

A Routing Infrastructure for XIA

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Introduction

Problem: XIA currently doesn't have full routing capability for any principal types (e.g. HIDs and ADs)

Goals:

- Enable routing for arbitrary HID and AD topologies in XIA
- Explore evolvability of XIA by extending it with a new routing protocol
 - Integrate SCION into XIA as a new protocol

Constraints:

- Use SDN-style centralized controller within domains

Motivation

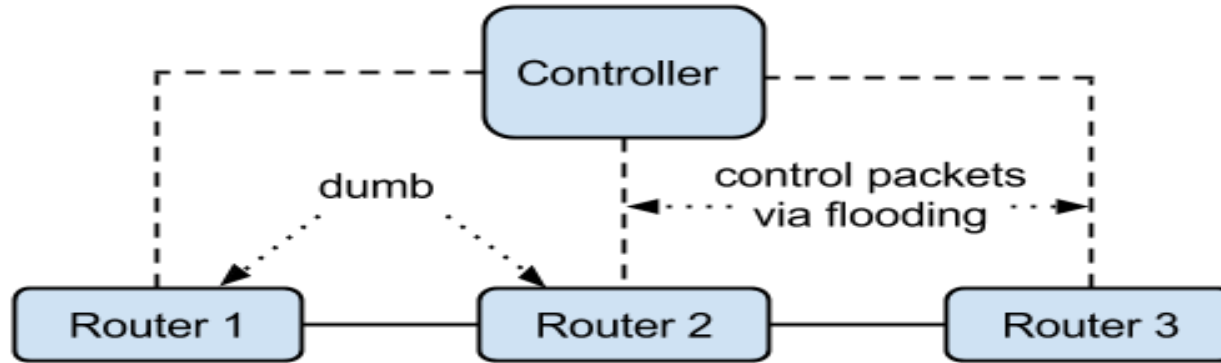
Current work:

- Explore implications of using an SDN-style architecture within XIA
- Test flexibility of XIA by using XIDs with different routing specifications
- Explore possible research aspects brought on by running SCION with XIA's architecture

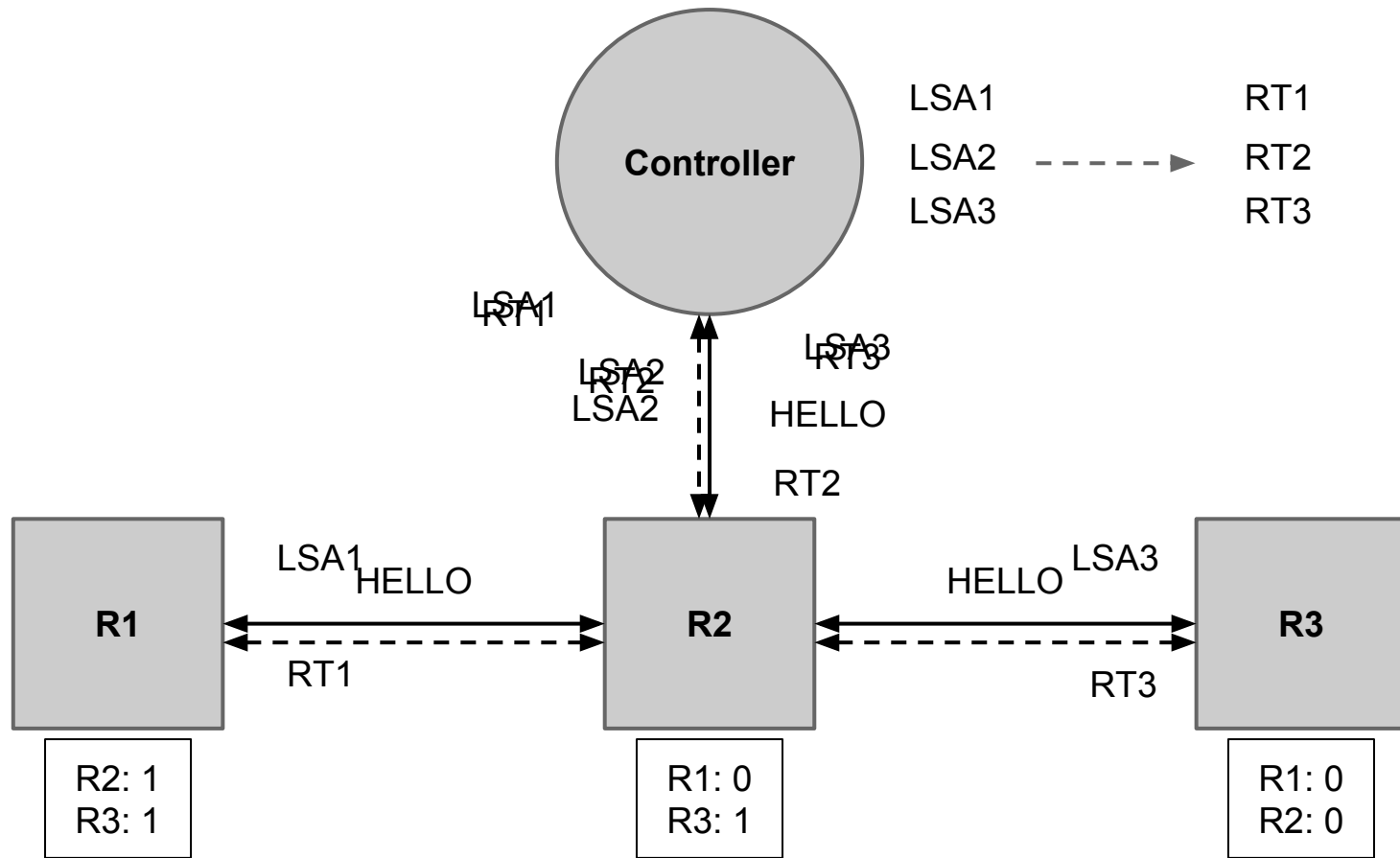
Future work:

- Enable routing for SID principal type
- Explore BGP-style interdomain routing protocol and possibilities for simplifying BGP routing policies within XIA

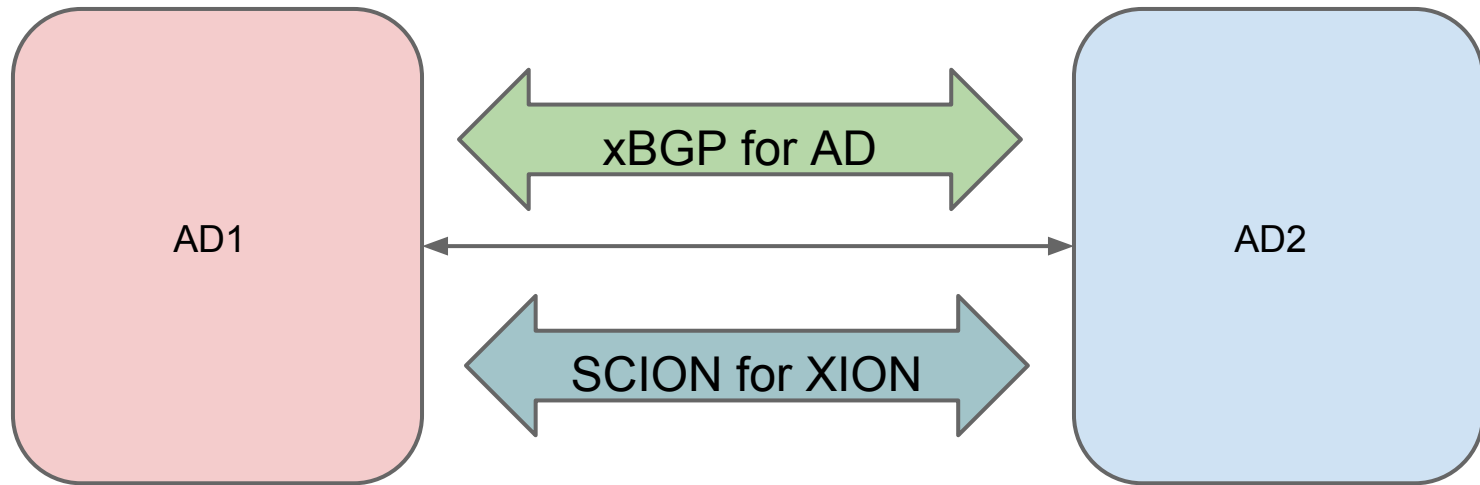
Intra-domain routing architecture



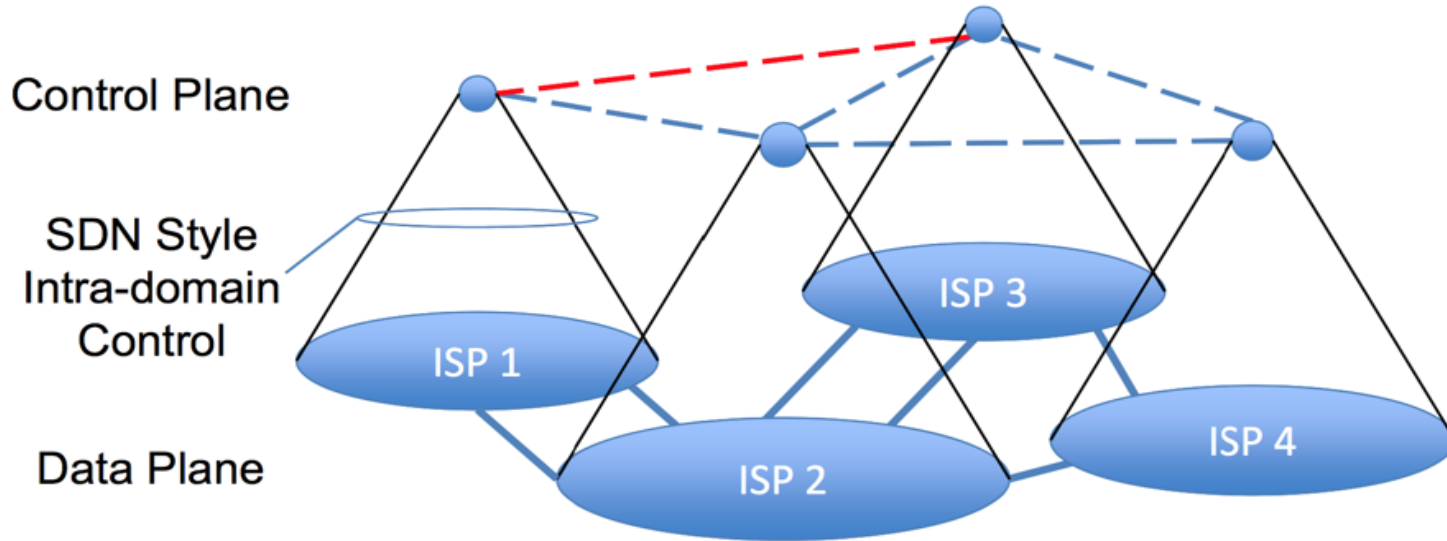
- Controller makes all routing decisions
- Controller and routers exchange control messages via flooding
- Advantages:
 - All decision-making centralized in controller so routers are very simple
 - Communication via flooding is simple to implement
- Disadvantages:
 - Loss of routing updates if controller fails
 - Flooding results in extra overhead



Inter-domain routing



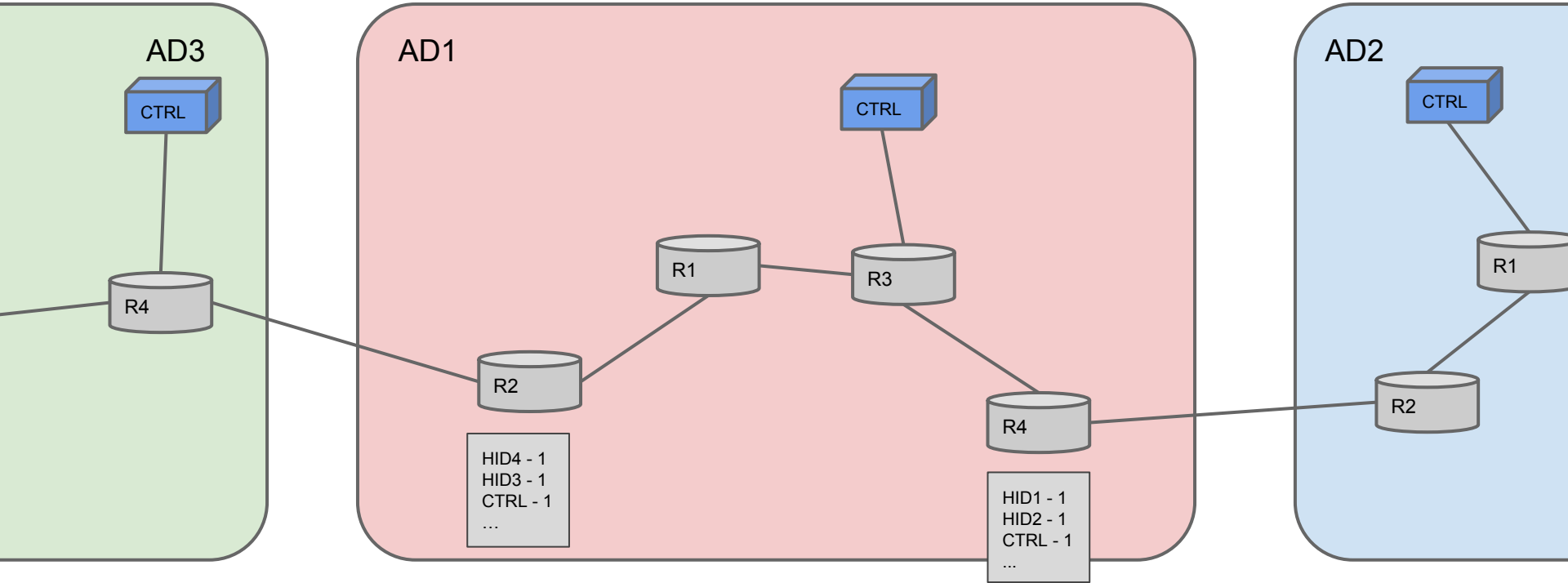
Inter-domain routing



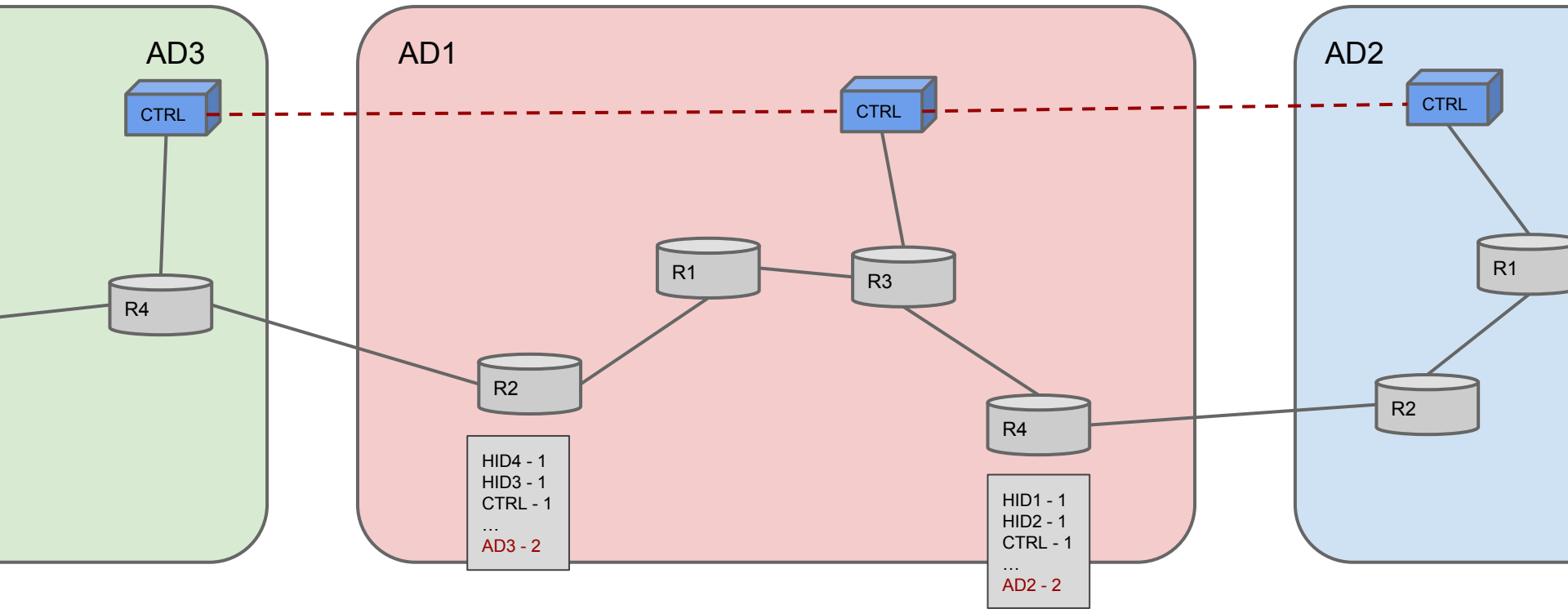
AD routing - Inter-domain

- Implemented link-state protocol with ADs as nodes
 - Not long-term solution, but for debugging purpose
- Bootstrap neighboring AD controller communication
 - [• \rightarrow AD(1) \rightarrow SID(CTRL)]
- Protocol
 - AD controllers exchange AD-level link state.
 - Create AD-level state of network.
 - Compute AD forwarding tables.
 - Disseminate table to routers.

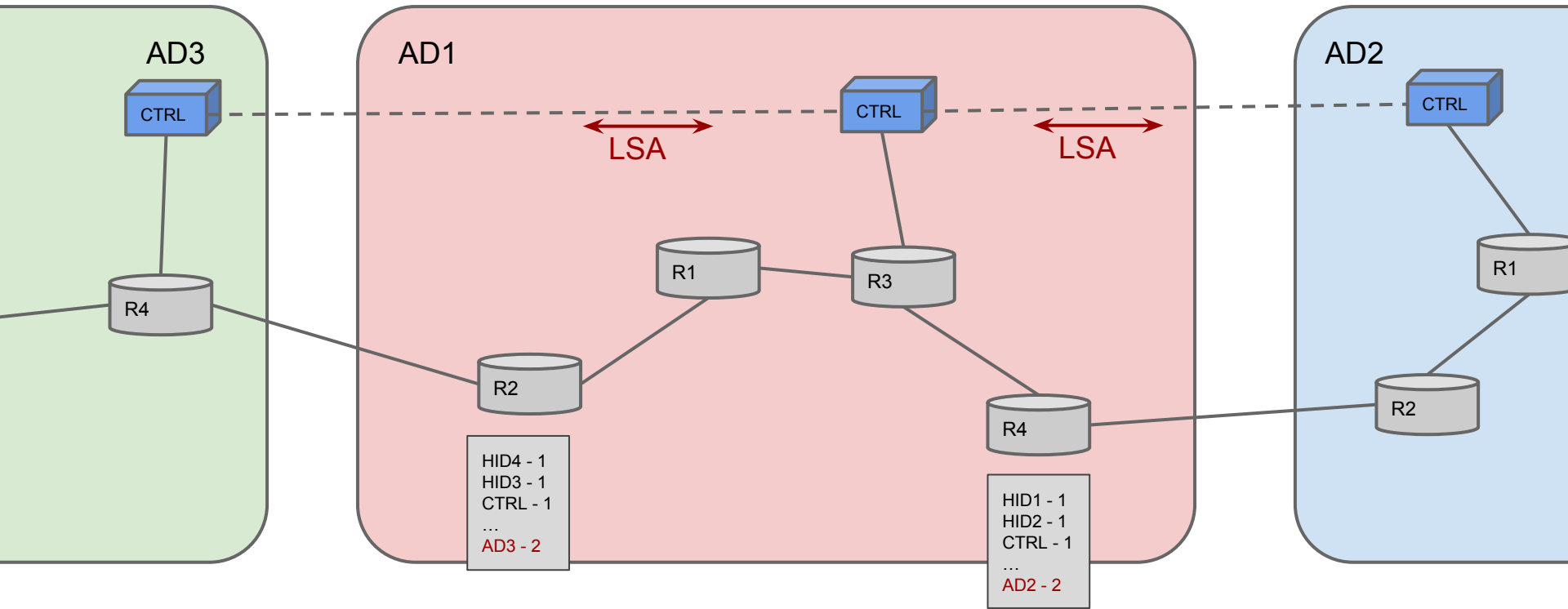
Phase 0: After intra-domain setup.



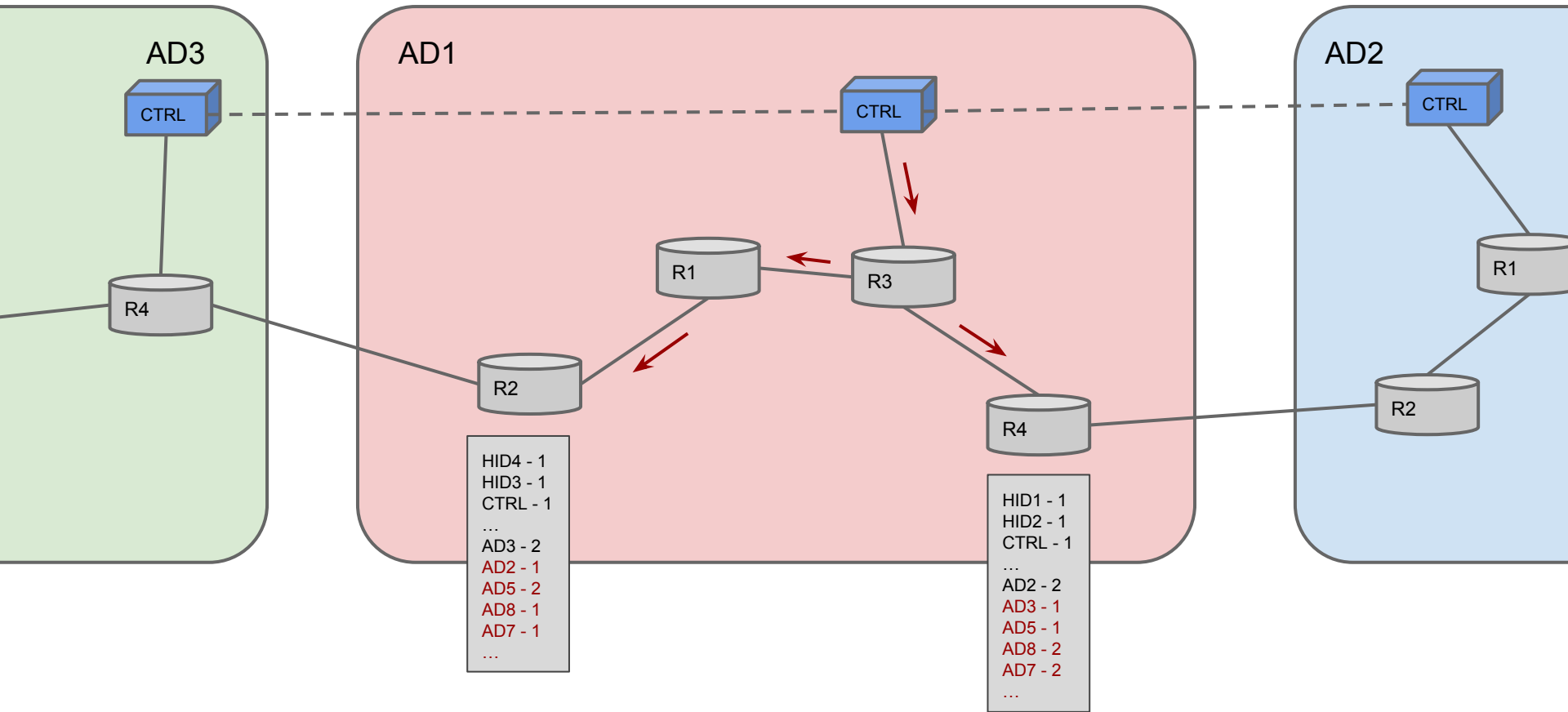
Phase 1: Bootstrap neighboring AD controller communication.



Phase 2: AD-level link state exchange

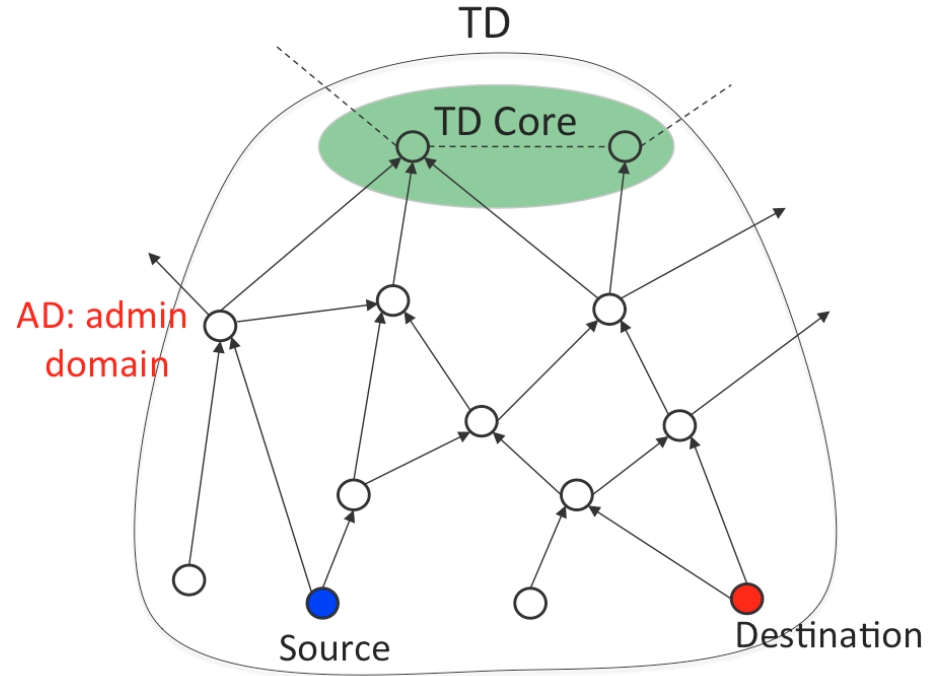


Phase 3: AD forwarding table computation & dissemination



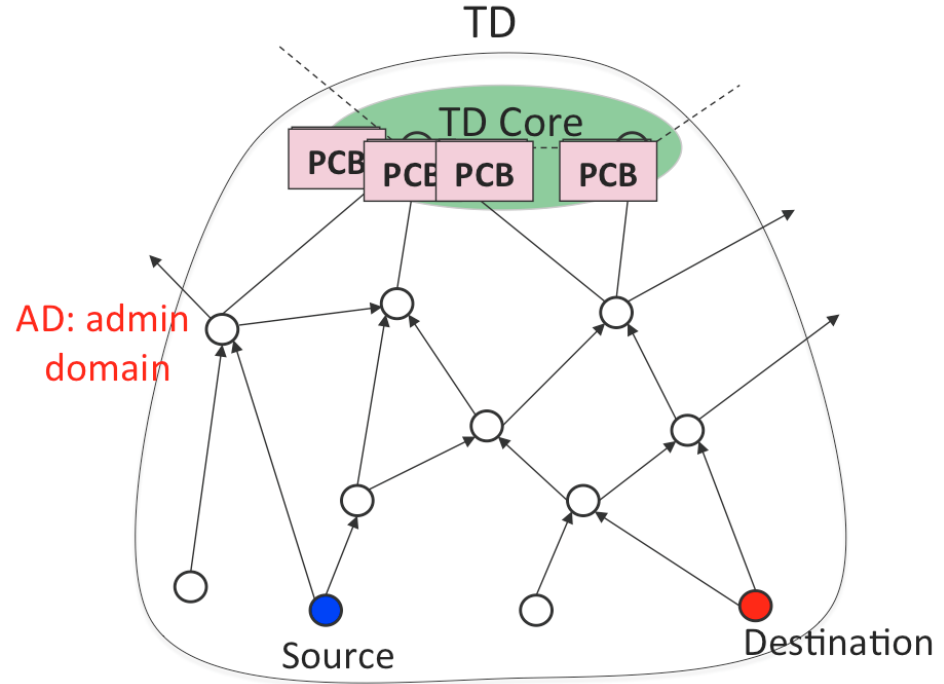
SCION Overview

- Secure inter-domain protocol
- Advantages
 - *Control*: more controls at end points
 - *Isolation*: a failure/attack will not have global effects
 - *Scalability*: achieve route freshness via path construction



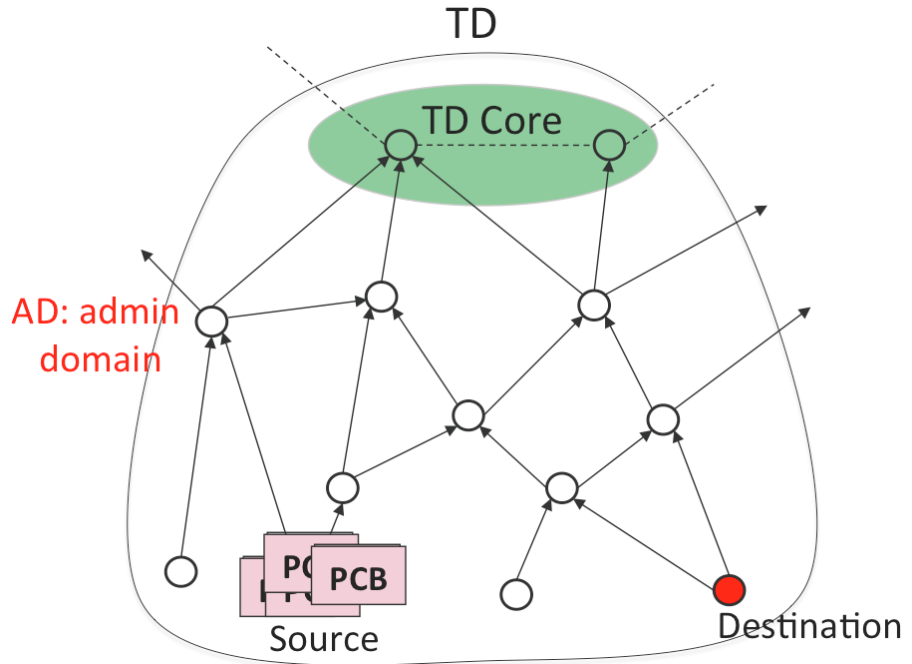
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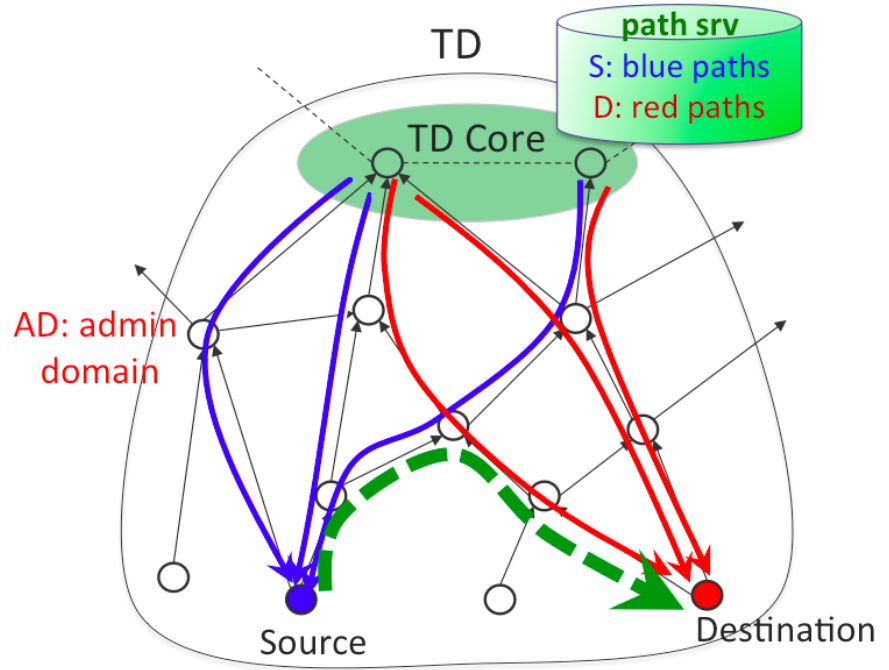
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SCION routing - Inter-domain

- Inter-domain path construction
 - Path Construction Beacon (PCB) propagation
 - Opaque Field (OF): ingress/egress edge router interfaces information
 - Signature/MAC: provide explicit trust
- Data transmission at end hosts
 - Up-paths from PCBs (Control for Sources)
 - Down-paths registered at TDC (Control for Destination)
 - Resolve end-to-end paths through up- and down-paths
 - Delivery data packets towards the destination with a selected path

Current status

- HID & AD routing
 - Implemented and functional
- SCION inter-domain routing
 - Integrating bootstrapping of root-of-trust
 - PCB generation and propagation planned out
 - Who constructs XION packets? end host or gateway

Design Questions

- How to transit principal types through a domain when they don't specify any intra-domain routing policy?
 - **Option 1:** All routers inside the AD can process the principal type.
 - This is what we have currently implemented for inter-domain AD-based routing.

Design Questions

- How to transit principal types through a domain when they don't specify any intra-domain routing policy?
 - **Option 1:** All routers inside the AD can process the principal type.
 - **Option 2:** Encapsulation
 - Only border routers can process the principal type.
 - They **encapsulate** the data packet with egress router HID.
 - $[\bullet \rightarrow \text{AD}(1) \rightarrow \text{HID}(\text{H1})]$ is transformed to:
 $[\bullet \rightarrow \text{HID}(\text{egress-router}) \rightarrow \text{DeCap}] [\bullet \rightarrow \text{AD}(1) \rightarrow \text{HID}(\text{H1})]$.

Design Questions

- How to transit principal types through a domain when they don't specify any intra-domain routing policy?
 - **Option 1:** All routers inside the AD can process the principal type.
 - **Option 2:** Encapsulation
 - **Option 3:** Modify DAG
 - Only border routers can process the principal type.
 - They **modify** the DAG to add egress router HID.
 - $[\bullet \rightarrow AD(1) \rightarrow HID(H1)]$ is transformed to:
 $[\bullet \rightarrow HID(egress-router) \rightarrow AD(1) \rightarrow HID(H1)]$.

Design Questions

- How to transit principal types through a domain when they don't specify any intra-domain routing policy?
 - **Option 1:** All routers inside the AD can process the principal type.
 - **Option 2:** Encapsulation
 - **Option 3:** Modify DAG
- More generally, when is it appropriate to modify a DAG vs. use encapsulation in XIA?

Design Questions

- How to handle XIDs which require additional routing information?
 - **Option 1:** Store the information in the XIA Extension Header.
 - **Option 2:** Encode the information in the DAG
 - e.g. with multiple/new XIDs or variable-length XIDs.
- For integrating SCION, we plan to use the extension header for now, since it is easier to implement
 - Can this be easily reversed if we eventually decide to encode in the DAG?

Questions?

Transit forwarding within an AD

- Interior routers have forwarding entries for external ADs
 - Advantages
 - No extra logic in border router.
 - More control. AD IDs are labels for traffic engineering.
 - Disadvantages
 - Larger forwarding tables at interior routers.
 - Control messages require more bandwidth