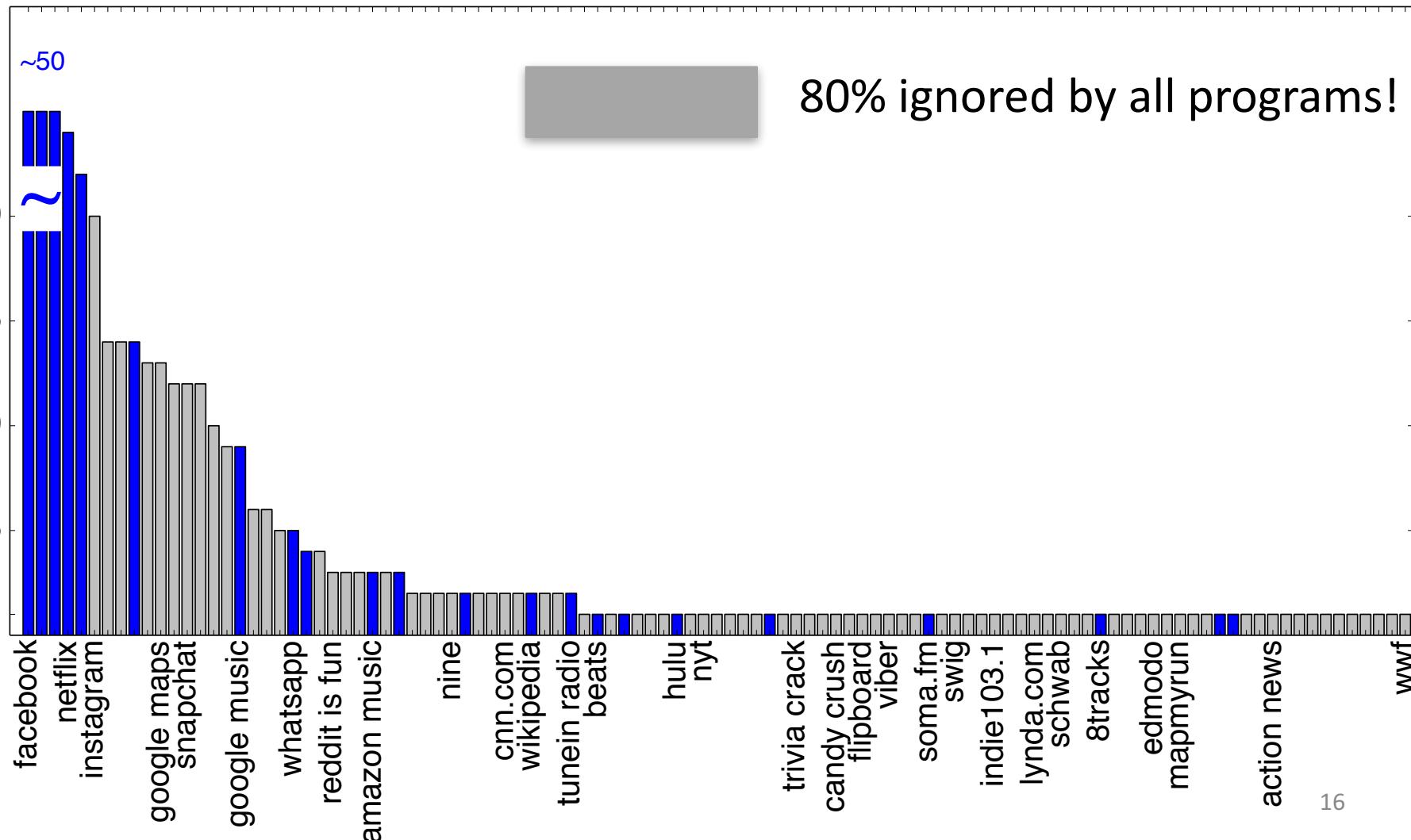


Heavy-tail of user preferences



What do users really want to zero-rate?

Which application would you choose to zero-rate?



User Preferences Takeaways

- Users have unique and diverse preferences
- Respect the heavy-tail
- Let users decide

Outline

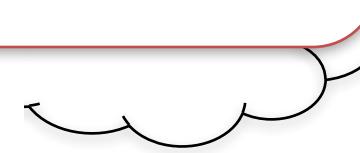
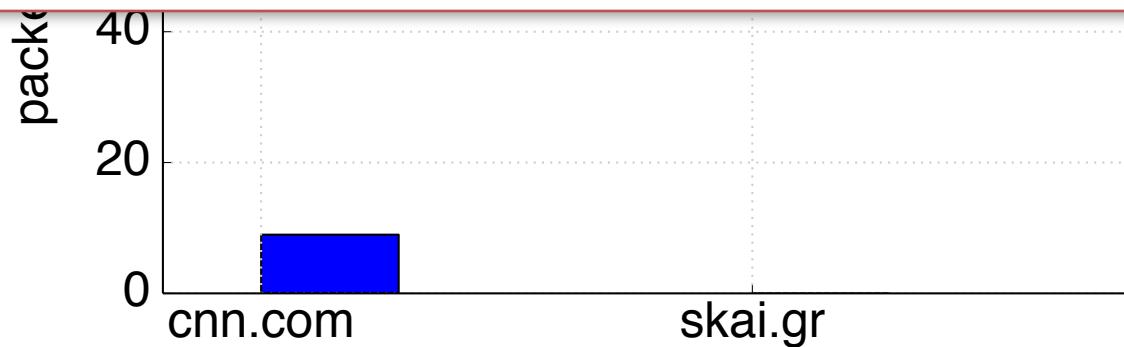
- Why user preferences matter
- Expressing user preferences to the network
 - Why existing mechanisms don't work
 - Network Cookies

Deep Packet Inspection

What is cnn.com ???



DPI is not expressive

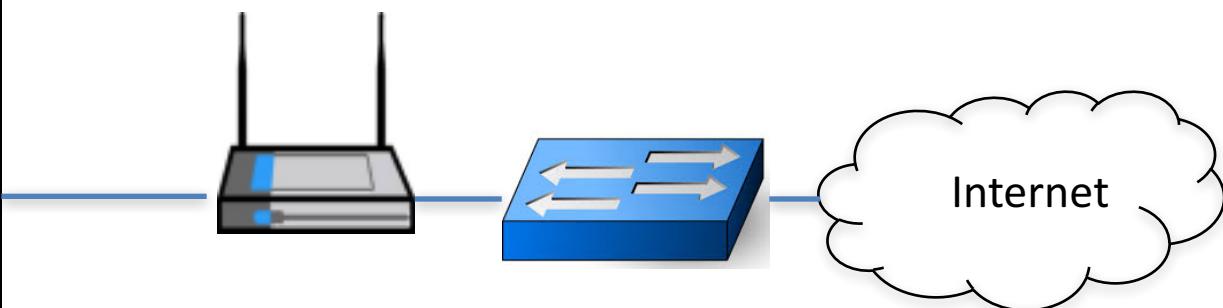


DiffServ

DiffServ doesn't work across network boundaries

“I want traffic X to get service Y!”

1. I want Netflix to be faster
2. I want Spotify zero-rated
3. I want low-latency Skype for work

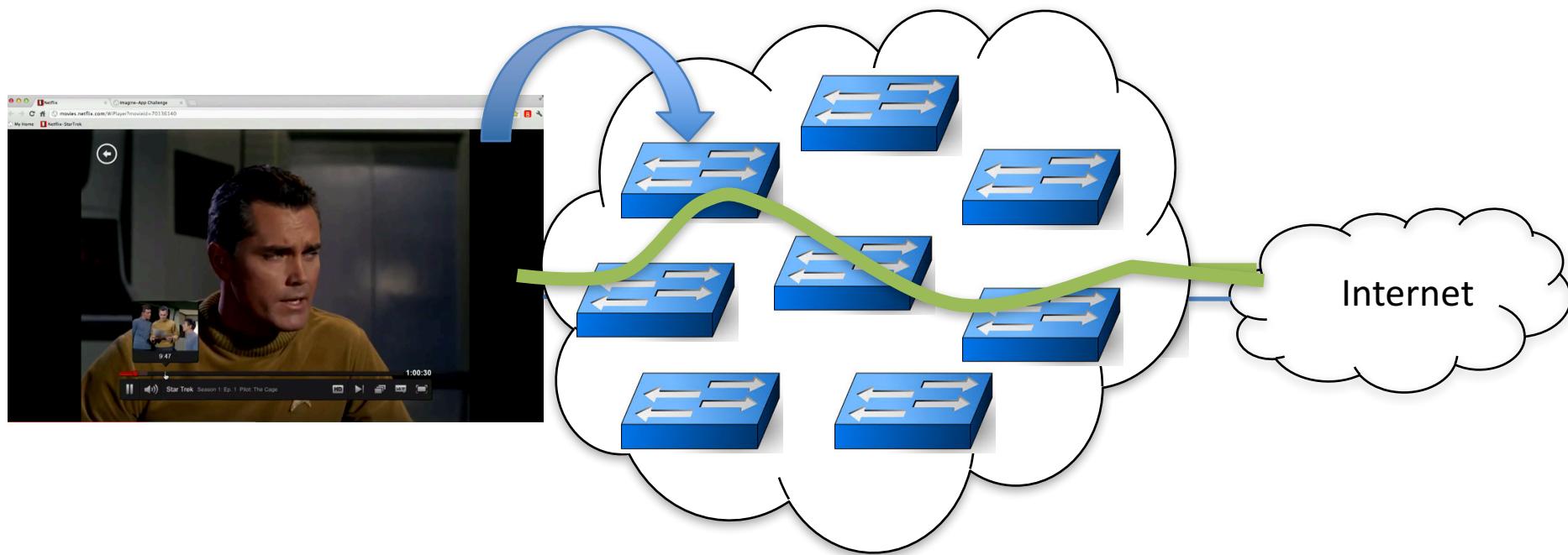


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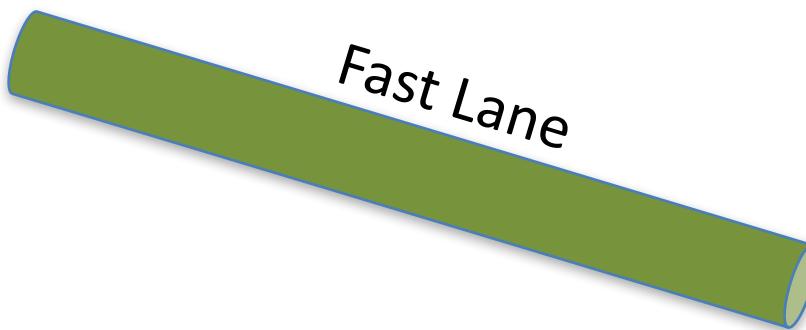
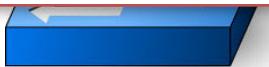
2. Communicate it to the network

3. Configure the network



...one

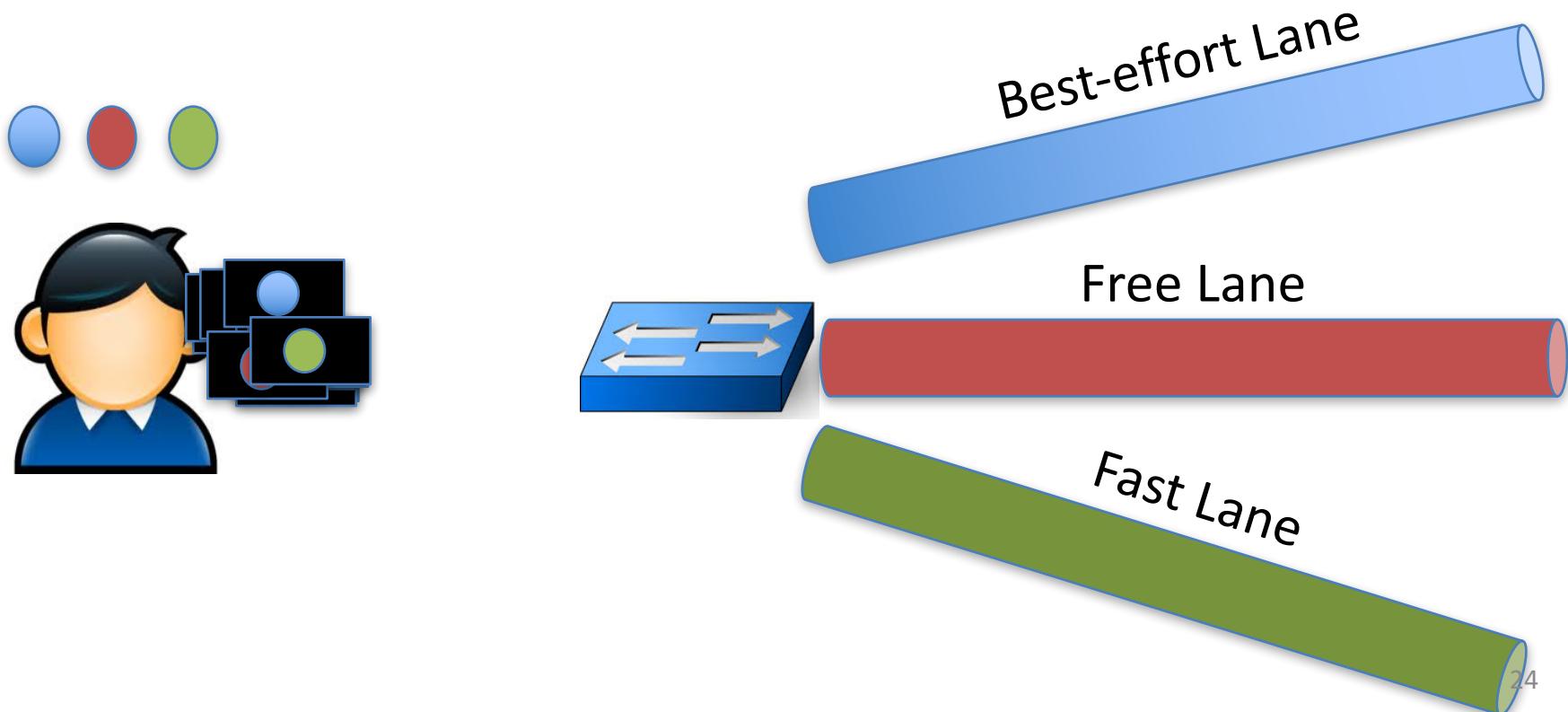
How do we map traffic to a lane?



Network Cookies: a mapping abstraction

Network Cookie : A small piece of data users append to their traffic

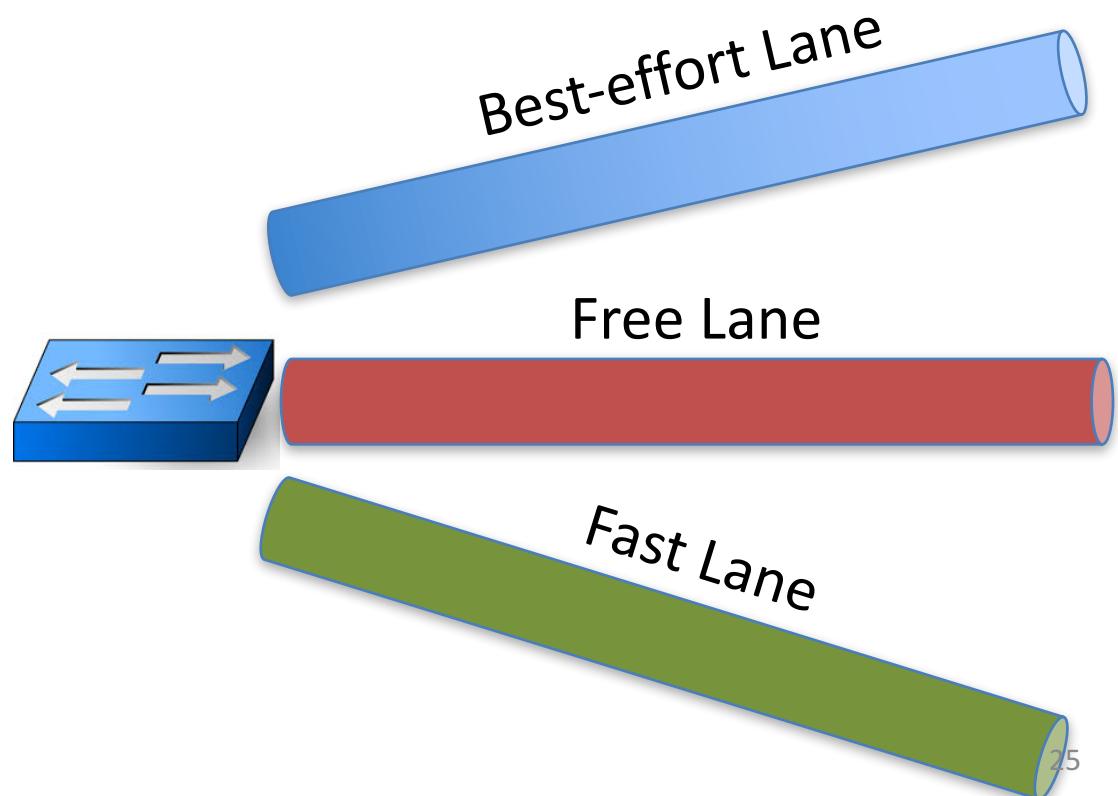
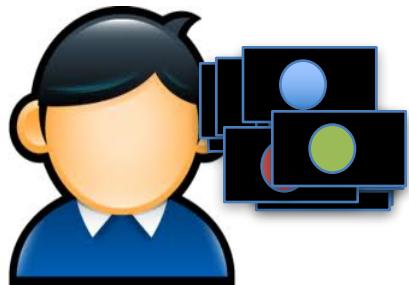
1. Get **cookie** for each service
2. User appends cookies to the desired traffic
3. Network matches against them and enforces service



Network Cookies: a mapping abstraction

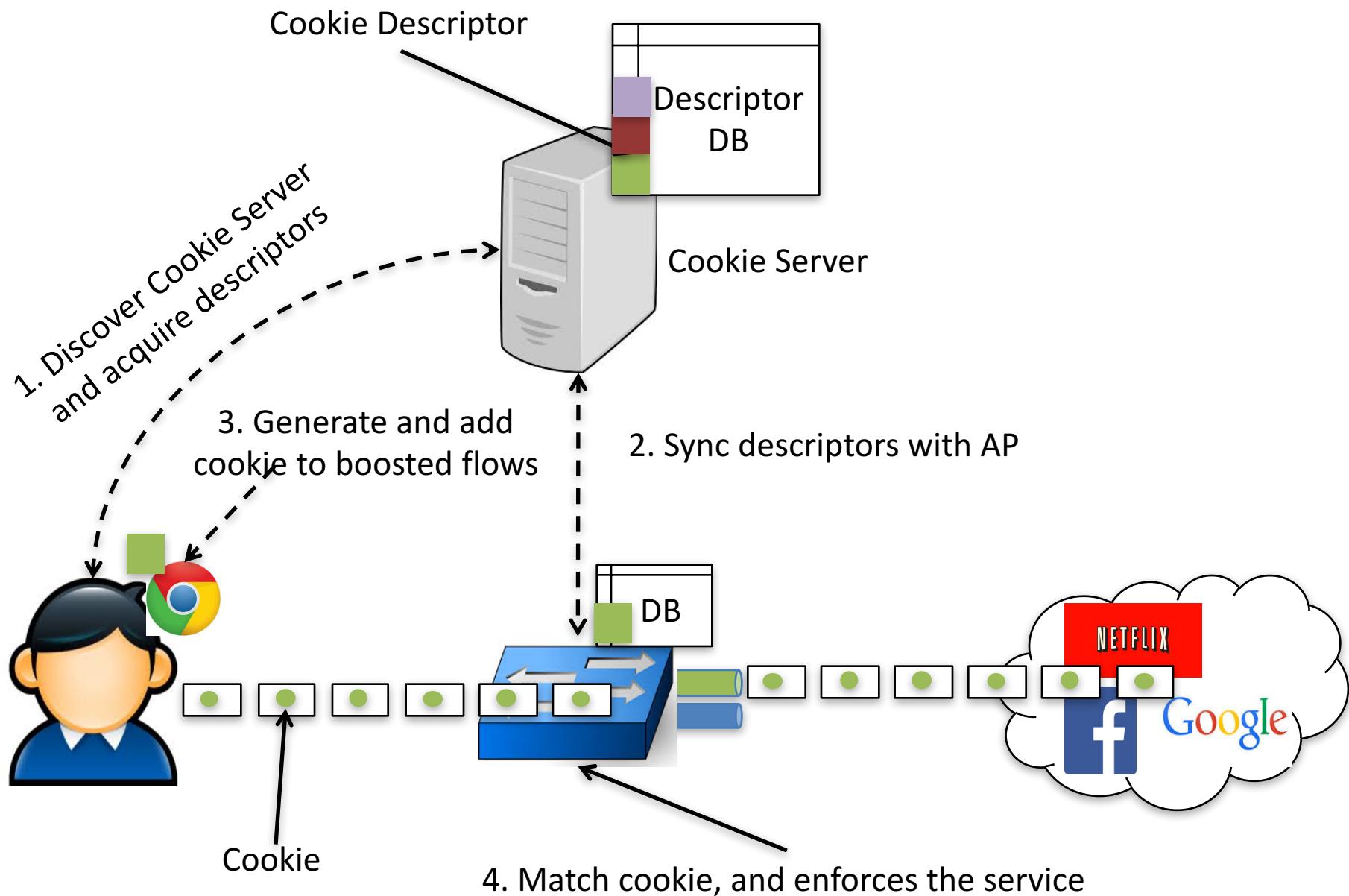
Cookie Descriptors : ID + Key + Metadata

Cookies: Unique, signed, use-once



Cookies & Cookie Descriptors

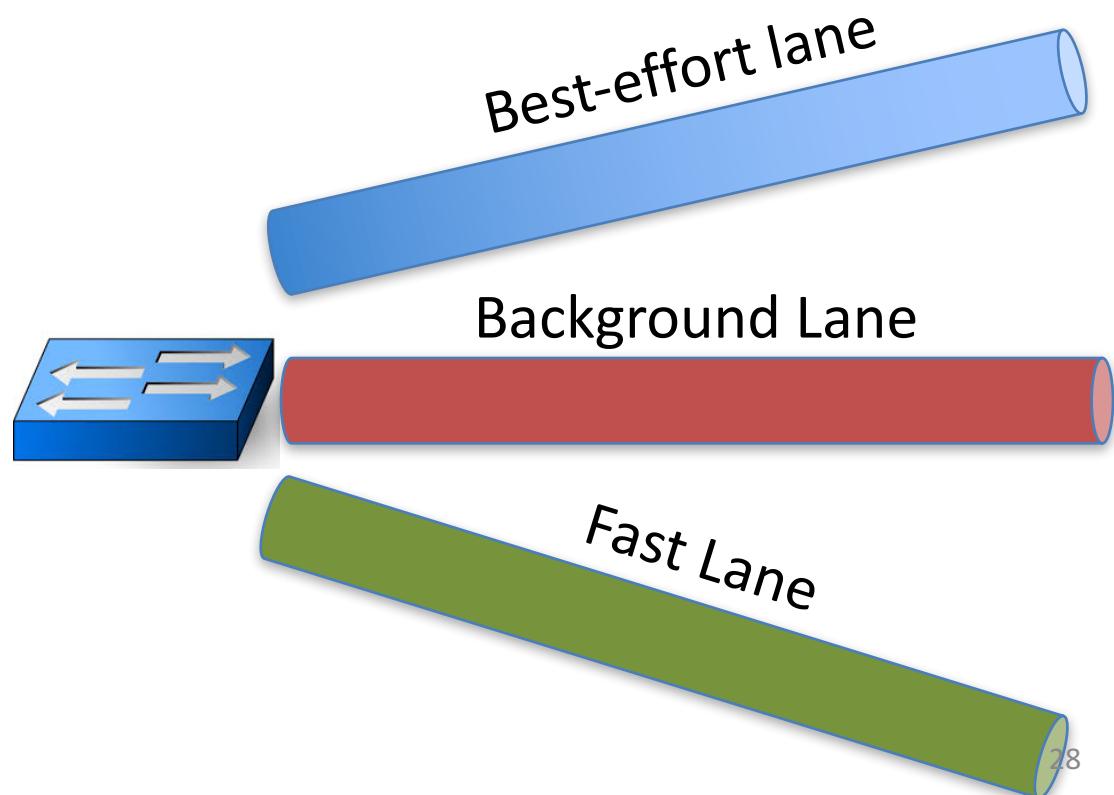
- Separation of data plane and control plane
 - ***Descriptors : Authentication + Service Definition***
 - **Cookies : Generate and Match locally at dataplane**
- Get cookie descriptors through an out-of-band mechanism
- Insert cookies through an “agent” (browser, OS, application)
- Where to insert a cookie?
 - Anywhere we can put a few extra bits
 - HTTP header
 - TLS handshake
 - IPv6 extension header
 - ...



Example Preferences

Everything goes to the best effort lane, apart from...

1. Dropbox and software updates → background lane
2. Google Hangouts and living room TV → fast lane

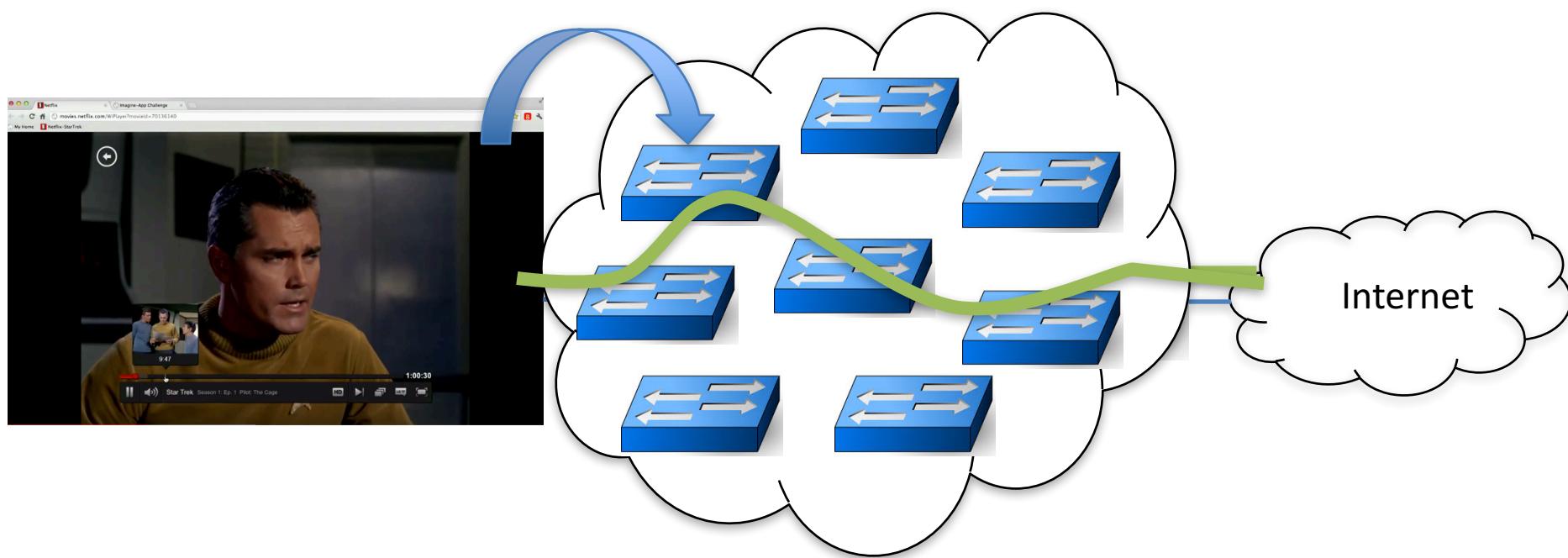


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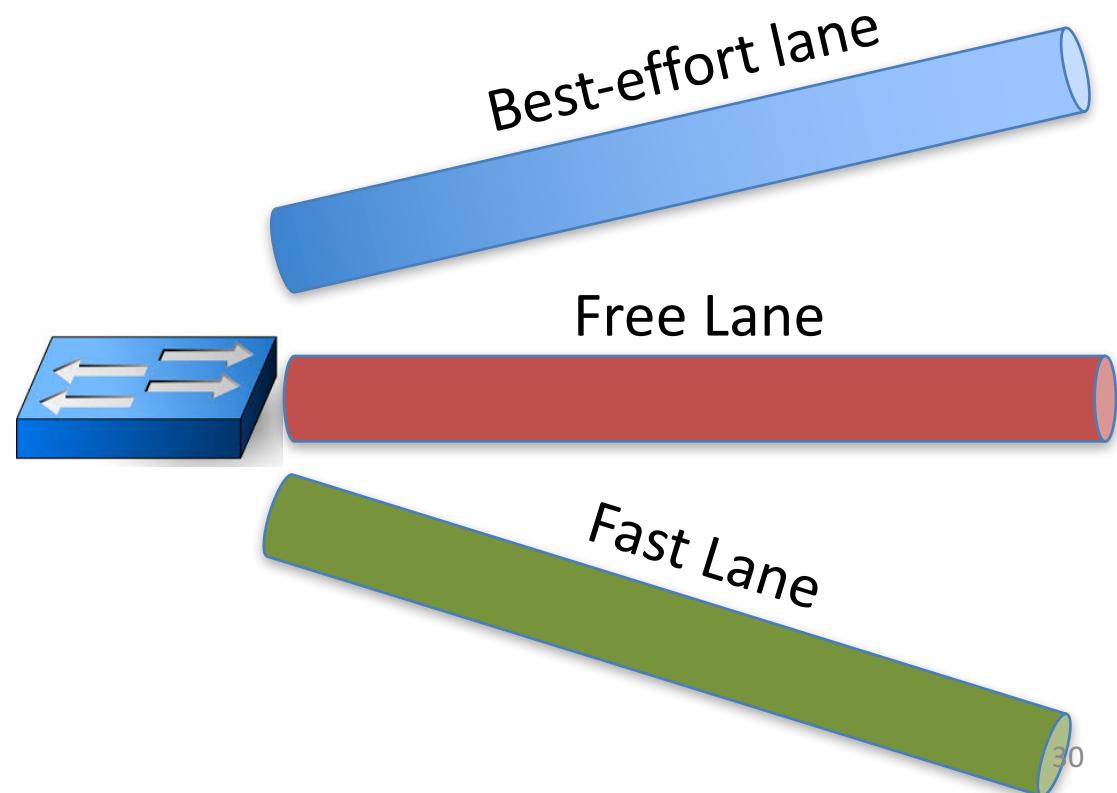
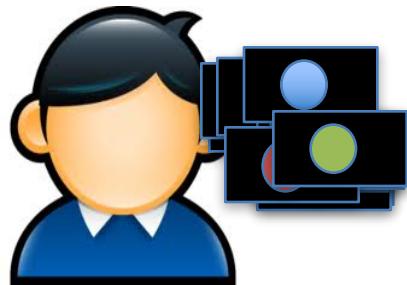
2. Communicate it to the network

3. Configure the network



Putting it all together...

1. Discover Cookie service and acquire cookie descriptors
2. Generate unique, use-once, signed ***cookies***
3. Append them to desired traffic (HTTP header, TLS extension, TCP, ...)
4. *Match in network*



Network Cookies Properties

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Simple & Expressive

Mapping abstraction	✓
Low transaction cost → Inclusive	✓
Composable/Delegetable	✓

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	High Accuracy	✓
	Multiple transport mechanisms	✓
	Only client-network support required	✓

Network Cookies Properties

Simple & Expressive	Mapping abstraction	✓
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Deployable	Independent of packet header, payload, path	✓
	High Accuracy	✓
	Multiple transport mechanisms	✓
	Only client-network support required	✓
Respect trust	Built-in-Authentication	✓
	Protected from replay, spoofing	✓
	Transparent, Revocable, Auditable	✓

Outline

- Why user preferences matter
- Expressing user preferences to the network
- Conclusions

Conclusions & Next Steps

① A User-Driven approach is practical and beneficial

- Evidence from real users (Boost, Zero-Rating)

① How we communicate user preferences is important!

- Network cookies one way to do it

① Next Steps

- Trials
- Standardization
- Net Neutrality Regulation

FORGET NET NEUTRALITY



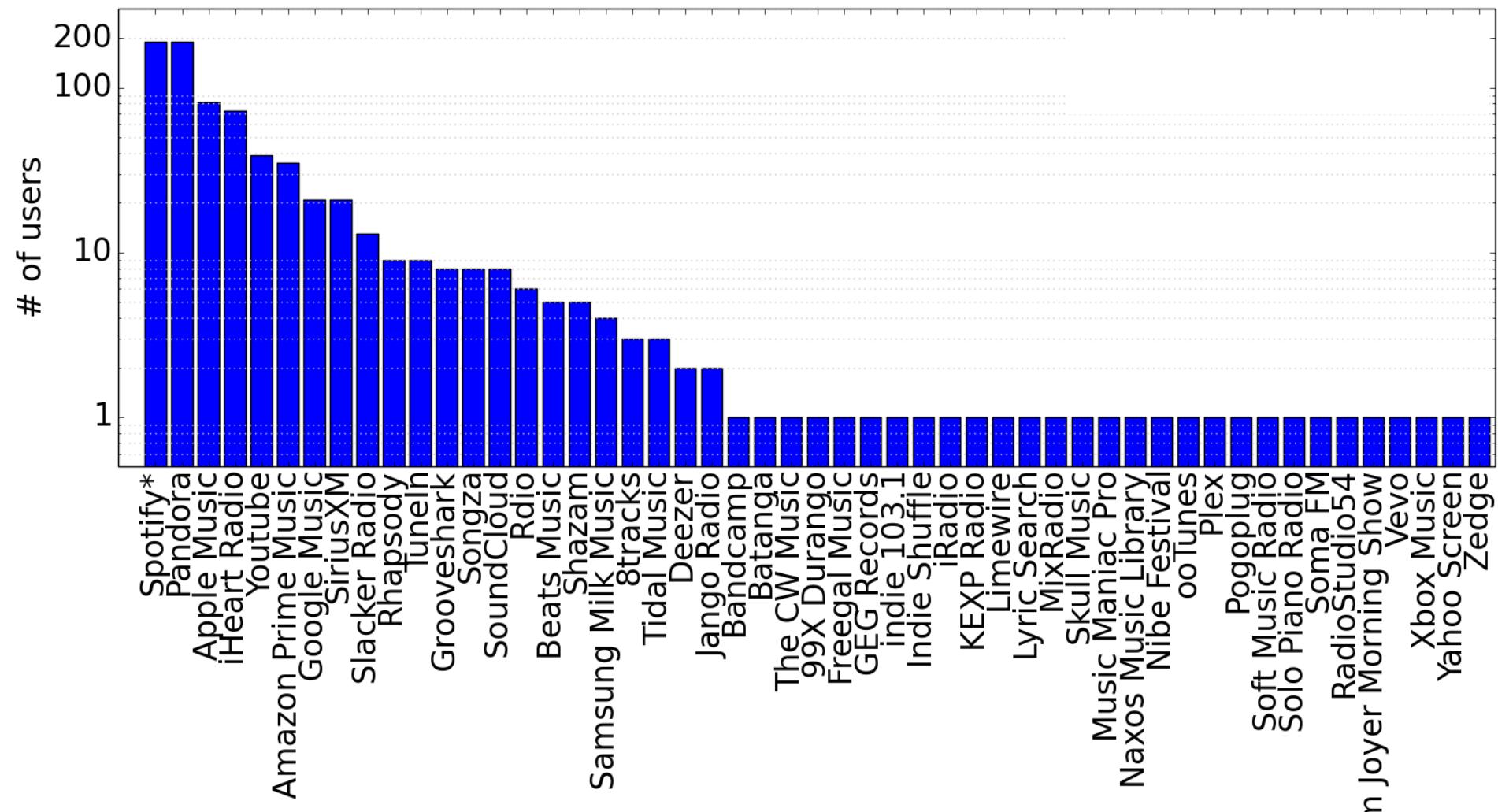
yiannis@stanford.edu

LET USERS DECIDE!!!!

Thanks!
yiannis@stanford.edu

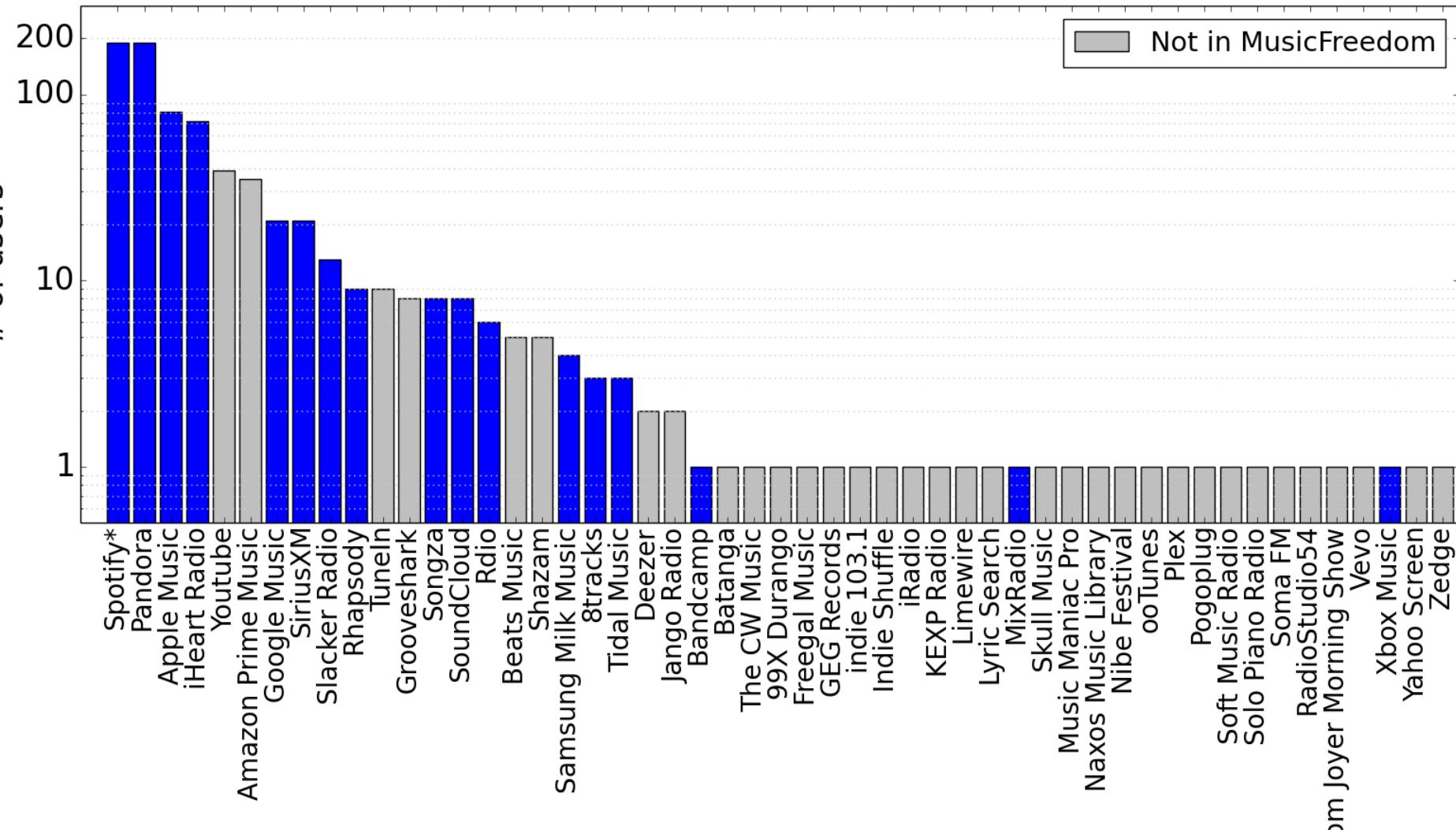
BACKUP SLIDES

What music do users want to zero rate?

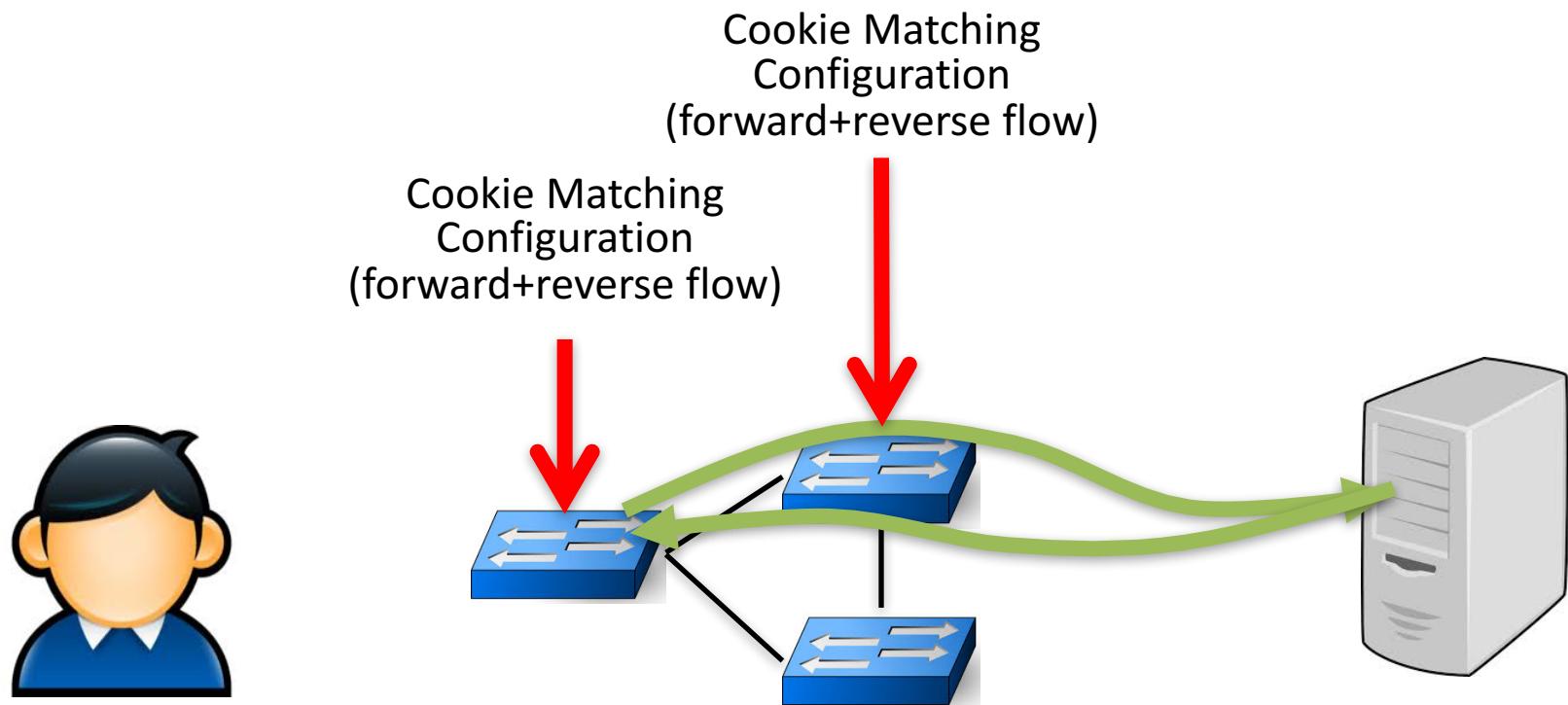


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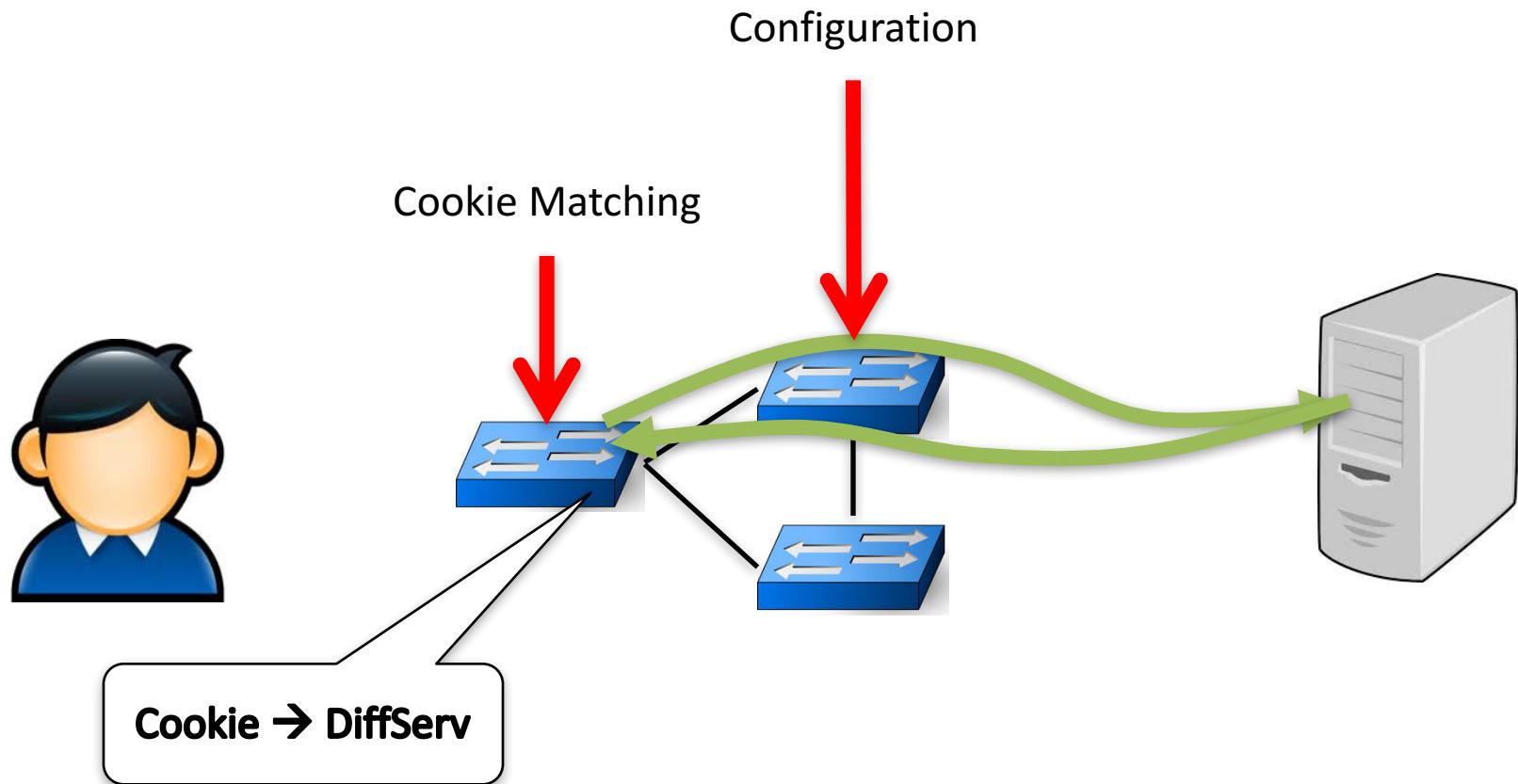
66% of user preferences not in Music Freedom (November 2015)



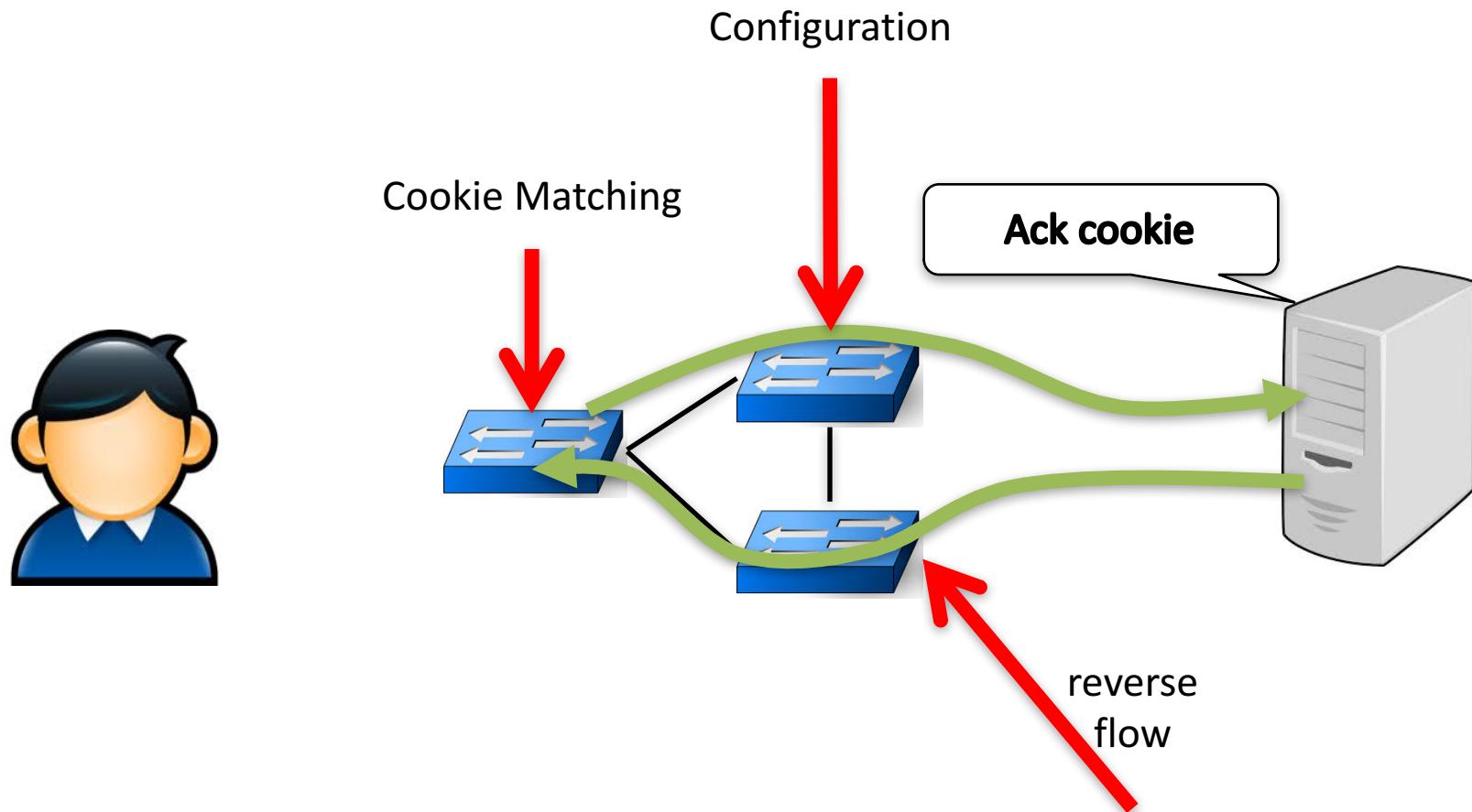
Cookie → Network Configuration



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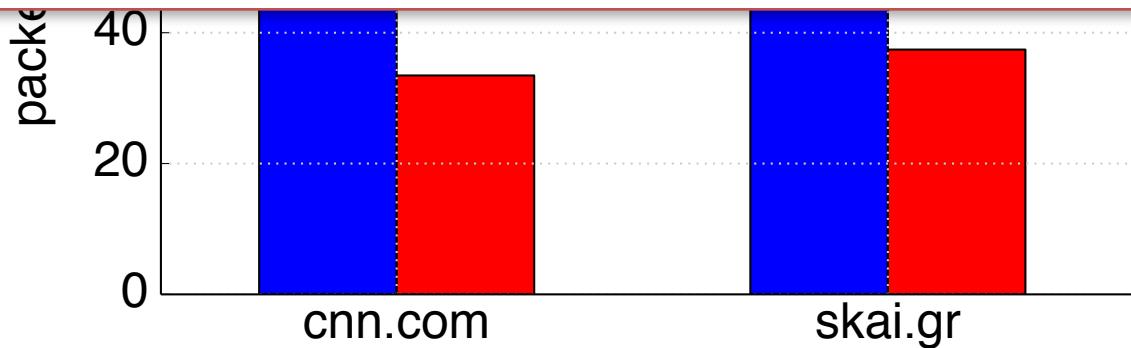


Out-of-band (or SDN*)

Flow tuple changes in the network



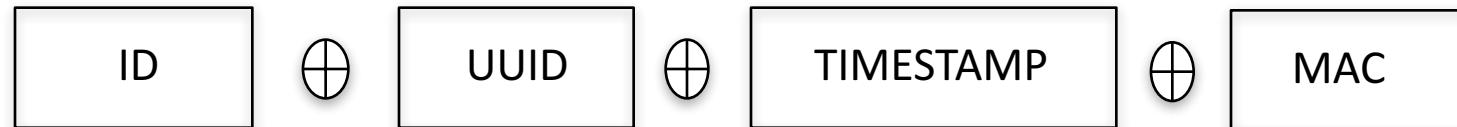
OOB doesn't work with middleboxes (e.g. NAT)



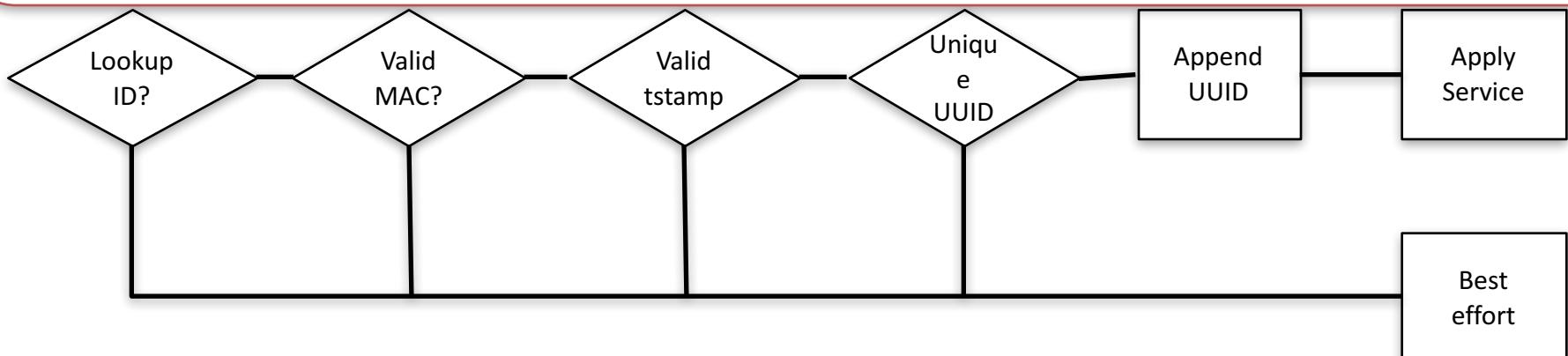
* SDN → Software-Defined Networking

What does a cookie look-like?

Generation



Low overhead, cannot be replayed or spoofed



Where do I get a cookie descriptor?

- Well-known server
- Discovery protocols
- Given by content provider

Out-of-band + authentication primitives

Scalability

