
A Scalable Routing System Design for the Future Internet

Dan Massey (Colorado State University)

Lan Wang (University of Memphis)

Beichuan Zhang (University of Arizona)

Lixia Zhang (UCLA)

Where We Are

- In the original Internet, all routers were in the same domain.
- The current global routing has two levels: intra- and inter-domain.
 - to accommodate administrative needs
 - to scale to a large number of routers
- Why only two levels?
 - Two levels are (scalable) enough.
 - Where to draw the line for the third or more levels?
- But, will these hold true in the future?

Scalability Challenges

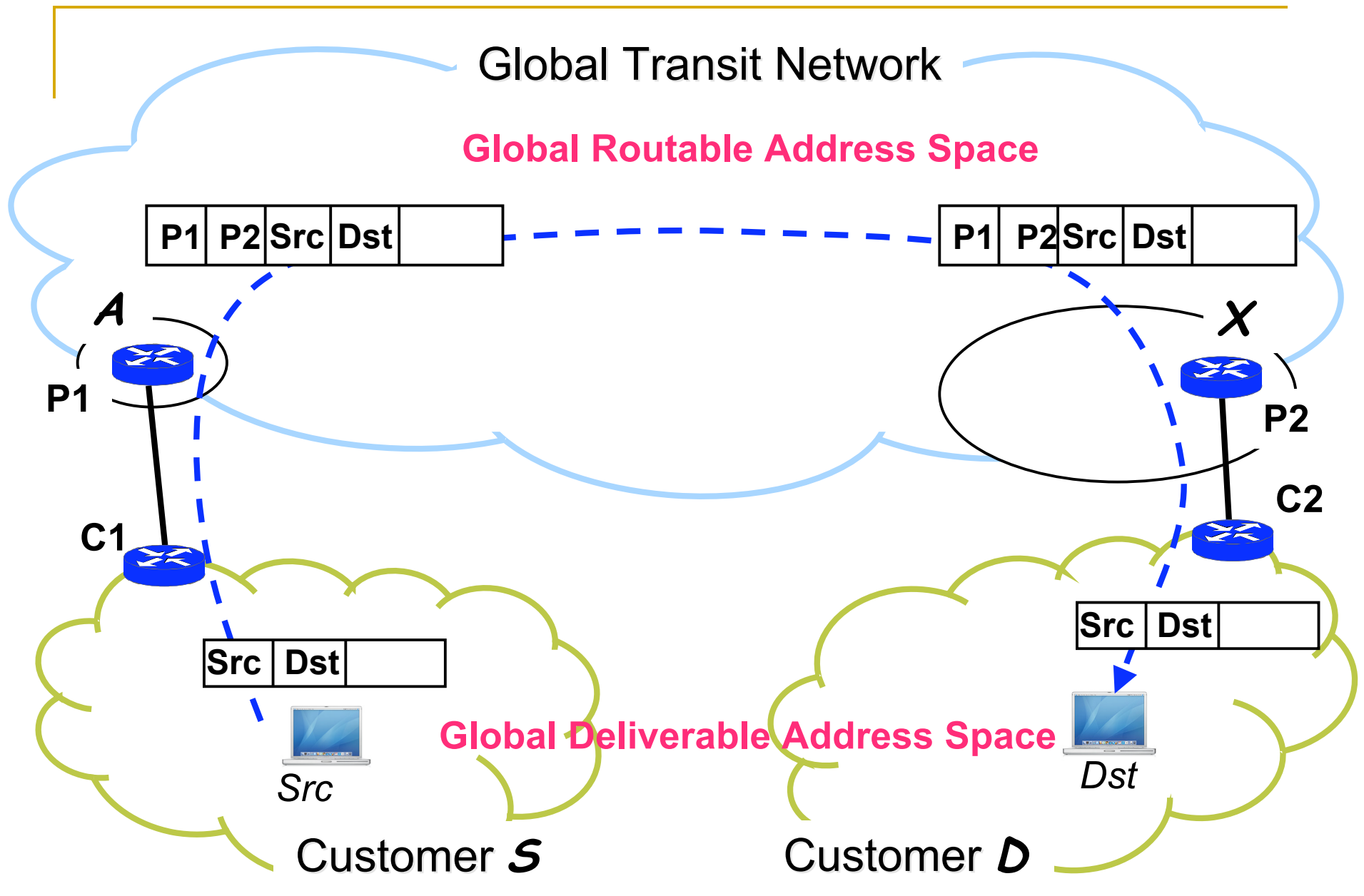
- The Internet routing architecture is facing serious scalability challenges.
- Growth
 - IP address: IPv4 to IPv6
 - AS number: 16-bit to 32-bit
 - Denser connectivity
- Failure of aggregation
 - Site multi-homing
 - Traffic engineering
- Churns

Customers vs. Providers

- Customer networks are consumers of the global transit service; Provider networks are the producer of the global transit service.
 - whether appear in the middle of an AS path
- They are different in many ways:
 - Types of business
 - Operational goals
 - Network characteristics
 - Growth trends

Our Proposal

- Separate customer networks from provider networks in the global routing.
 - Distinct address spaces
 - Globally routable addresses (GRA)
 - Globally deliverable addresses (GDA)
 - Distinct routing spaces
 - DFZ routing table is limited to provider prefixes only.
 - Distinct forwarding spaces
 - Tunneling through provider networks.
 - Need a mapping service between GRA and GDA



Estimating Provider Prefixes

- Need # of provider prefixes vs. customer prefixes to estimate the table size reduction.
 - Take one-month RouteViews data, find customer networks and provider networks based on AS paths.
 - However, prefixes originated from provider networks could belong to customers.
 - Compare WHOIS records of the origin (provider) AS and the prefix
 - If match, then the prefix belongs to the provider.
-

Provider Prefixes

| AS Number (ISP name) | Total Prefix | Transit Net. Pref (manual) | Transit Net. Pref (automated) |
|-------------------------|-----------------|-------------------------------|----------------------------------|
| 7018 (ATT) | 1501 | 39 | 35 |
| 174 (Cogent) | 930 | 21 | 19 |
| 1668 (AOL) | 202 | 115 | 100 |
| 1239 (Sprint) | 852 | 133 | 131 |
| 701 (Verizon) | 4989 | 537 | 570 |
| 3549 (GBLX) | 342 | 133 | 81 |
| 3561 (Savvis) | 521 | 231 | 263 |
| 3356 (Level3) | 514 | 50 | 99 |
| 209 (Qwest) | 691 | 59 | 63 |

Routing Scalability and Stability

- If we separate customers from providers on today's Internet, both the table size and the routing churns will be reduced significantly.
 - Overall 11% of all prefixes belong to provider networks
 - Of all the routing updates, 15% belong to provider prefixes

Site Multi-homing and TE

- Site multi-homing won't cause table size growth.
- Customers can change providers without renumbering.
- The indirection introduced by mapping service can be used to express TE requirements explicitly.

Security Benefits

- Raise the barrier for attackers to target routing infrastructure.
 - Most attacks come from customer networks
- May be able to trace back to the source provider.
- Still need to secure the provider space.

The Mapping Service

- The key component to glue customers and providers together.
 - Scalable
 - Flexible
 - Resilient
 - Secure
- Design choices
 - Push data to local routers (e.g., flooding the mapping information in provider space)
 - Pull data from a DNS-like service
 - Overlay, DHT, ...

Border Link Failures

- The link connecting a customer network and a provider network.
- When the link flaps, how to ensure that data will be re-routed to alternative links?
 - The flaps will not be propagated into the provider's routing system.
 - Too frequent/short-term for mapping service.

Network Diagnosis

- The provider space will become a black box to customer networks.
 - may frustrate some network diagnosis tools.
- Can still do end-to-end probing and diagnosis
- Expose some network information to the customers via well-defined interfaces?

Summary

- The Internet has grown to the stage that we need another level of separation: customer networks vs. provider networks.
 - not a brand-new idea: ENCAPS, LISP, HLP, CRIO, ...
- Benefits
 - Smaller routing table, less routing churns, easier multi-homing and TE, higher security barrier.
- Challenges
 - How to implement the mapping service, handle border link failures, and facilitate network diagnosis

Thanks!