PostModern Internetwork Architecture (PoMo): Cross-layering and Transport

Justin P. Rohrer, Abdul Jabbar, Sarvesh Varatharajan, Ramya Naidu, James P.G. Sterbenz – **http://wiki.ittc.ku.edu/pomo**

KU INFORMATION & TELECOMMUNICATION TECHNOLOGY CENTER, The University of Kansas

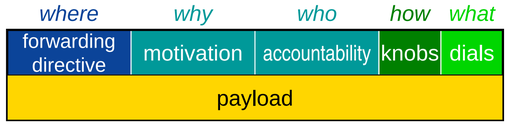
UNIVERSITY OF MARYLAND 1856 · UK LANCASTER UNIVERSITY · InfoLab 21

PoMo Overview

Goal: provide minimalist internetwork layer for the connection of *network realms* into heterogeneous *internetwork*

PoMo Principles

- Heterogeneous ***realms***: mechanism, policy, trust
- strict separation of concerns



Novel characteristics

- determine path based on ***forwarding directive***
- ***motivation*** to support policy decisions
- ***accountability*** records path traversed by each packet
- explicit support for cross-layer ***knobs*** and ***dials***

Knobs and Dials

- Knobs (***how***): influence behavior of transport or network from above
- Dials (***what***): instrumentation to transport or application from below

Knobs ↓	Layer	Dials ↑
service class reliability mode	application	service characteristics
	E2E transport	
PoMo knobs, FD, motiv.	PoMo internetwork	E2E path characteristics
realm oper. parameters	network realm	realm characteristics
link type and coding error control type/strength	HBH link	link characteristics

Cross-layer optimizations

- ***translucent*** layer boundaries
- cross-layer control loops
- composable protocol functionality

ns-2 Cross-Layer Framework

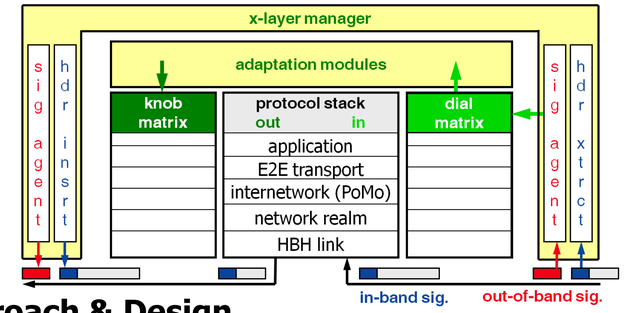
Existing ns-2 architecture:

Traditional strict layer boundaries:

- good architectural abstraction
  - e.g. anything over IP over anything
- but strict layers result in poor performance
  - too much information hiding
  - implicit assumptions ⇒ improper response

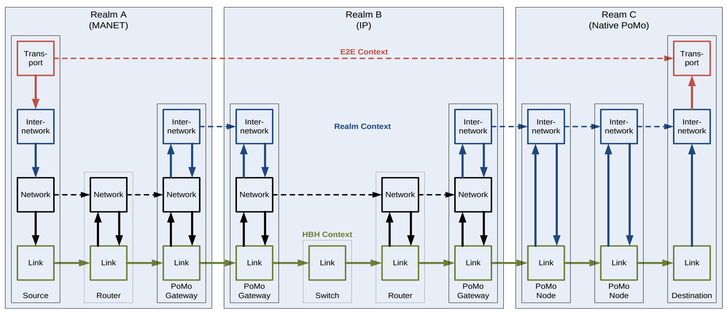
Our goal:

- ns-2 modifications to support cross-layering
- integration with existing protocol models



Approach & Design

- add cross-layer management plane
  - defines inter-layer control and signaling
  - new data structures at each node
  - triggers adaptation mechanisms
- adaptation modules
  - use dials to tune protocol behavior at each layer
- ***in-band*** : shared dials in protocol headers
- ***out-of-band*** : new signaling messages

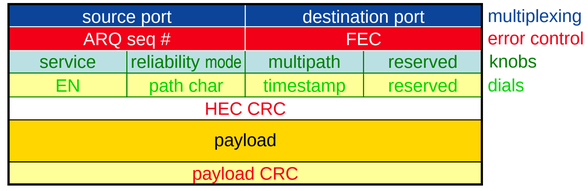


Multi-Realm Resilient Transport

Composable operational modes

- Service classes with specified metrics: delay, peak and average bandwidth, jitter and burst tolerance, etc.
- Reliability modes:
  - reliable: ARQ with E2E ACKs
  - near-reliable: custody transfer from realm-to-realm
  - quasi-reliable: open-loop FEC or erasure coding
  - unreliable: relies on lower layer best effort service
- Multipath with spatial diversity for reliability

TPDU flexible composed header



- Error control - ARQ, FEC, multipath erasure code, …
- Knobs - service type, reliability mode, multipath, …
- Dials - E{C|L|D}N: explicit {congestion|loss|delay} notification, path characteristics, timestamp, …

Simulation-based Preliminary Findings

- Multipath source-routing increases fault-tolerance
- Transport layer aware of bi-connected resilient topology
- Transmits duplicate packets on up to 3 diverse paths
- Cost is increased bandwidth usage
- Plots: performance as links fail & loss due to congestion