# Software-Defined Crowdshared Networks

2nd GAIA Meeting

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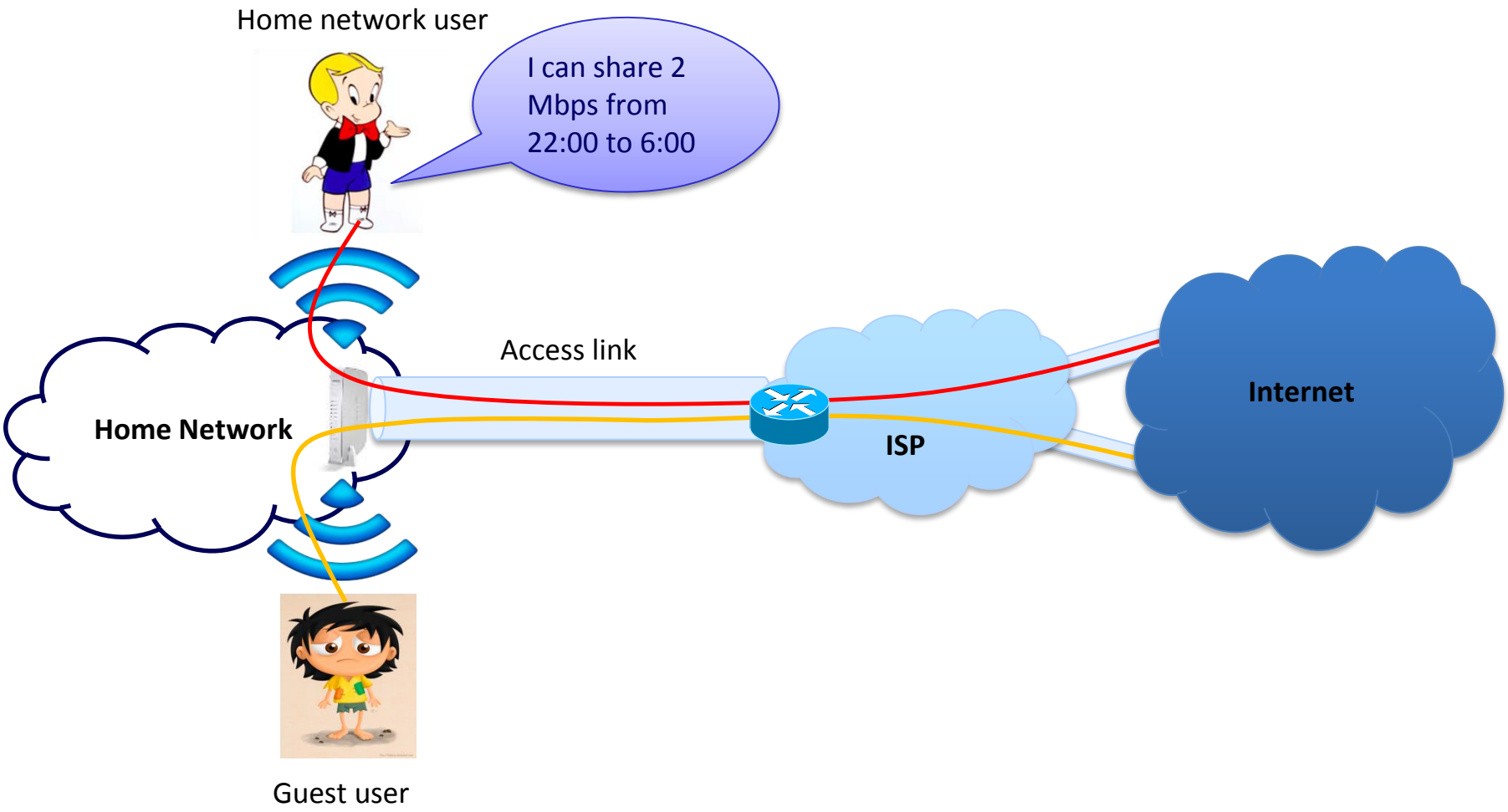
# Introduction

- Affordability is the main barrier to Internet access in residential areas
  - Internet access costs 10x – 40x the average income in some developing countries
  - Internet is not entirely affordable in the developed world
    - 22.7 % of Nottingham population without Internet access, can't afford it (Nottingham Citizens Survey, 2011)

- Home network sharing
  - Bandwidth availability during off-peak periods
  - Density of wireless access points
    - Opportunities for WiFi resource pooling

# Crowd-shared Networks




LCD-Net: Lowest Cost Denominator Networking, ACM CCR 2013

Virtual Public Networks, IEEE EWSDN 2013

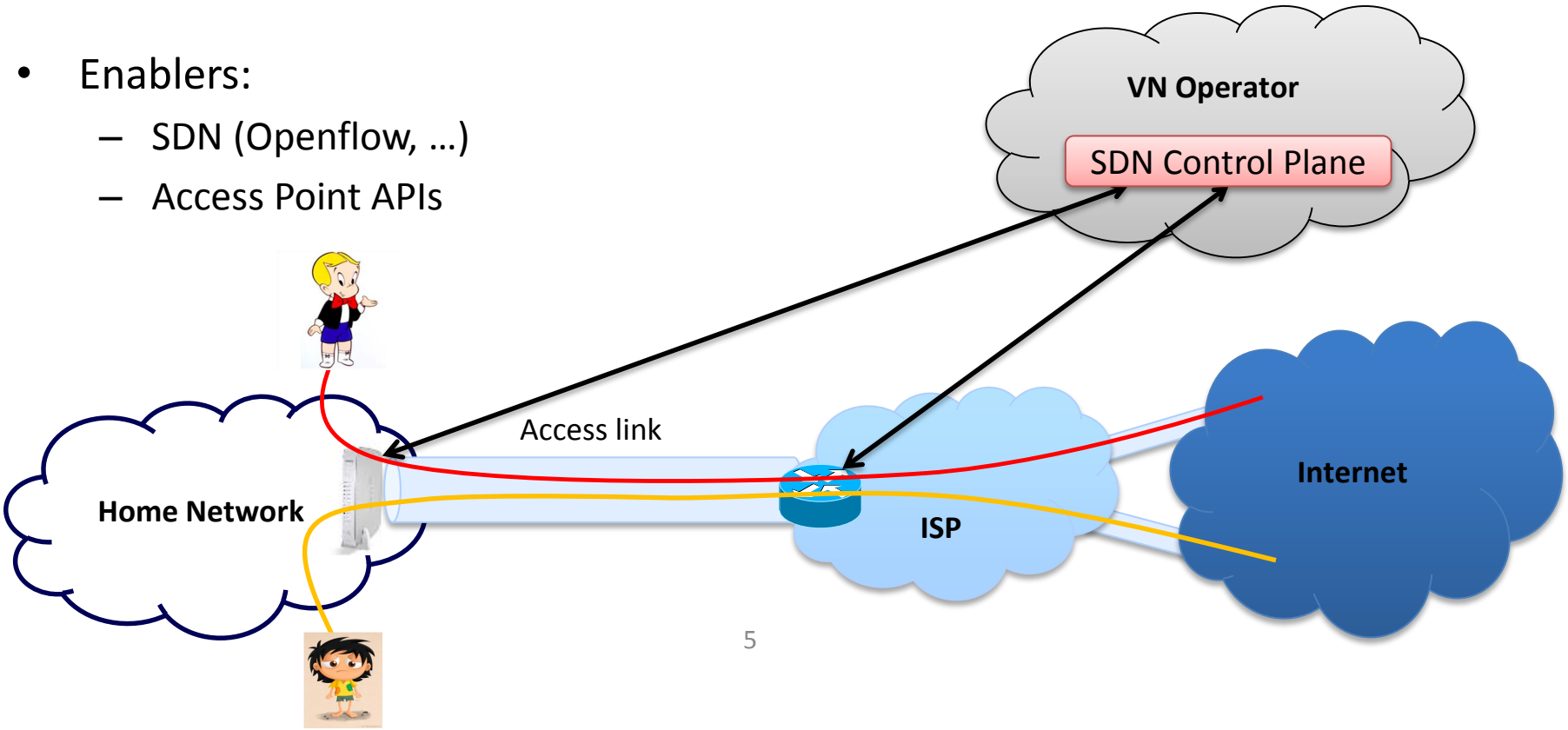
# Requirements

- Bandwidth isolation
  - Guest users should not be allowed to hog the bandwidth
- Confidentiality
  - Traffic eavesdropping by collocated devices should be prevented
- Authentication
  - Guest users should be able to authenticate themselves with the network
- Accountability
  - Sharers should not be accountable for the actions of guest users
- Minimal configuration overhead for users and ISPs
  - Network configuration and management should be outsourced to third parties

# Virtual Network Operators

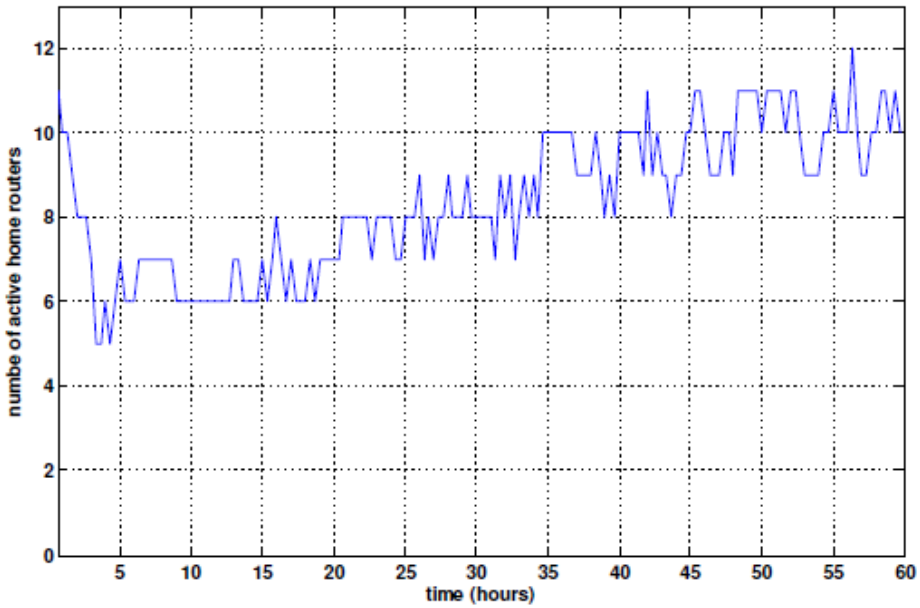
- Extending the stakeholder value chain with Virtual Network Operators
  - Incentives for home users and ISPs
  - Opportunities for cheaper Internet Access

- Enablers:
  - SDN (Openflow, …)
  - Access Point APIs



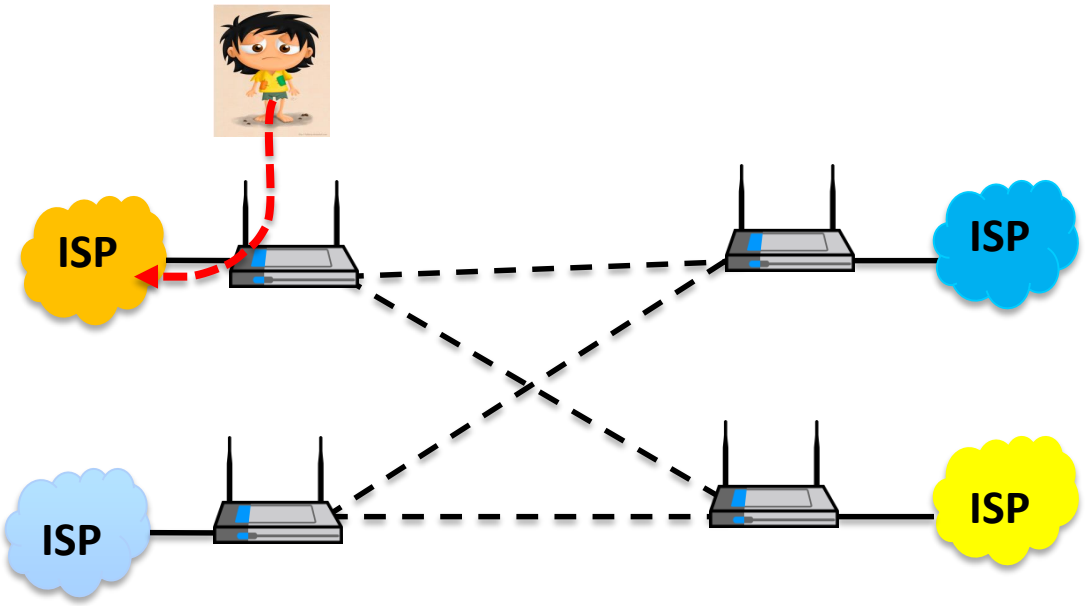
# User sharing patterns

- Internet access may not be shared for certain periods
  - Users need all their bandwidth
  - No free port in the home router
  - PAWS deployment:
    - Limited number of active home routers
  - Need for extended coverage



# Crowd-shared Wireless Mesh Network

- Extend coverage with wireless mesh network (WMN)
  - Multiple points of access
  - Opportunities for resource pooling



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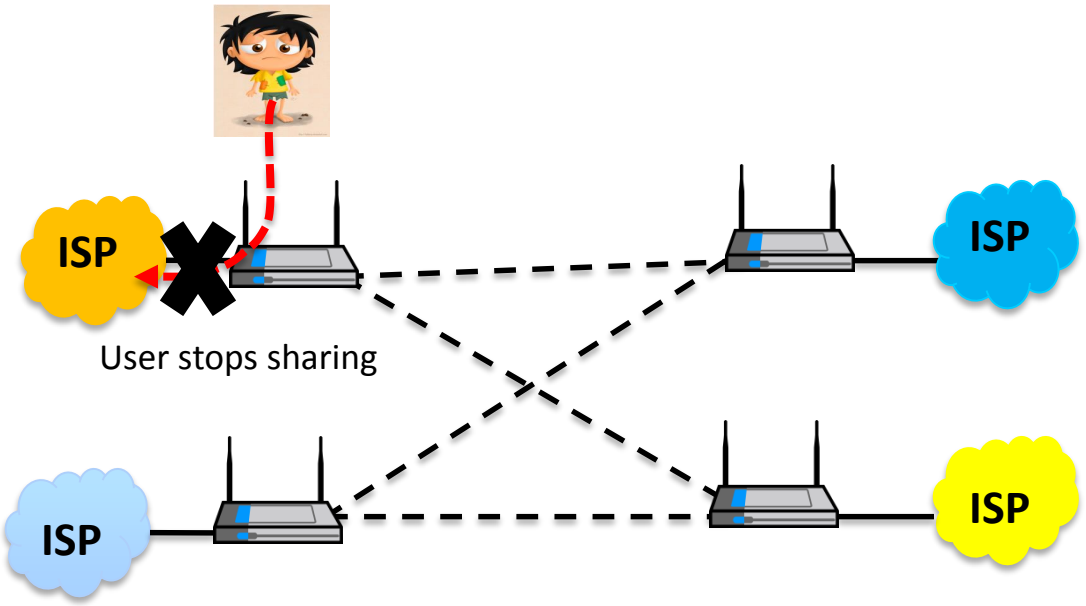

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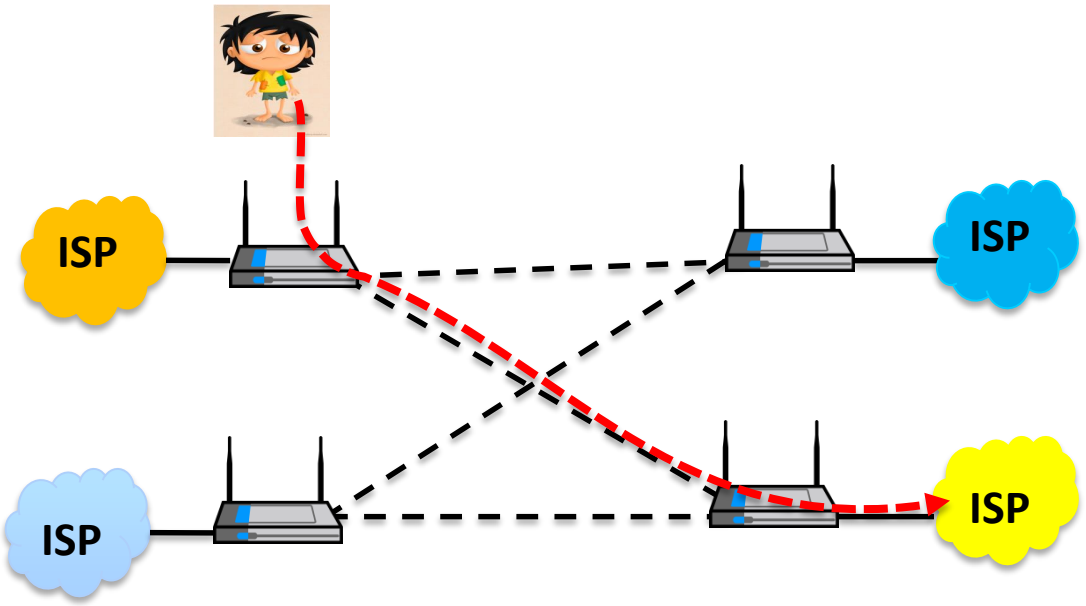
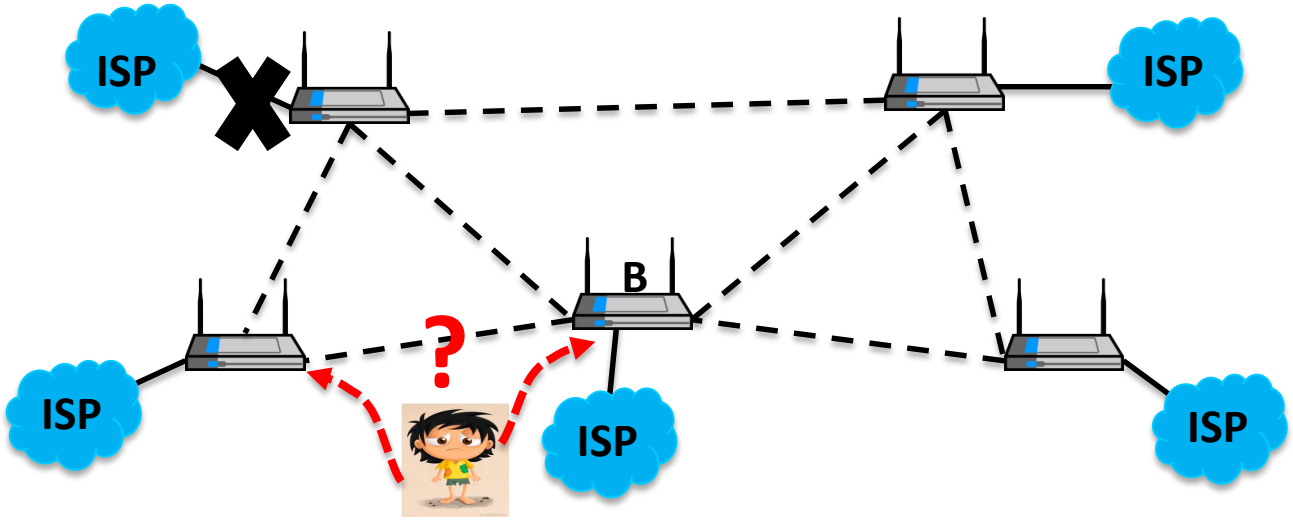


# WMN Management Challenges




- Guest users with diverse traffic rate/patterns
  - Guest user-to-AP assignment
  - WiFi resource pooling

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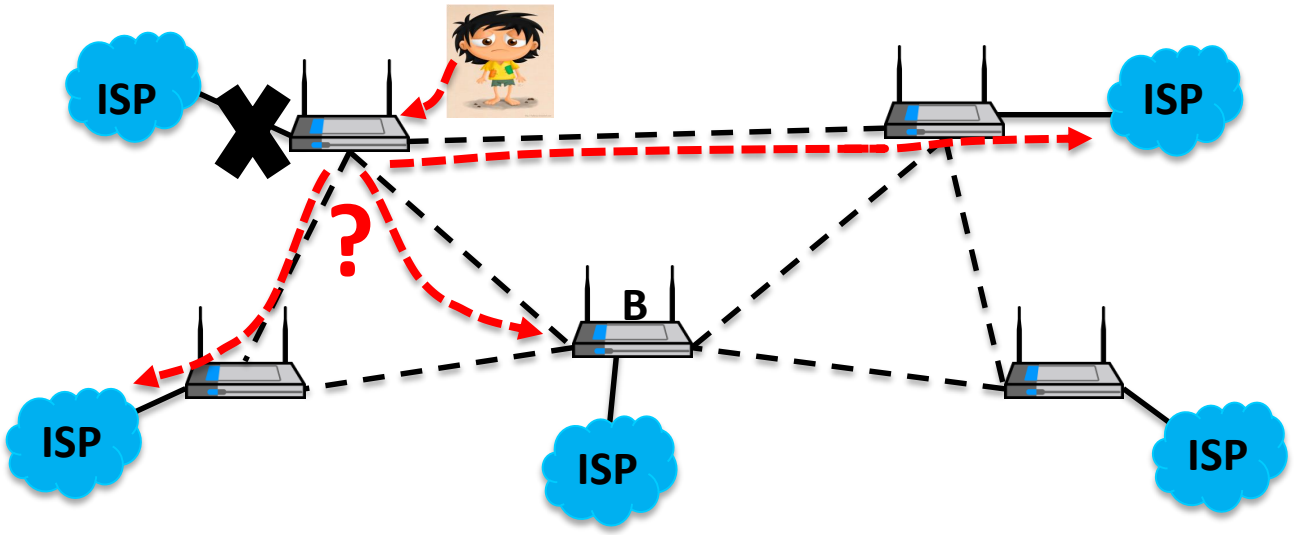
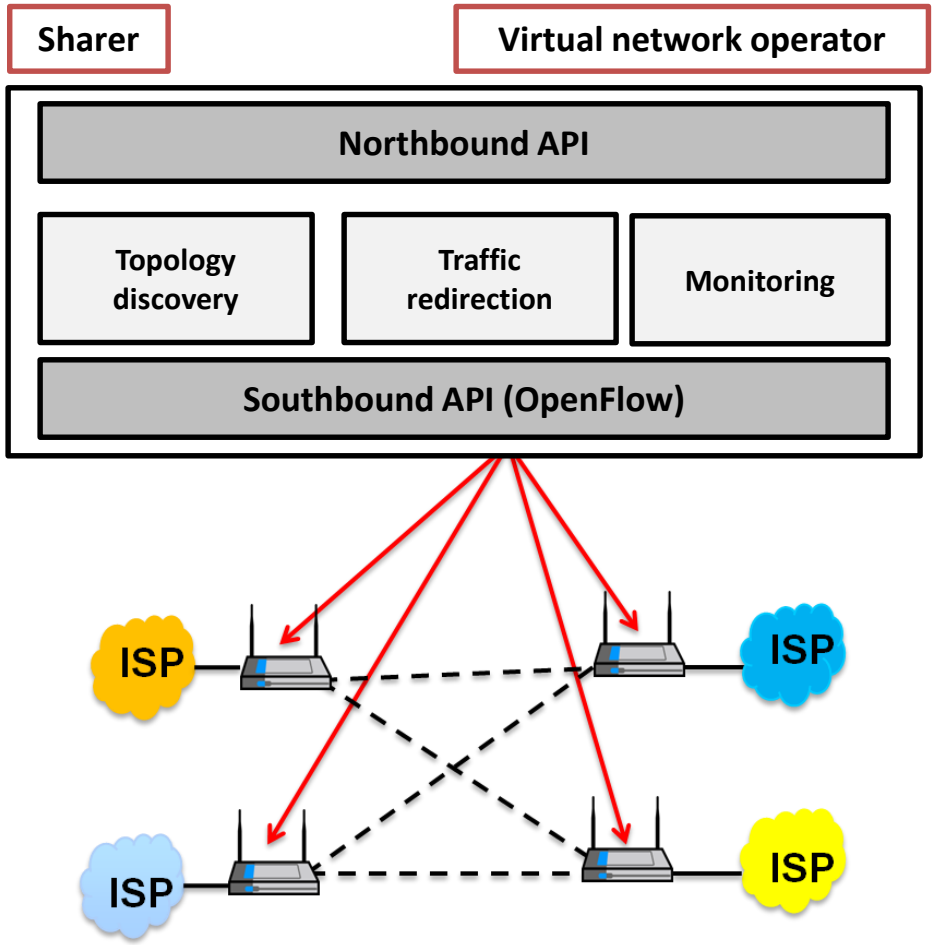


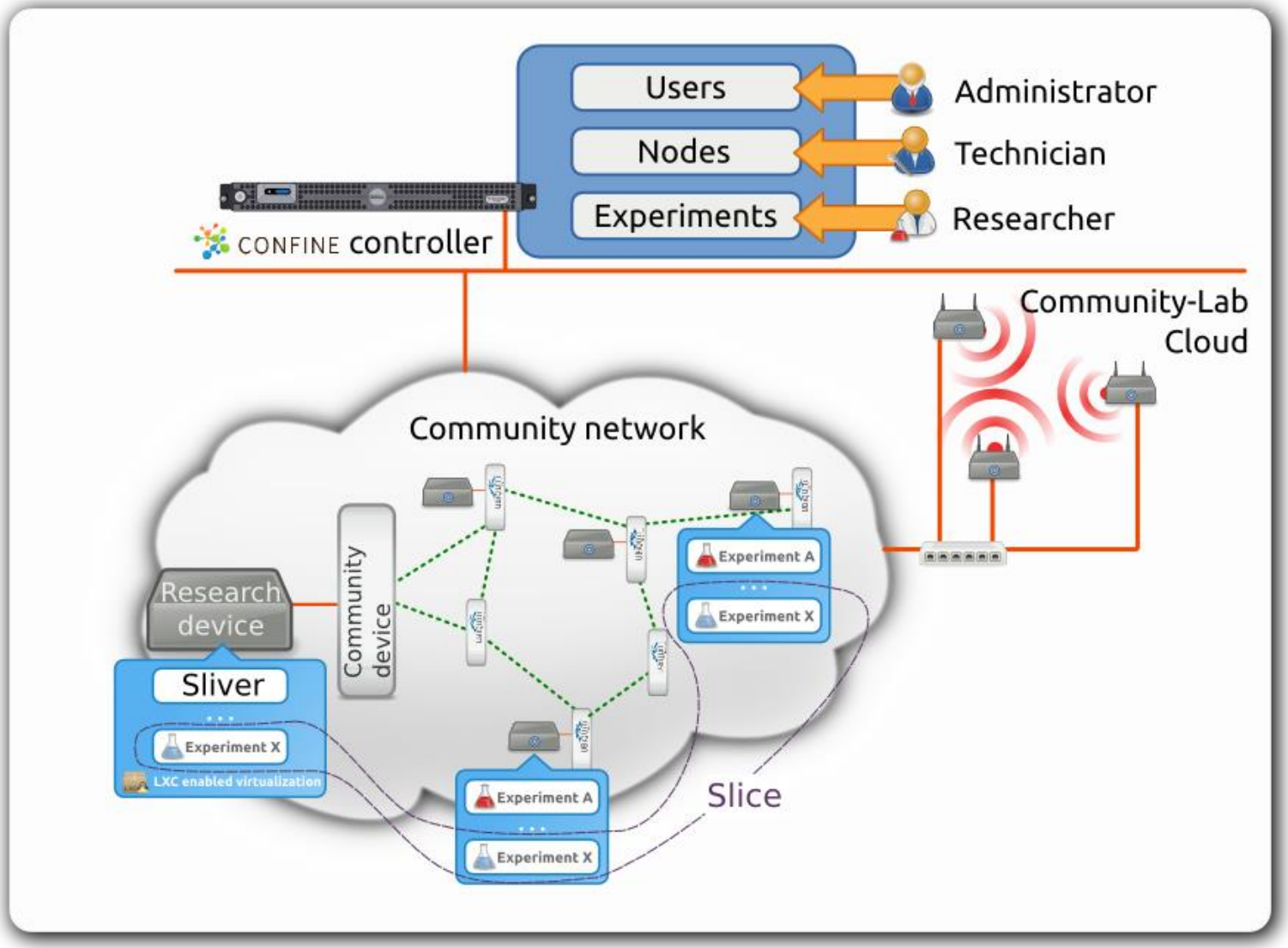

- Guest users with diverse traffic rate/patterns
  - Guest user-to-AP assignment
  - WiFi resource pooling
- Diverse sharing patterns
  - Guest user traffic redirection

# Software-Defined Crowed-Shared WMN

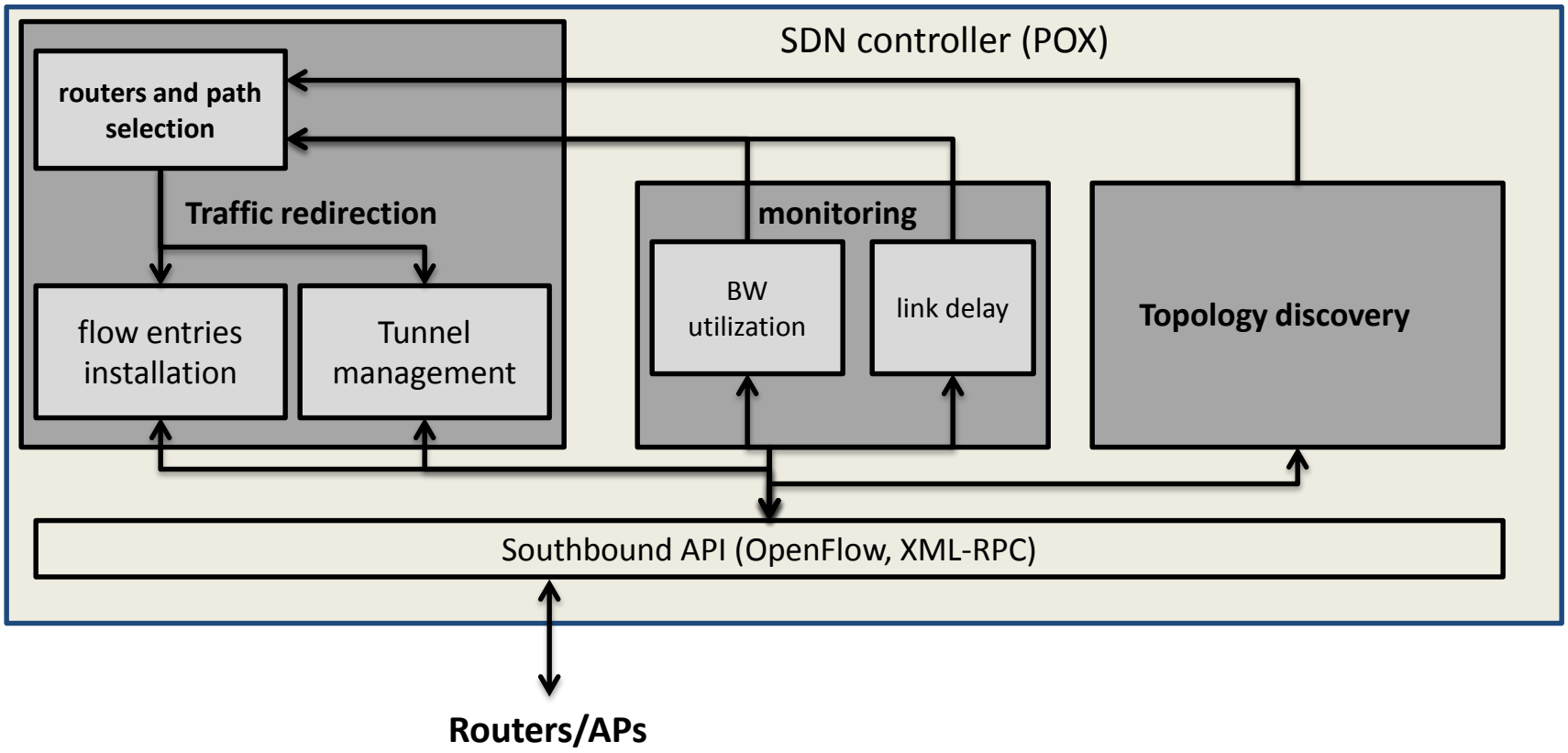
- WMN management and control
  - SDN control plane implementation
  - Deployment in CONFINE community networks
  - Evaluation against PAWS



# CONFINE Community-Lab



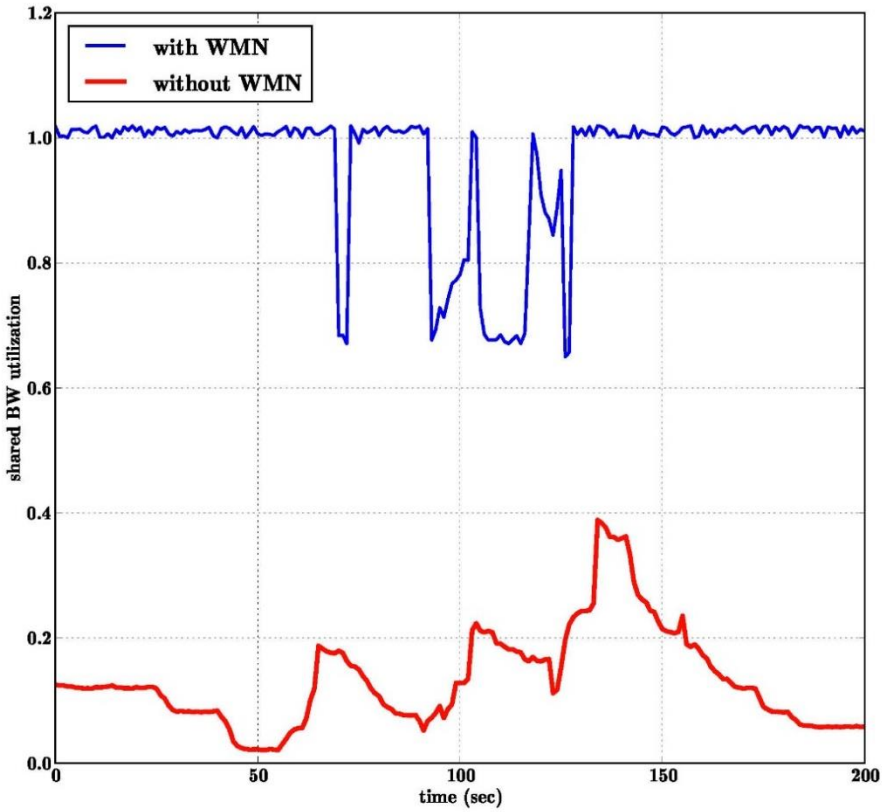
# SDN Control Plane Implementation




- Control plane modules implemented in POX
- Tunnel management and monitoring via XML-RPC

# Crowd-shared WMN vs. PAWS

- Experimental setup in Athens Wireless Metropolitan Network (AWMN) :
  - 5 home routers and a controller
  - Using TAP devices, emulated DSL links with 4 Mbps (traffic shaping with Click)
  - Router availability modeled as on-off Markov chain, based on PAWS datasets
- Evaluation metrics:
  - Shared bandwidth utilization
  - Guest user serving rate



# Application-Centric Wireless Access

# Motivation

- Public WiFi networks are highly underutilized[1]:

1.2 billion of connections per year
100M customers

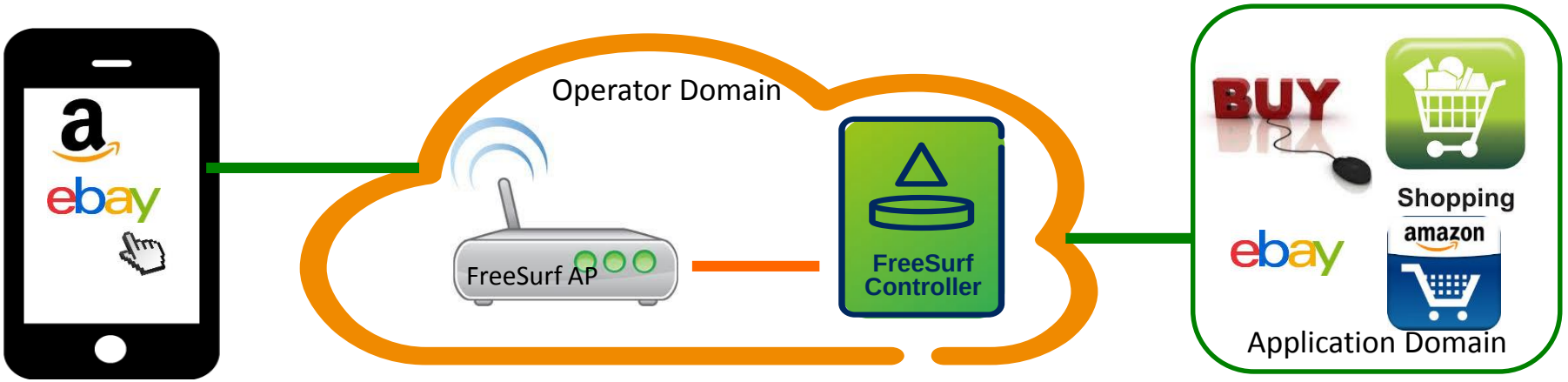
1.0 connection per customer per month
10% active customers

- User-centric public WiFi infrastructure impacts user experience[2]:
  - 12 clicks are required by users to access Internet with a splash page on iPhone
  - 25% of users abandon the web page after 4 seconds
  - 50% of users abandon the web page after 10 seconds

[1]Profile of AT&T WiFi in 2012 per its public announcement

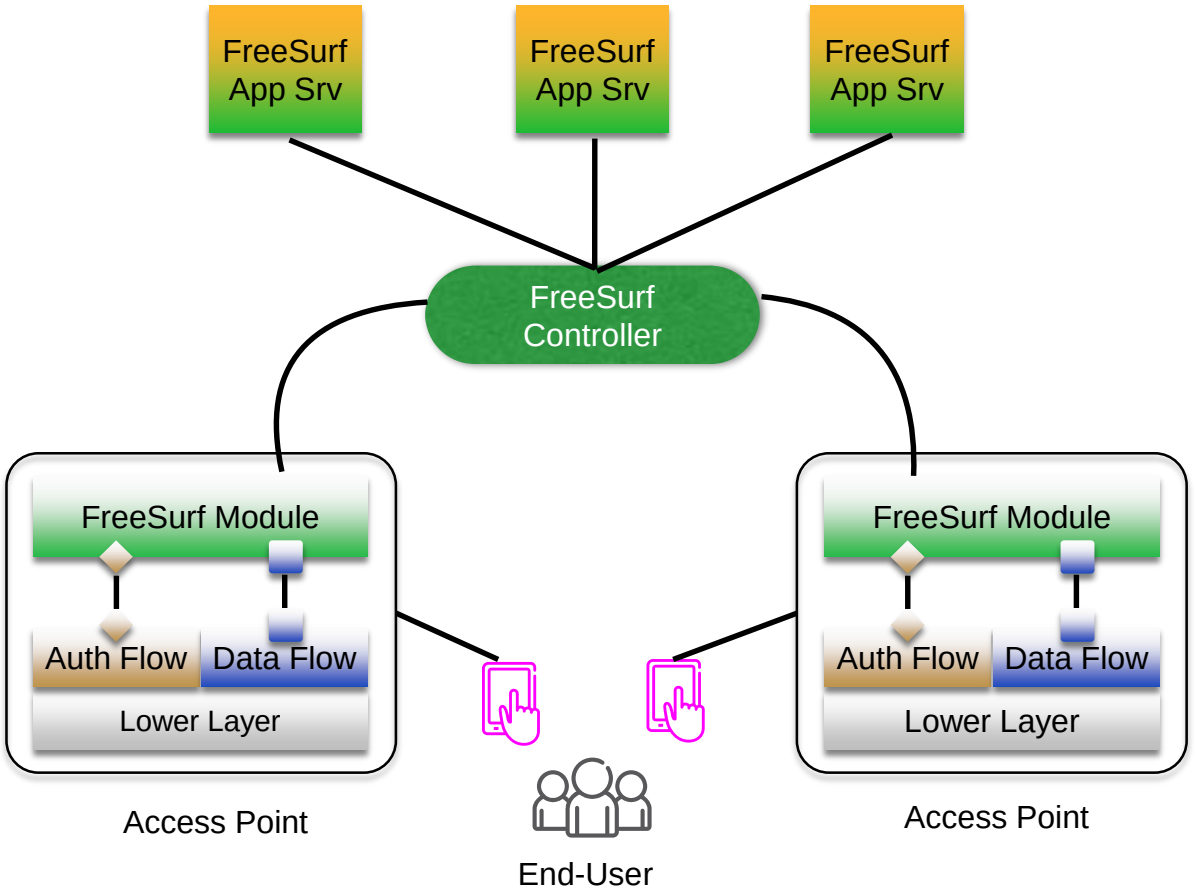
[2]Ericsson

# FreeSurf: Application-centric Wireless Access

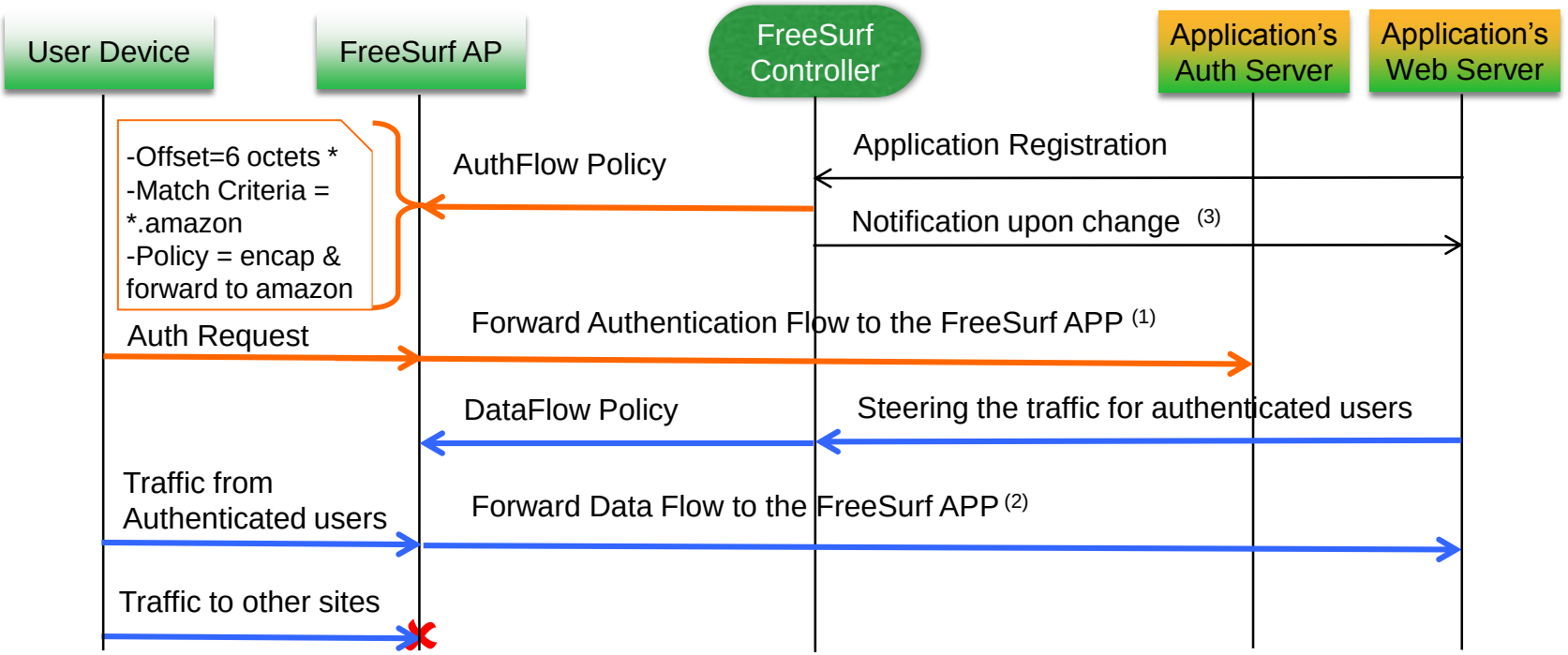



| | Challenges | Solutions |
|---|---|---|
| Discovery | *Networks are dynamic in terms of configuration and scale* | *Application servers are fed with updated information from the FreeSurf Controller* |
| Authentication | *User authentication requests must reach the application server to authenticate* | *FreeSurf Controller installs the flow table on the AP so that the authentication requested are routed securely* |
| Access control | *Only access to the applications should be allowed Application diversity and efficiency problem* | *FreeSurf APs forward the data based on policy BloomFilter used to improve efficiency* |

# FreeSurf Architecture



# Wireless Access with FreeSurf




(1) Content-aware secure forwarding
(2) Policy based traffic filtering
(3) Observatory based discovery
* The authentication username starts from the 6th octet in the EAP message

# Conclusions

- SDN as enabler for home broadband connection sharing:
  - More efficient shared bandwidth utilization
  - Ability to accommodate greater volumes of guest user traffic
  - Creates opportunities for new stakeholders (mostly driven by social goals)

- Application-centric wireless access with FreeSurf:
  - Driver for free Internet access
  - Opportunities for mobile application vendors to opt-in

*Thank you!*

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