

## A Routing Infrastructure for XIA

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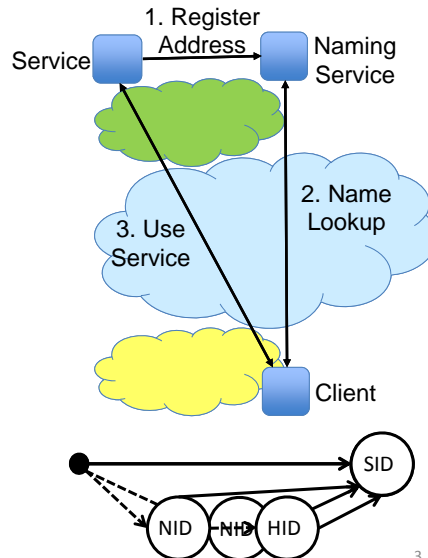
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## Outline

- Goals and principles
- High level design
- Implementation status
- Broader context

## XIA 101:

- Client-server access using simple DAG
- Naming, routing, and forwarding interact
  - All impact execution of communication operation
  - Case study: incremental deployment of “new network architectures” [Conext 2013]
- Today: how routing sets up forwarding
  - Impact on fault handling, performance, ... later

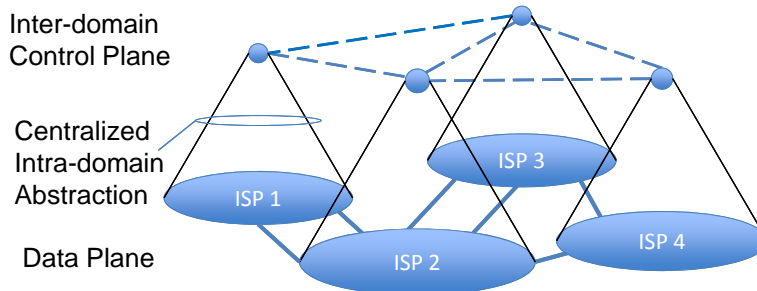


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## Goals and Design Principles

- High level goals
  - Clean separation of inter and intra domain control
  - Evolvability
  - Interfaces for “tussle”
- Design principles
  - Intra-domain
    - Logically centralized control, e.g., 4D, SDN (not required)
    - Maximize component reuse across XID types
  - Inter-domain
    - Allow for rich transit policies (e.g., non-neighbor agreements)
    - Facilitate inter-domain protocol evolution
    - Diversity, e.g., across XID types
    - Incremental deployment

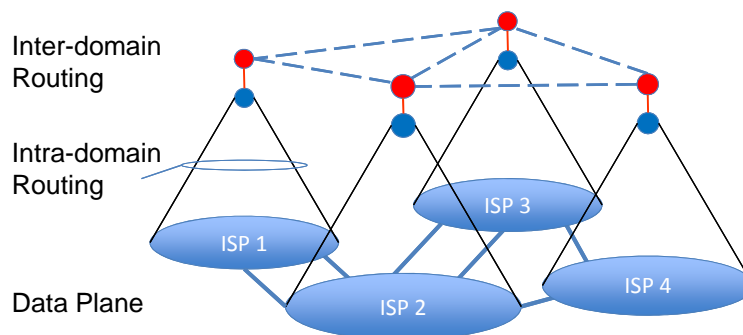
## Control Plane The 10K Mile View



- Domains present a single point of control at inter-domain level
- Matches logically centralized intra-domain control
  - But actual implementation can be anything

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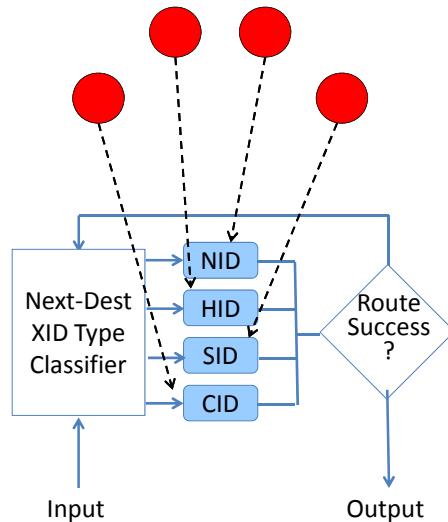
## Routing The 100 Mile View



- Inter and intra domain routing protocols driven by different concerns and metrics
  - True today – likely to remain
- Need to define interface between the two protocols

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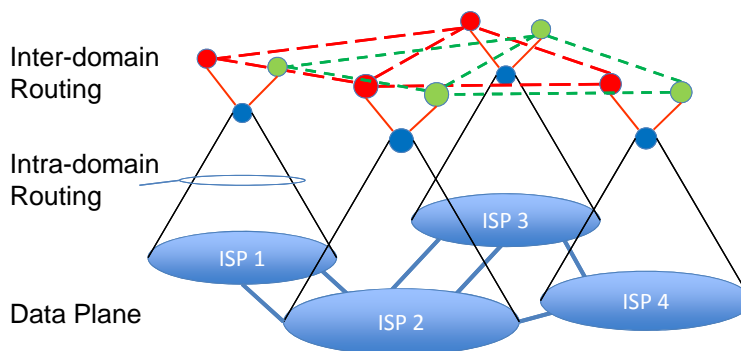
## XIA Packet Processing Pipeline



- Principal-independent processing defines how to interpret the DAG
  - Core architecture
- Principal-dependent processing realizes forwarding semantics for each XID type
  - Logically: one forwarding table per XID type
  - Reality: anything goes, e.g., no forwarding table
- Control plane sets up forwarding for each principal type

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## Routing in XIA The 1 Mile View



- Logically different “routing” protocols for XIDs
  - May not look like OSPF or BGP
  - Multiple protocols may co-exist for a given XID (e.g., BGP, MIRO)
- Some routing protocols may be shared
  - Inter- or Inter-domain

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## Goals of Implementation

- Goals are to support research in ...
  - Routing protocols for different XID types, e.g., considering business policies, etc.
  - Diversity in forwarding and routing
  - Evolution, broadly defined
- Design principles for the prototype
  - “Framework” – shared infrastructure + examples
  - Diversity from day 1
  - Focus on APIs – can evolve as research progresses

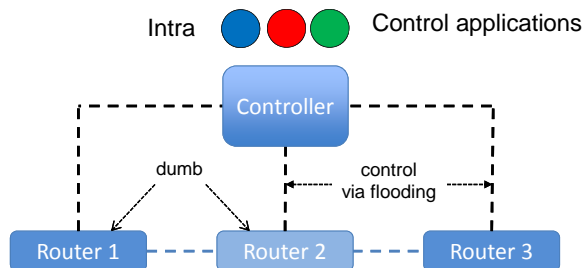
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## Components of Implementation

- SDN-style intra-domain for HIDs and SIDs
  - Bootstrapping the network
  - Provide all-all communication; also CIDs
- Simple “node = AD” inter-domain routing protocol
  - Naïve routing for NID-based forwarding; policy next
  - Support for Scion path selection and forwarding
- Coordinating inter and intra domain routing

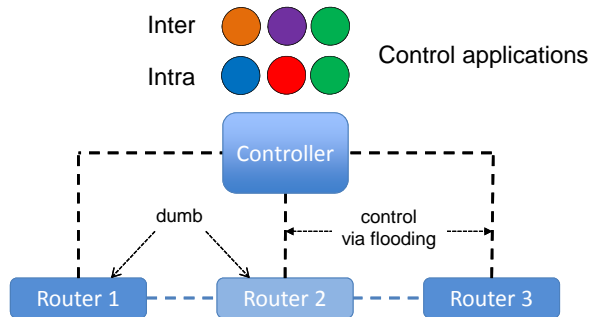
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## Intra-domain Routing Architecture



- Routing done by centralized routing applications
  - Controller applications are services with SIDs (of course)
- Use flooding as control channel
  - Easy and robust; can optimize later
- Different applications for different XID types
  - Currently share the same “protocol”

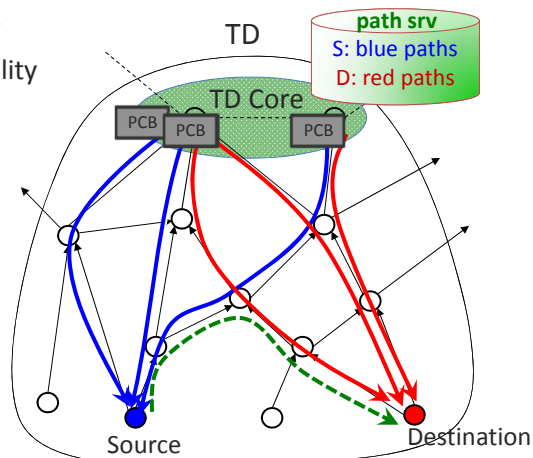
## Inter-Domain Routing Architecture



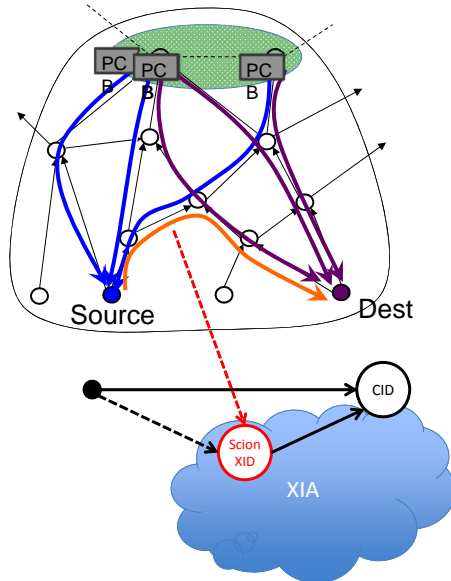
- Centralized routing applications for each domain
- Initial focus on NIDs, Scion and services
  - NIDs offer “traditional” all-all connectivity
  - Scion supports path-based forwarding
  - Services support anycast, use different policies from ADs

## Scion Architecture Overview

- Trust domain (TD)s
  - Isolation and scalability
  - Enforceable accountability
- Path construction
  - Path construction beacons (PCBs)
- Path resolution
  - Control
  - Explicit trust
- Route joining (shortcuts)
  - Efficiency, flexibility



## Scion over XIA Data Plane



- Store paths generated by Scion into a new type of XID
  - Sequence of per-AD forwarding states (cryptographic)
  - Can be combined with other principal types in DAG
- Scion always used centralized per-AD controller
  - Beacon controller controls paths, i.e., “routing”
- XIA network supports both path and destination-based forwarding

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## Status of Implementation

- Basic infrastructure is working
  - Inter domain - NIDs; intra domain - HIDs and SIDs
  - Additional principal types in progress
- Securely bootstrapping the network is hard problem
  - Using the Scion bootstrapping infrastructure
- Provides interesting insights in XIA
  - Impact of different XID types, use of DAGs for control traffic, ...

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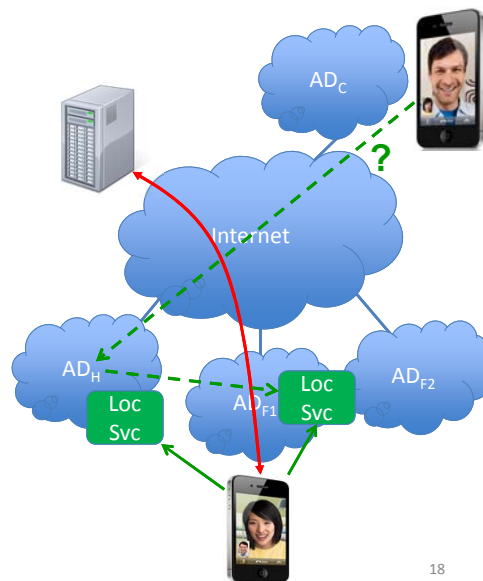
## Mobility

- XIA naturally separates identifiers and locators: XIDs versus DAGs
- Hand-off of sessions: based on coordination between mobile and fixed device
  - DAG change can be signed using cryptographic XID
  - Basic implementation already in our release
- Initial contact with mobile host based on rendez-vous service
  - Can be linked into the DAG (different approaches)
  - Can also be used for simultaneous mobility

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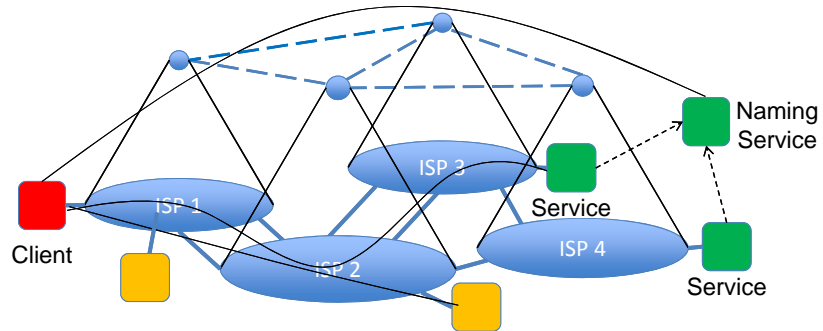
## Finding Mobile Devices

- Must map identifier into an up-to-date locator
  - Challenges include scalability, security, deployment complexity, latency, overheads, ....
  - Lots of previous work
- Exploring solution based on locator services
  - Keeps track of user's current location
  - User can choose service



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## Examples Uses of Interfaces



- Many choices: DAG, XID type, SID/CID routing, Scion vs NID, path selection, services, ..
- Examples: fault management, optimizing video distribution

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The End

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