# Overview:
# The MAMI project

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mami

measurement and architecture for a middleboxed internet

measurement | architecture | experimentation

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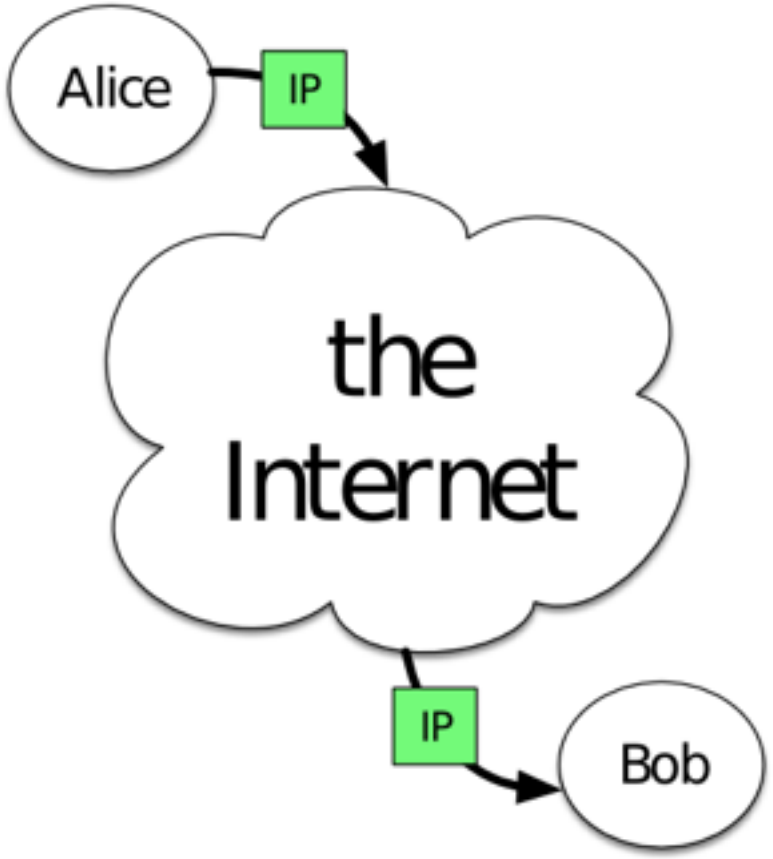
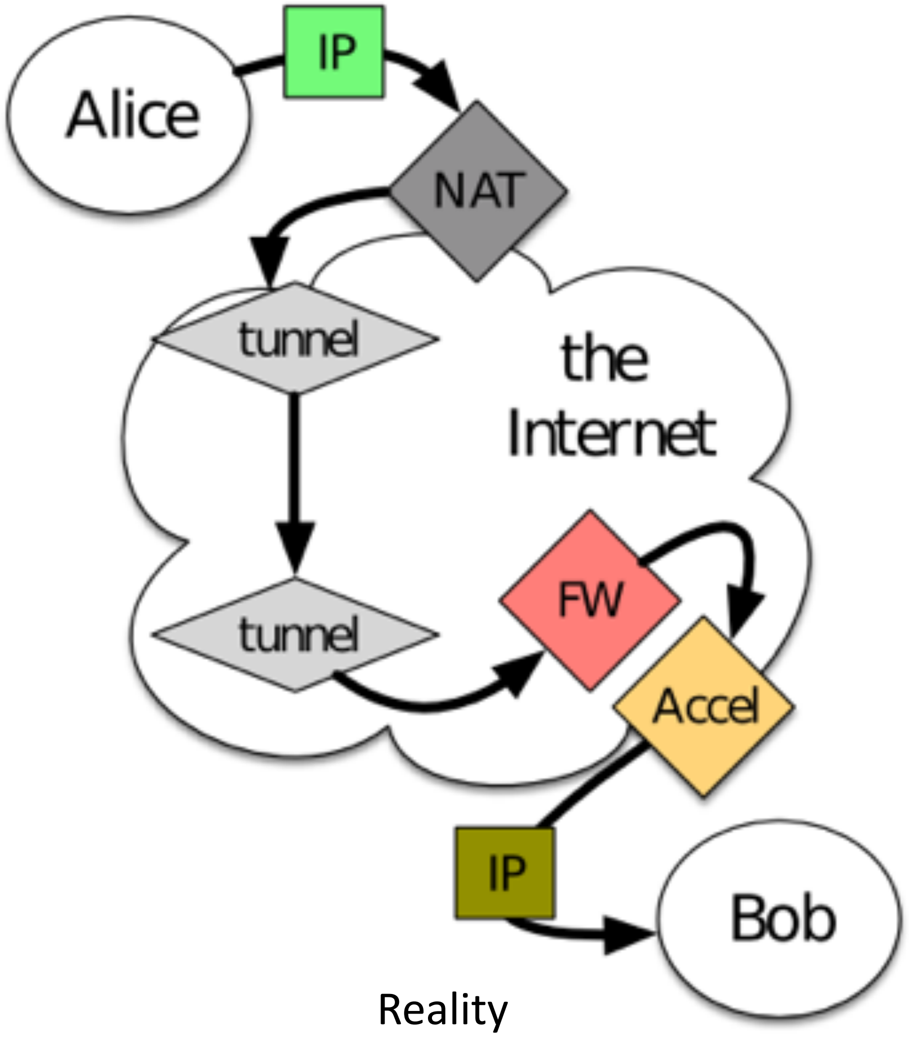
# Packet Mangling in the Internet

Middleboxes make restrictive, implicit assumptions about traffic passing through them

➡ Deployment of "new" protocols/extension limited



End-to-end view



Reality

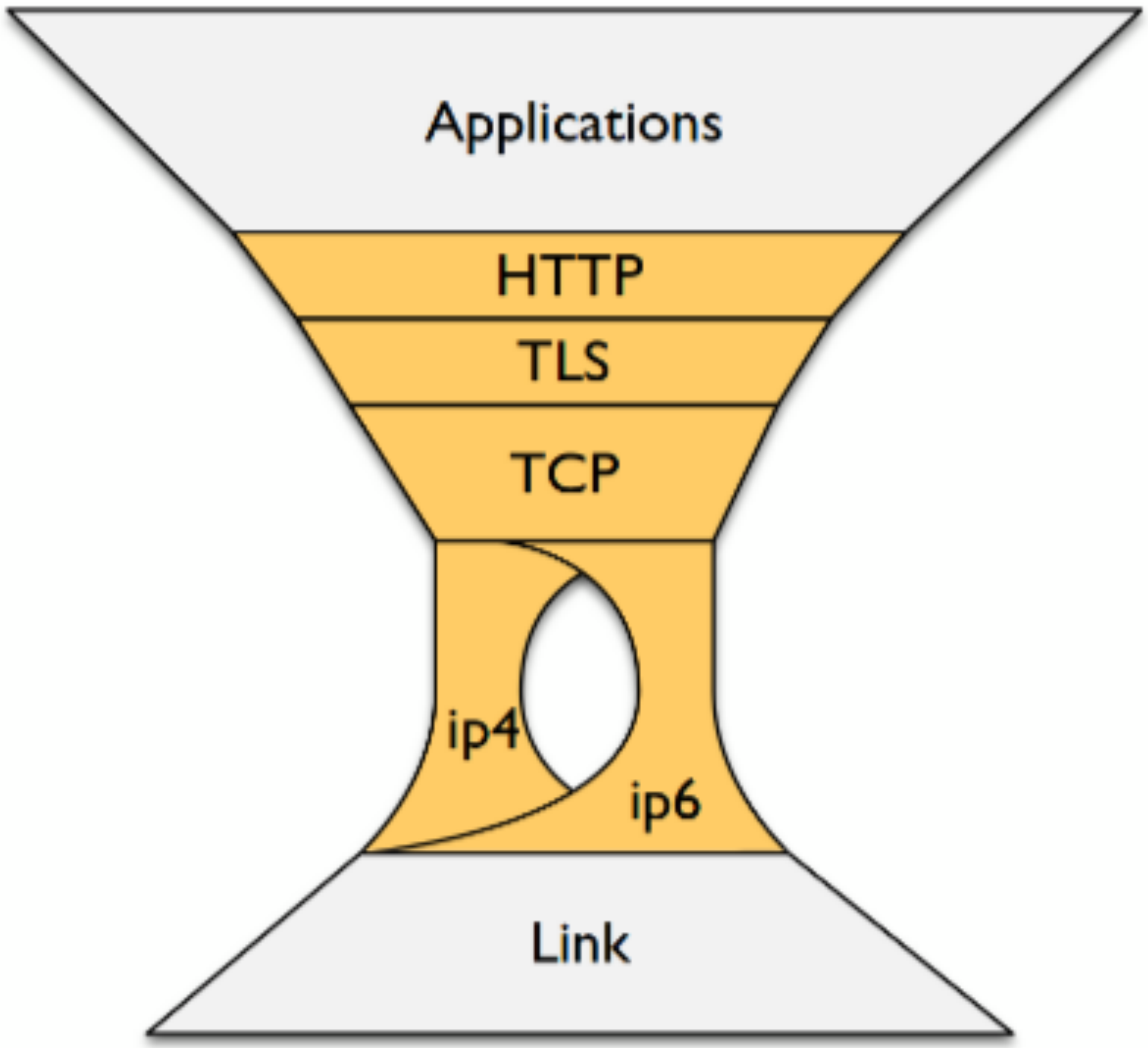
**Goal**: Reduce the *accidental manipulation* to zero, while minimizing the *essential manipulation*!

# Ossification and Encryption

- Are all applications forced to use the same protocol(s)?
  - HTTP (on TLS) on TCP

**OR**

- Large-scale encryption to restore of the e2e principle?
  - But some in-network function are needed to make the Internet manageable and viable



# MAMI Goal and Approach

**Goal**

Enable **innovation in network protocols** and the provision of **in-network functionality in a cooperative way** while preserving privacy by ***encryption***!

**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

# MAMI Objectives

**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

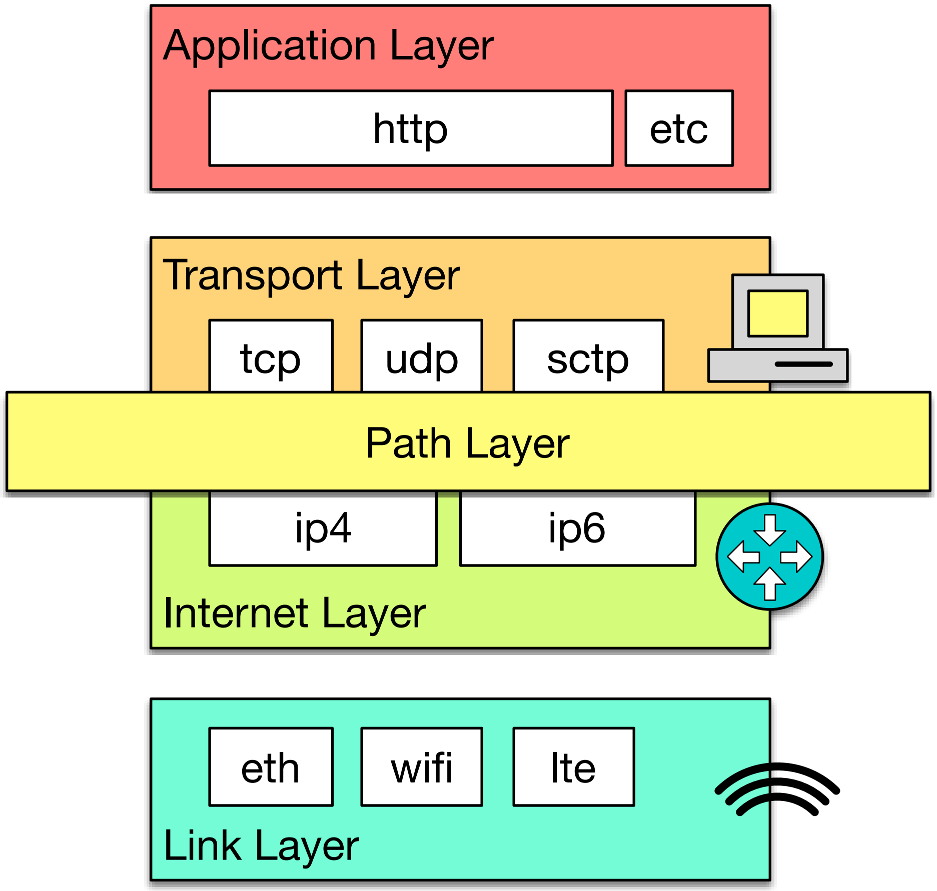
# Internet Path Transparency and Middlebox Impairments

- **Path transparency:** the likelihood a packet that arrives unmodified at the end of the path
- **Impairment:** something that keeps a path from being transparent for a certain kind of traffic, dependent on that traffic's characteristics, e.g.
  - Blocking: 100% packet loss
  - Differential treatment: Increased drop rate or latency
  - Bleaching/modification: removal or rewrite of header bits
  - Proxying: replacing one e2e path with two

# Mapping Manipulation in the Internet

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)?

# Why a new shim?



- Transport layer: end-to-end sockets
  - flow information
  - stateful and s g at the
- handling
  - rmation
  - 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

# Middlebox Cooperation

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

# Middlebox Modeling and Testing

1. **Middelbox classification and modeling**
    - Understanding the key characteristics of middleboxes to develop a middlebox taxonomy based on measurements
    - Model-based approach for NFV-based testing
2. **Incremental deployability and testbed experimentation**
    - Handling uncooperative middleboxes
    - Evaluation of operational challenges in mobile networks (based on MONROE testbed)
3. **Applicability and evaluation of selected use cases**
    - Incentives for adaptation of the developed protocols and extensions

# 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!

3.Experimentation and Testing (in mobile networks)