# Middlebox Measurement and Cooperation

***Mirja Kühlewind*** and Brian Trammell, ETH Zürich

CleanSky Workshop

Heidelberg, 29 Feb 2016

mami

measurement and architecture for a middleboxed internet

measurement

architecture

experimentation

*This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 688421.The opinions expressed and arguments employed reflect only the authors' view. The European Commission is not responsible for any use that may be made of that information.*

*Supported by the Swiss State Secretariat for Education, Research and Innovation under contract number 15.0268. The opinions expressed and arguments employed herein do not necessarily reflect the official views of the Swiss Government.*

# Problem Statement:

## Ossification of the Internet due to Middlebox Impairments

### Problem

Middleboxes make restrictive, implicit assumptions about traffic passing through them

➡ Deployment of "new" protocols/extension limited
by packet/flow modifications of middleboxes

### Goal

*Reduce the accidental manipulation to zero, while minimizing the essential manipulation!*

### Needed

1. More data about the nature and distribution of middlebox impairments

   ➡ ***Common data model*** for storage and analysis of middlebox impairment

2. Explicit Middlebox cooperation to declare assumptions and intentions independent of the used transport or higher-layer protocol

   ➡ New (UDP-based) ***transport encapsulation*** + in-band signaling

# The MAMI Project

## Measurement and Architecture for a Middleboxed Internet

**measurement**
of deployed middleboxes

**architecture**
for middlebox cooperation

**experimentation**
of use case applicability and deployability

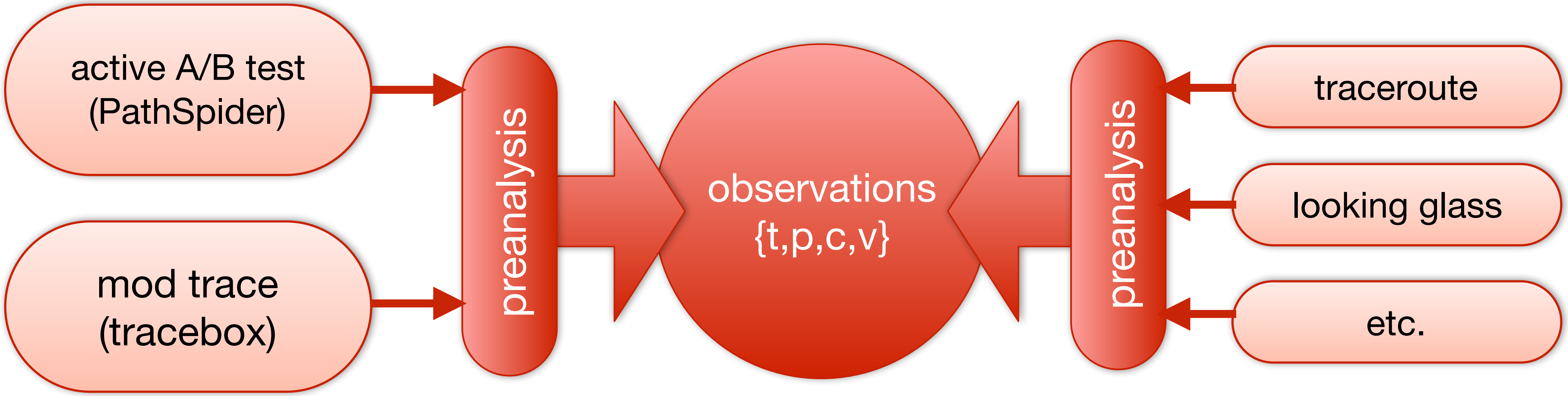
- Strong interaction with relevant standards organizations for impact on deployment
- FIRE testbed (MONROE) support for measurement as well as experimentation, especially on mobile broadband access networks
- Learn more at **http://mami-project.eu/**

# Middlebox Measurements: Golas and Overview

1. **Large-scale measurements of path impairments**
   - using FIRE MONROE as well as RIPE Atlas, CAIDA Ark…
   - UDP/TCP/SCTP connectivity, TCP options (e.g. TFO, MPTCP), and other protocol (ICMP, DNS, …)
2. **Development of new measurements tools:** https://github.com/mami-project/
   - Tracebox: tracing + impairment analysis
   - PathSpider: A/B testing (currently on ECN support)
3. **Path Transparency Observatory**
   - Active measurements by the project + external measurements
   - Query interface to access observations on path impairments:
     - *What is the likelihood that a certain path impairment impacts my traffic* (modifications/stripping/dropping/blocking)?

# Path Transparency Observatory

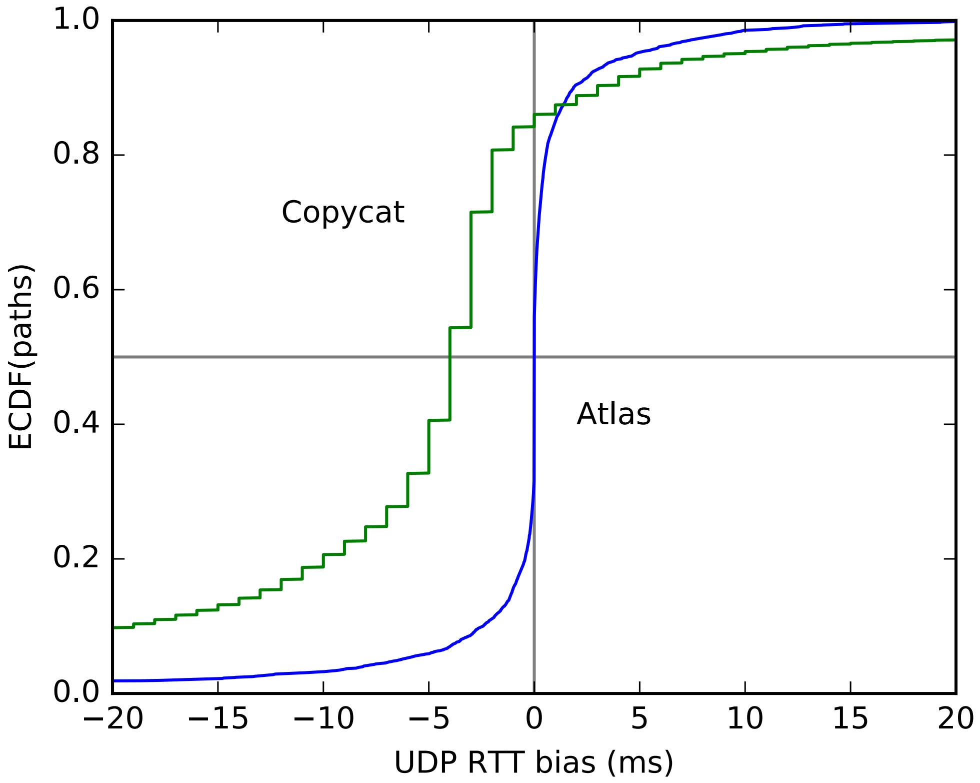
- Observatory (public release end 2016) to derive common ***observations*** about *conditions* on a given *path* at a given *time*
- Combining disparate measurements leads to better insight
  - e.g. own measurement data, traceroutes, BGP, traces



Follow http://mami-project.eu for availability!

# Is it possible to run the Internet over UDP? Preliminary Results

- A/B testing for TCP/UDP connectivity
  - Copycat tool on 120 PlanetLab nodes
    - 3,67% UDP blocking on port 33435
    - 2,7% UDP blocking on all tested ports (33435,1228, 8008, 12345)
  - RIPE Atlas traceroute
    - 3.661% UDP blocking based on existing traceroutes



- We are currently running more measurements!
  - Use all existing testbeds available, e.g. CAIDA Ark, MONROE

# Middlebox Cooperation:
# Architectural Considerations

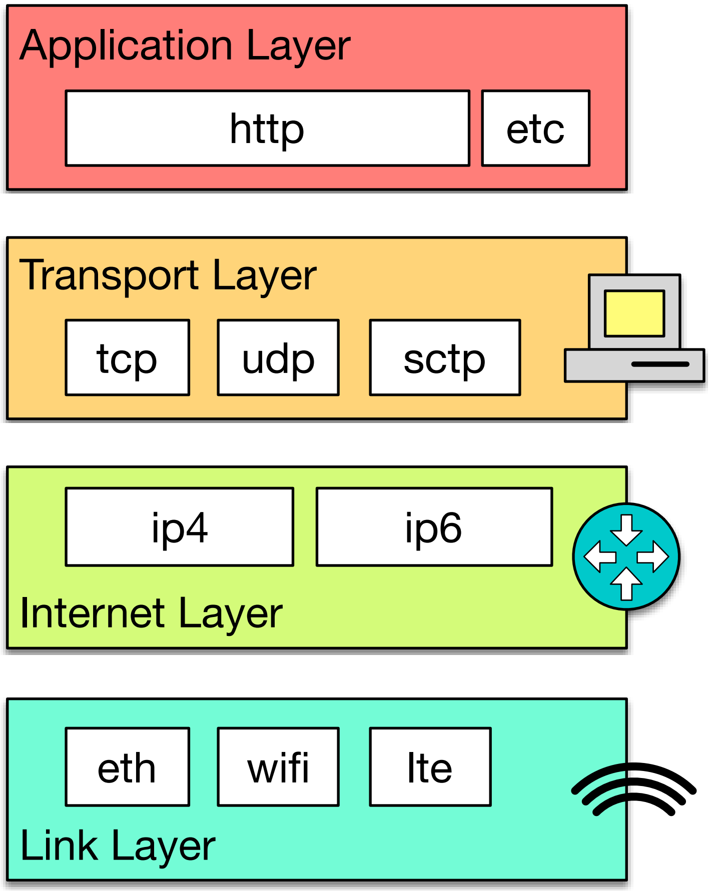
## 1. Shim for Middlebox Cooperation Protocol (MCP)

- Transport and applications can selectively expose semantic information to middlebox
- Higher layers can fully be encrypted

## 2. Flexible Transport Layer (FTL)

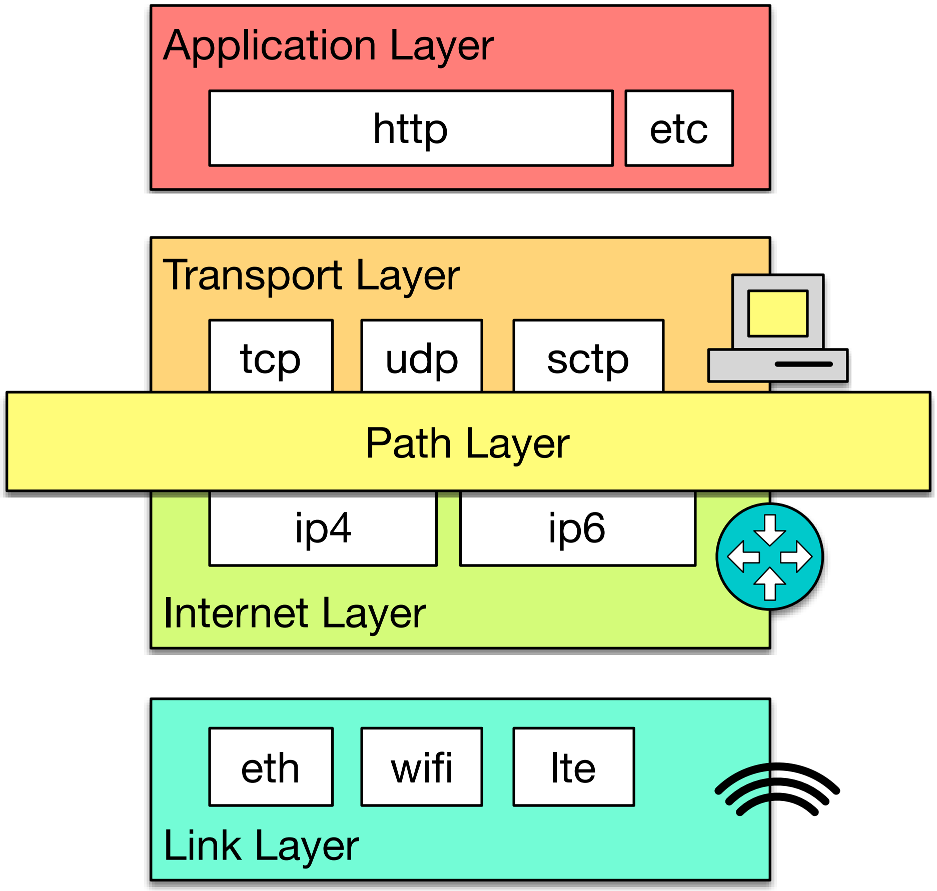
- Maintain connectivity (even if the MCP is not supported) e.g. fallback or happy-eyeball mechanisms
- Provision of encryption context for different layers/ protocols

# Why a new shim?



- Transport layer: end-to-end sockets
  - flow information
  - stateful and ‚smart‘ processing at the edge
- Internet layer: hop-by-hop handling
  - per-packet information
  - stateless and simple processing in the middle

# Why a new shim?



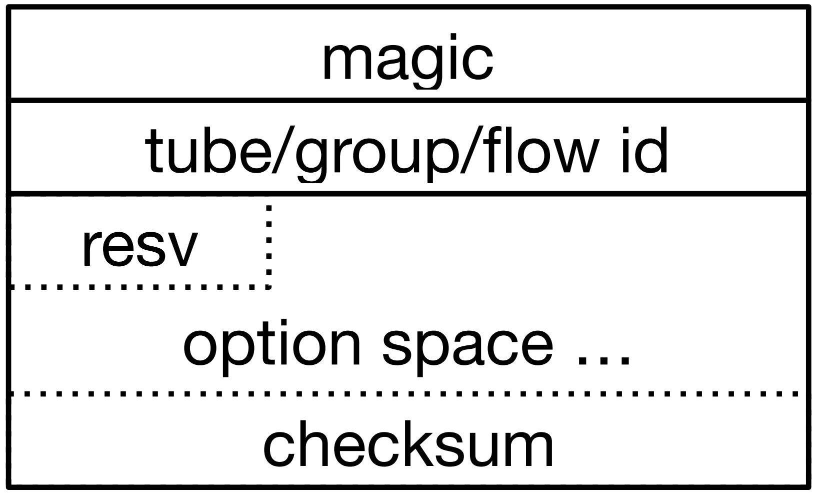
- Transport layer: end-to-end sockets
  - flow information
  - stateful and s g at the
- p handling
  - rmation
  - s ss and simple processing in the middle

**Missing:**
**Per-flow information for stateful in-network functions**

➡ **Path layer** for explicit cooperation with middleboxes instead of implicit assumptions

# Path Layer: (Basic) Functional Requirements

- Grouping of packets into flows



magic

tube/group/flow id

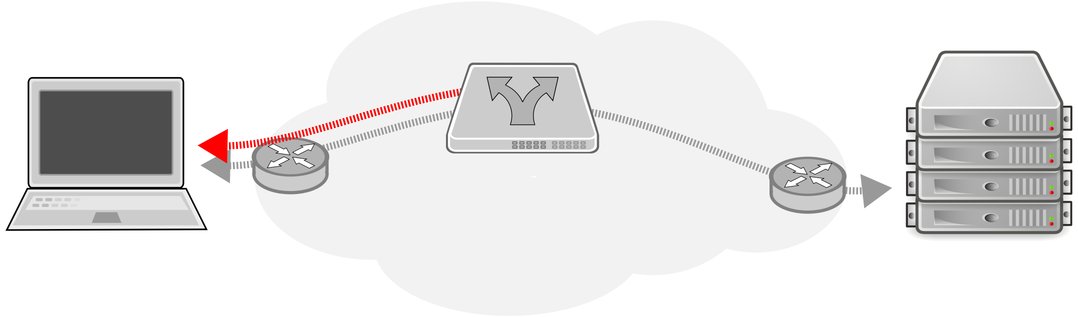
resv

option space …

checksum

- Extensibility to provide per-flow network information

- Explicit feedback channel



# Example 1:
# Firewall Traversal

**Problem**

UDP often blocked as it is hard to maintain state

**Needed**

- group ID
- start/stop signal and confirmation by receiver (‚SYN/ACK')

**Action**

- firewall can forward first packet and set up state based on confirmation from receiver
- group ID must be large enough to not be guessable

# Example 2:
# Low Latency Support

## Problem

Network service not optimized for latency sensitive traffic

## Needed

Flag to signal loss sensitivity vs. latency sensitivity

## Action

- network device can treat latency sensitive traffic differently, e.g. in a separate smaller queue
- trade-off between loss and latency gives not incentive to lie

# Why should I trust what you say about your flows?

- **Default**: *trust but verify*
  - declarative signaling: **no** negotiation, **no** guarantees
  - the best way to prevent cheating is to make it useless to do so
- Leverage existing trust relationships for higher-assurance declarations
  - e.g. your enterprise firewall, access network middleboxes, etc.

# References

- Substrate Protocol for User Datagrams (SPUD) in the IETF
  - draft-trammell-spud-req
  - draft-kuehlewind-spud-use-cases
  - draft-hildebrand-spud-prototype
- IAB Stack Evolution Program
  - Workshop on Stack Evolution in a Middlebox Internet (SEMI) 2015 [RFC7663]
  - B. Trammell, J. Hildebrand: Evolving Transport in the Internet
- IRTF proposed research group on Measurement and Analysis for Protocols (MAPRG)
- MAMI webpage (mami-project.eu) or twitter (@mamiproject)

# Summary and Conclusion

## Problem

Ossification of the Internet Protocol Stack

## Needed

1. Measurement to identify path impairments
    - Large-scale using all available testbeds (incl. MONROE)
    - New measurements tools (Tracebox, PathSpider)
    - Path Transparency Observatory
2. Path layer for explicit middlebox cooperation
    - Middlebox Cooperation Protocol (MCP): trust by verify
    - Encrypted everything else!