



Virtual Public Networks

EWSDN 2013

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In collaboration with:

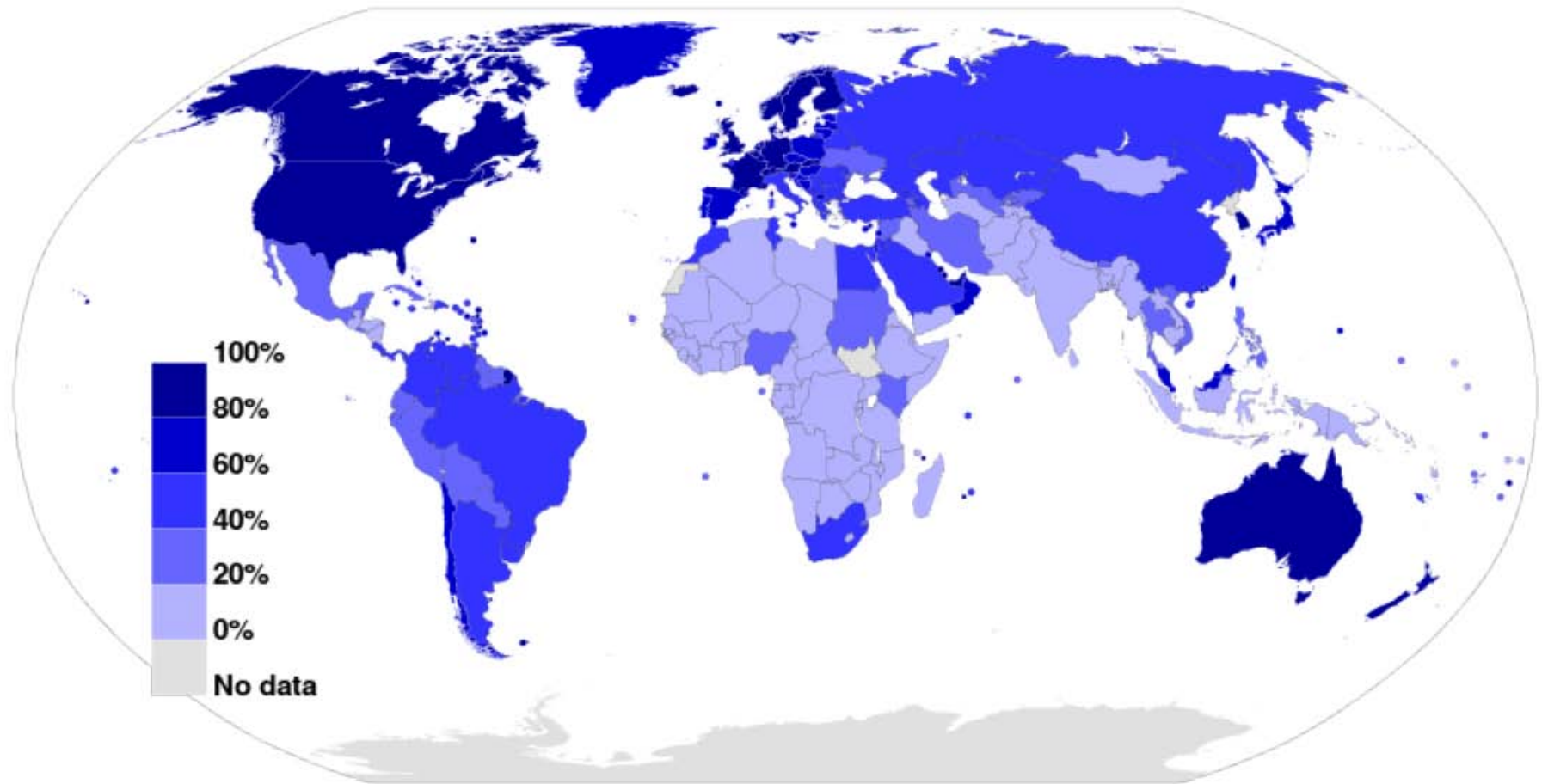
A. Sathaseelan, C. Rotsos, D. Trossen, J. Crowcroft (University of Cambridge, UK)

C. S. Sriram (Paxterra Solutions)





- Vint Cerf:
 - “but it won’t be if it isn’t affordable by all that wish to partake of its services, so we must dedicate ourselves to making the Internet as affordable as other infrastructures so critical to our well-being”
- Tim Berners-Lee:
 - “would like to see everybody given a low-bandwidth connection by default”
- UN Human Rights Council:
 - “All people should be allowed to connect to and express themselves freely on the Internet”



Source: ITU (2012)



■ Cheapest:

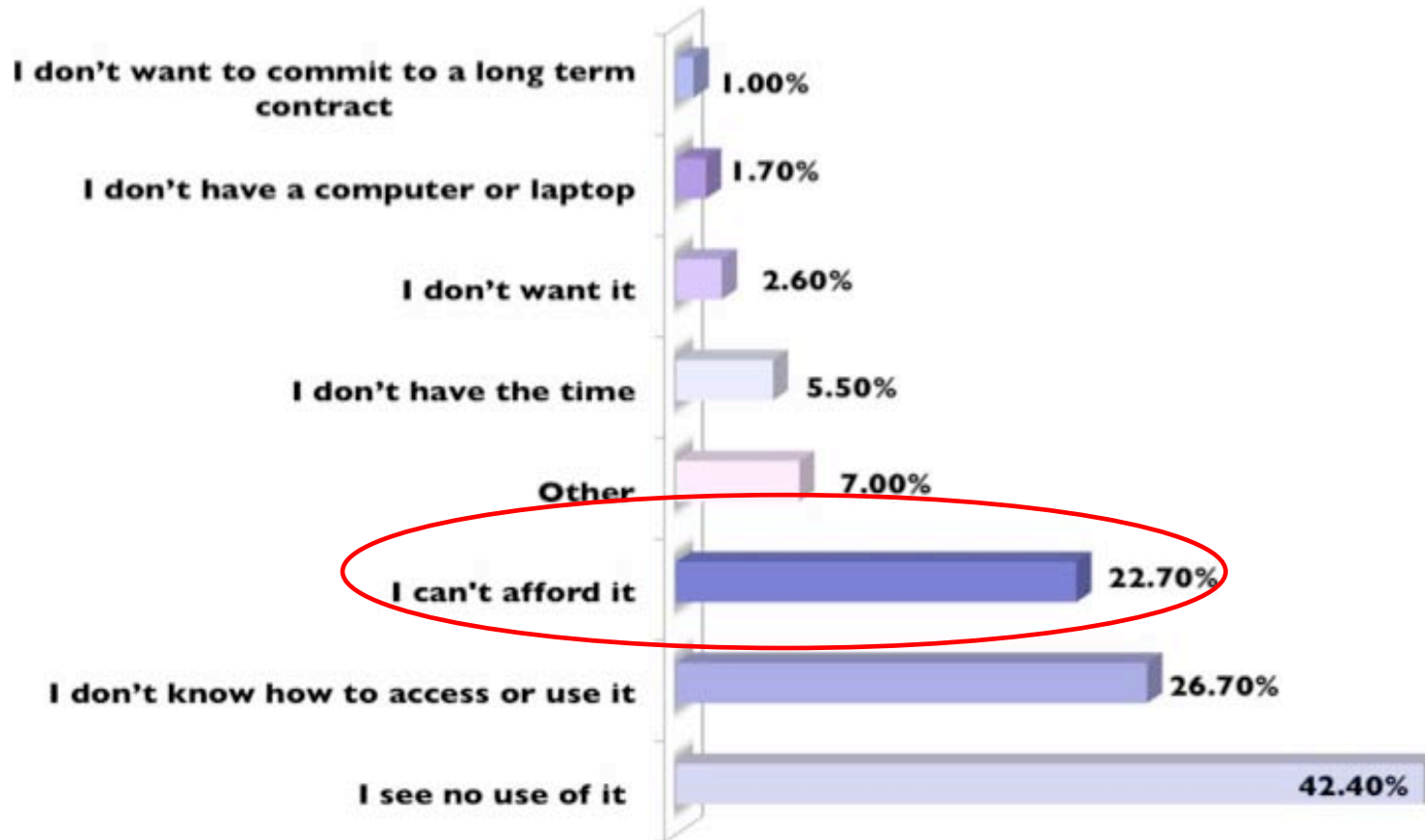
- Macau (0.30%)
- Israel (0.33%)
- Hong Kong (0.49%)
- USA (0.5%)
- Singapore (0.55%)

■ Most Expensive:

- Central African Republic (3891%)
- Ethiopia (2085%)
- Malawi (2038%)
- Guinea (1546%)
- Niger (967%)



- 10% of UK population do not have Internet access



Nottingham Citizens Survey, 2011



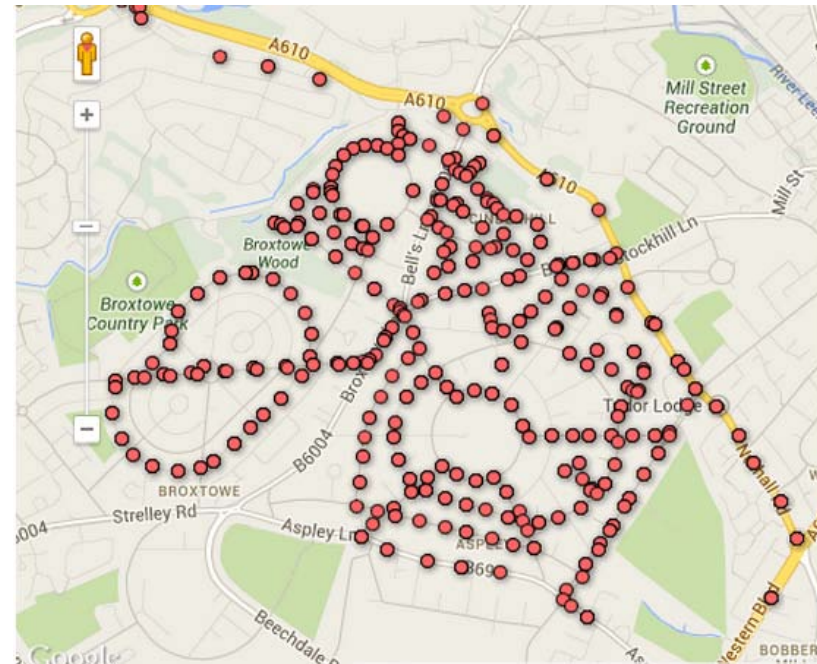
- Home Network Sharing
 - Public Access Wifi Service (PAWS)
- Virtual Public Network (VPuN) Architecture
 - Architecture Overview
 - Home Network Setup
 - Access Point Control API
- Related Work
- Conclusions and Future Work



Home Network Sharing

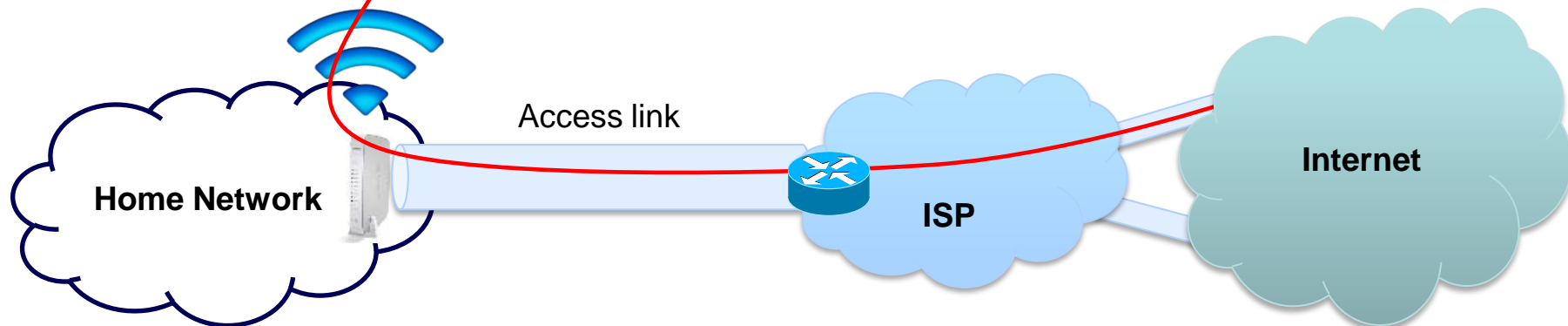


- Basic level of Internet access (Lowest-Cost Denominator Networking)
 - Less-than-best-effort (LBE) access to all
- Public Internet access by opening up and sharing home networks
 - Exploit unused capacity in home broadband networks
- PAWS trial deployment in Nottingham
 - 50 households sharing their Internet connection





Home network user

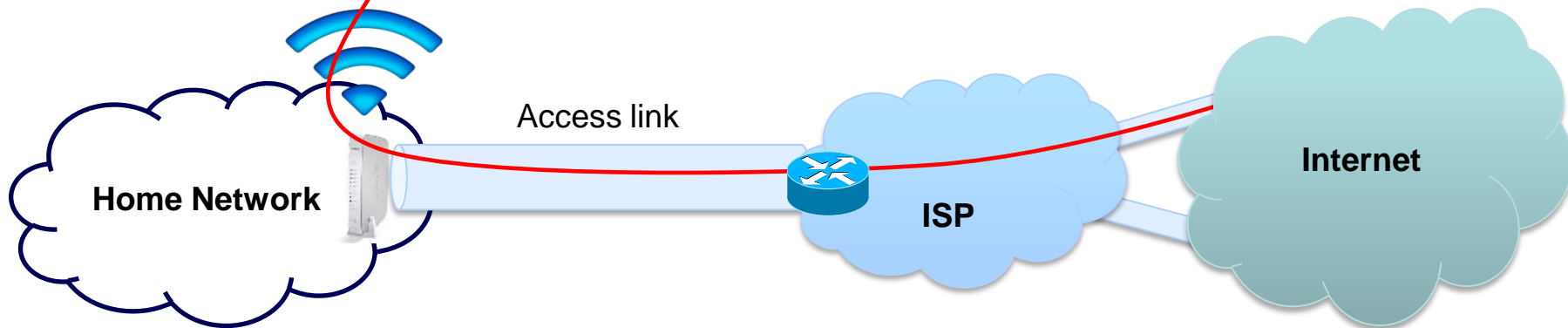


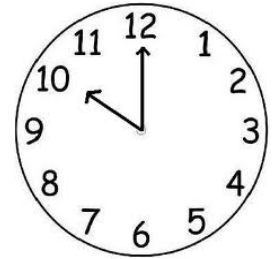


Home network user



I can share 2
Mbps from
22:00 to 6:00

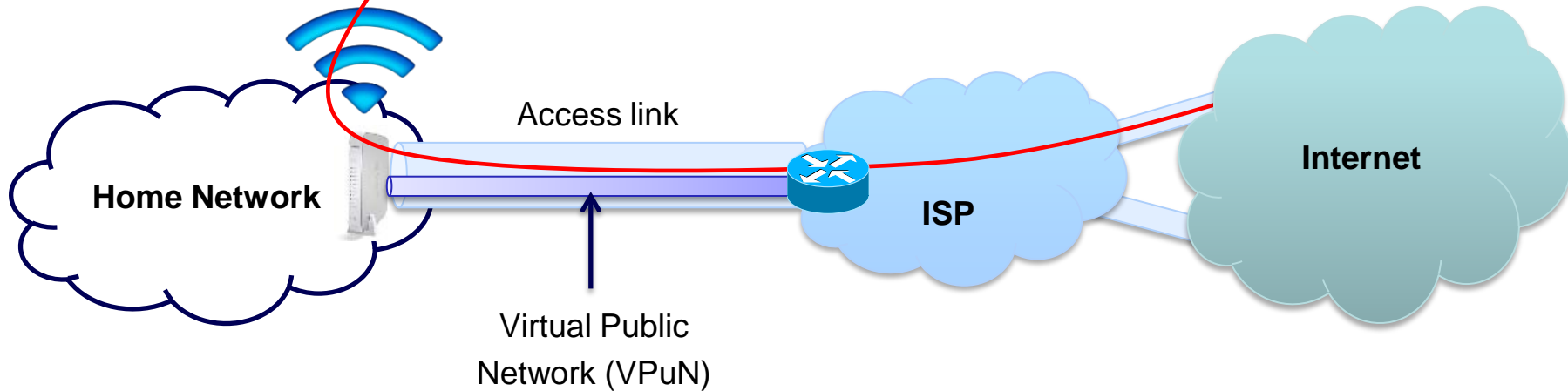


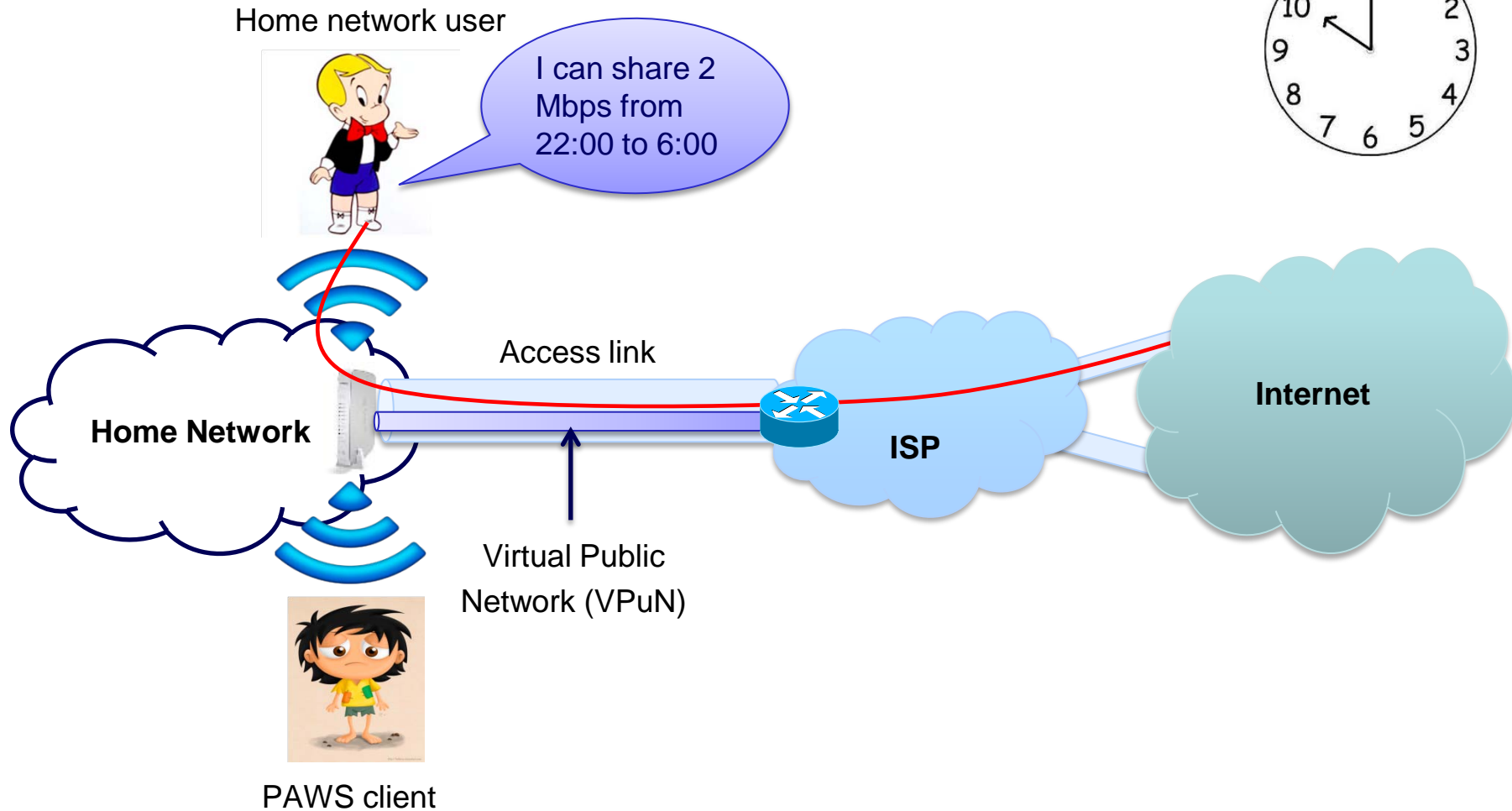
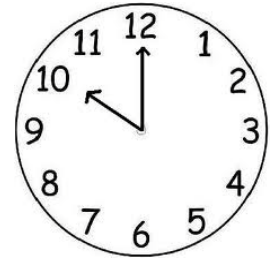


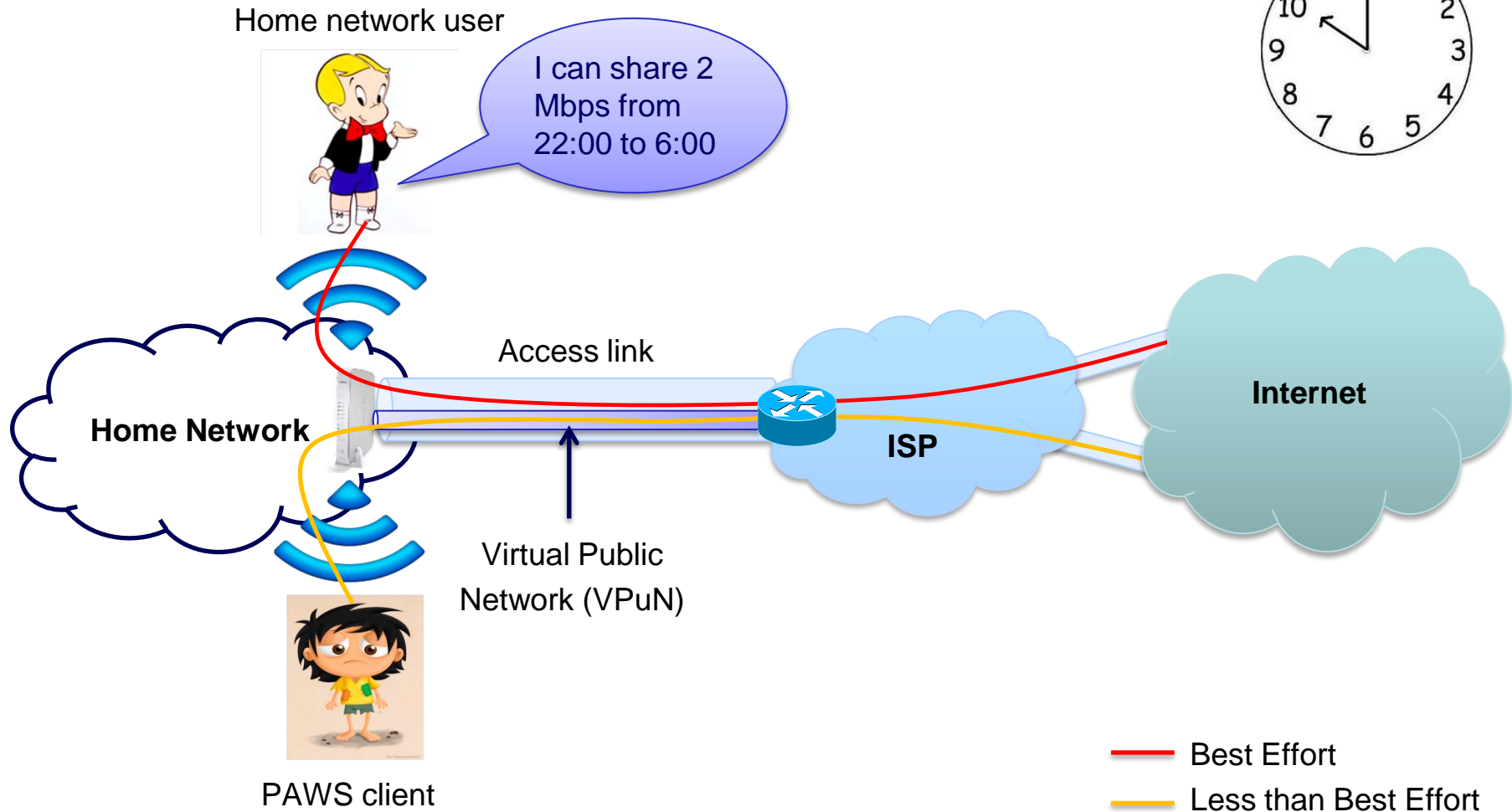
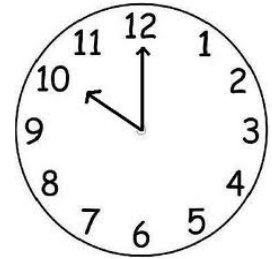
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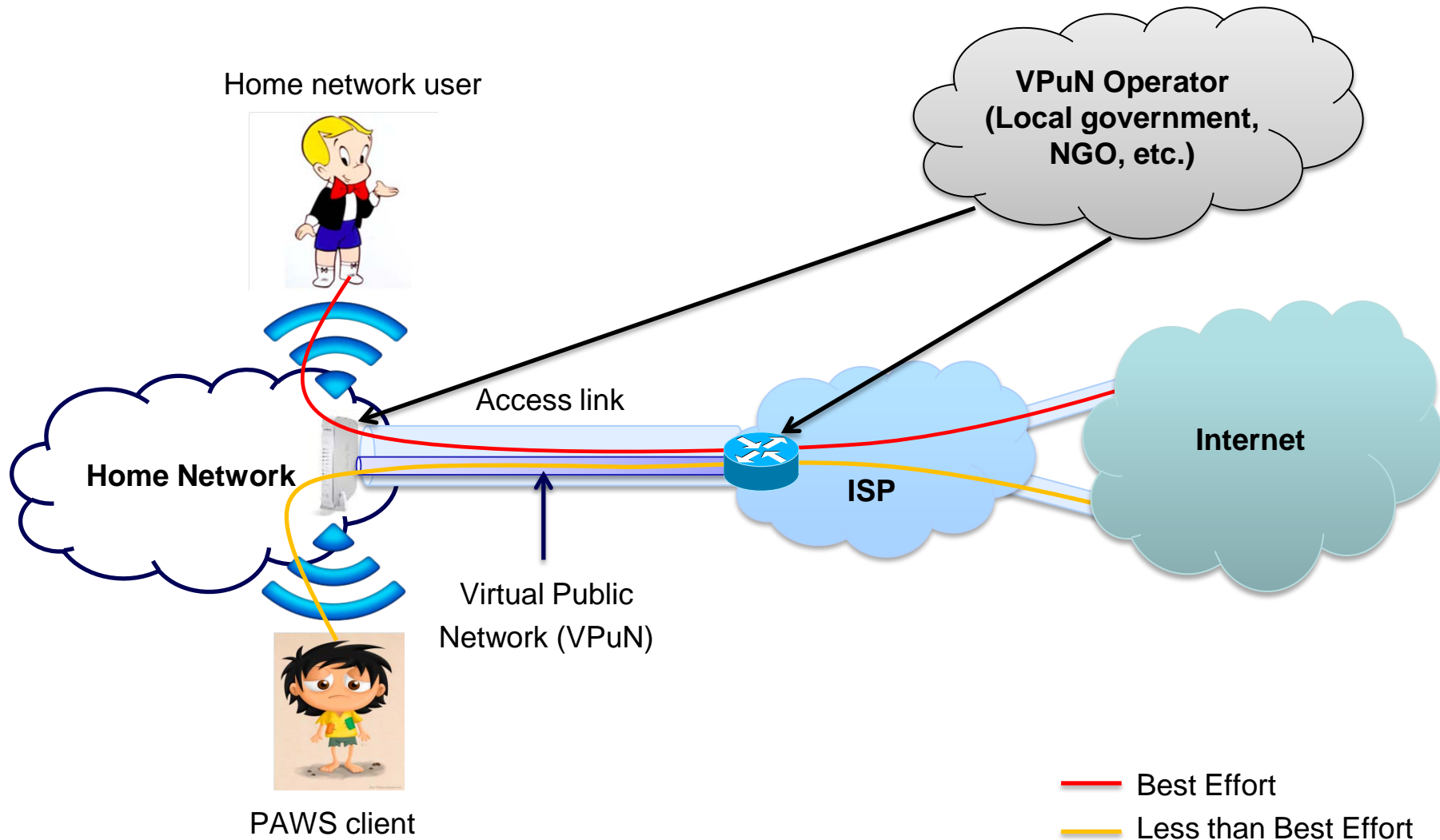








- Bandwidth isolation
 - PAWS clients should not be allowed to hog the bandwidth
- Confidentiality
 - Traffic eavesdropping by collocated devices should be prevented
- Authentication
 - Clients should be able to authenticate themselves with the PAWS network
- Accountability
 - Sharers should not be accountable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



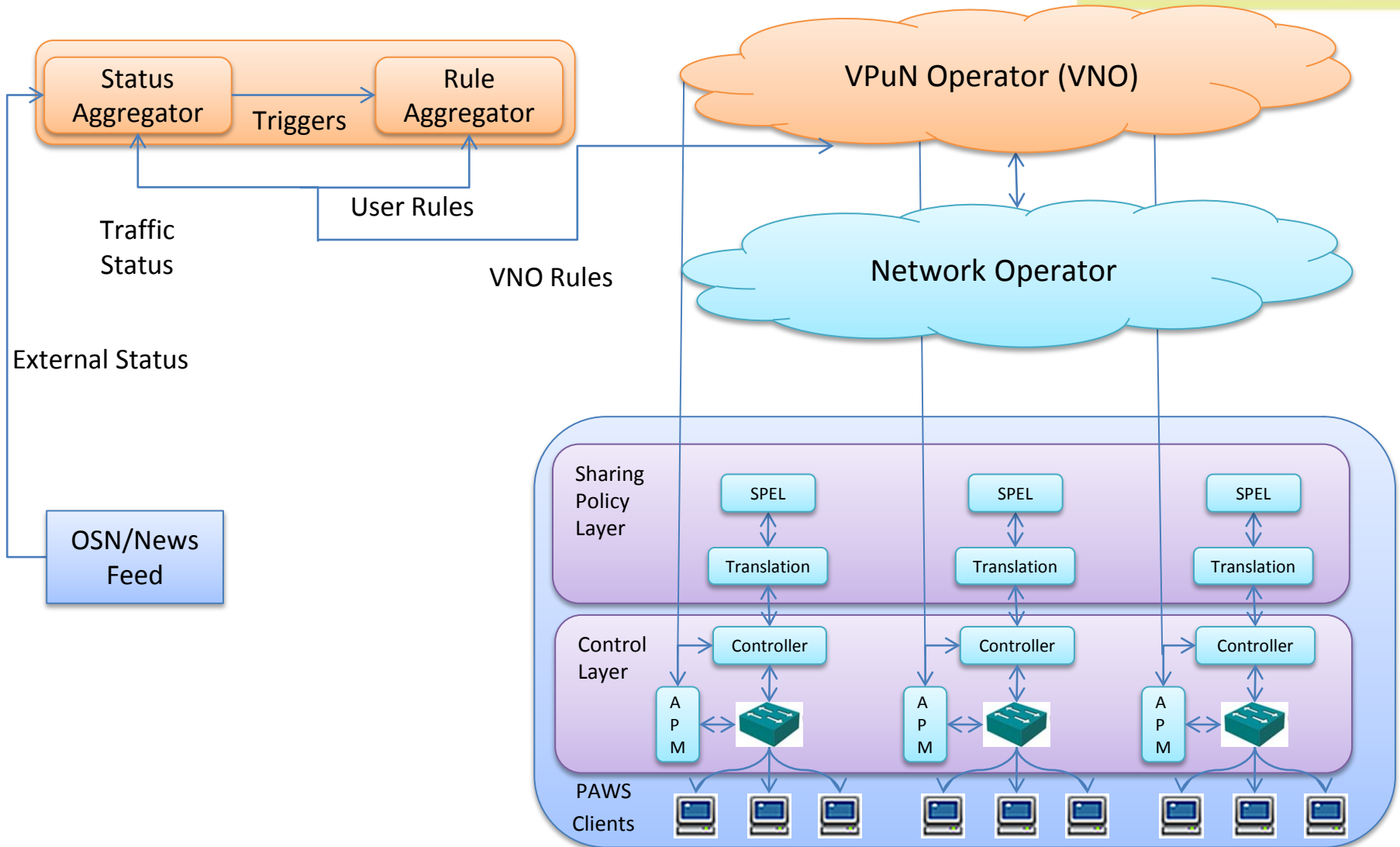


- Capitalizing unused bandwidth
- Wider Internet access in developing regions
- Better recovery during emergency situations and natural disasters
- New opportunities for application developers
 - Reward point management
 - Social media based access



VPuN Architecture

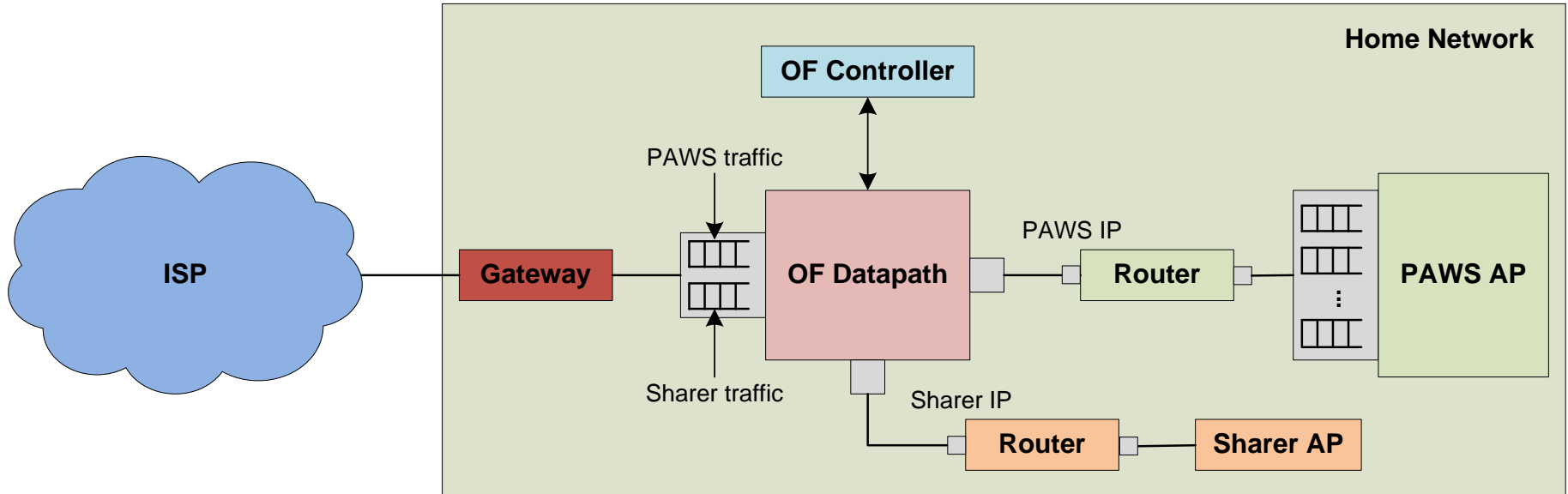
VPuN Architecture Overview





- XML-based schema for expressing sharing policies:

```
<rule id> 1 </rule id>
<name> Share when I sleep </name>
<condition>
  time_of_day > 22:00 AND time_of_day < 6:00
</condition>
<action value = SHARE>
  <data_cap value = 1>
    units = GB
  <data_cap>
  <rate_value = 2>
    units = Mbps
  <rate>
</action>
<expire> 00:00:00 31 Nov 2013 IST </expire>
```





- **User_On/User_Off:**

- AP→VPuNO:

- AP notifies VPuNO about the connection/disconnection of PAWS clients

- **User_Config:**

- VPuNO →AP:

- VPuNO configures resource parameters for a PAWS client

- **Get_User_Stats:**

- VPuNO →AP:

- VPuNO requests traffic usage information



- Switch datapath:
 - OpenvSwitch
 - Click Modular Router with OpenFlow element
- AP configuration:
 - OpenWrt
- Switch and AP control:
 - OpenFlow controller (e.g., NOX)
- PAWS client authentication:
 - EAP-TLS



Related Work



- Rural Wireless Network Management:
 - S. Hasan et al., **Enabling Rural Connectivity with SDN**, ACM DEV 2013
 - S. Surana et al., **Beyond pilots: Keeping rural wireless networks alive**, USENIX NSDI 2008
- Security for Wireless Community Networks:
 - M. Radenkovic et al., **Providing Security for Wireless Community Networks**, ACM MOBICOM LCDNet 2013



Conclusions and Future Work



- Virtual Public Networks:
 - Enabler for wider Internet access
 - Outsourcing control and management using SDN
 - Incentive for sharers and network operators
- Future Work:
 - VPU platform implementation:
 - Translation of SPEL expressions
 - AP control and queue management
 - PAWS network load balancing
 - PAWS client mobility



Thank you!

LCDNet: <http://www.cl.cam.ac.uk/~as2330/lcd/index.html>

PAWS project: <http://www.publicaccesswifi.org>