COSC 301
Network Management

Lecture 24: Exterior Routing and BGP

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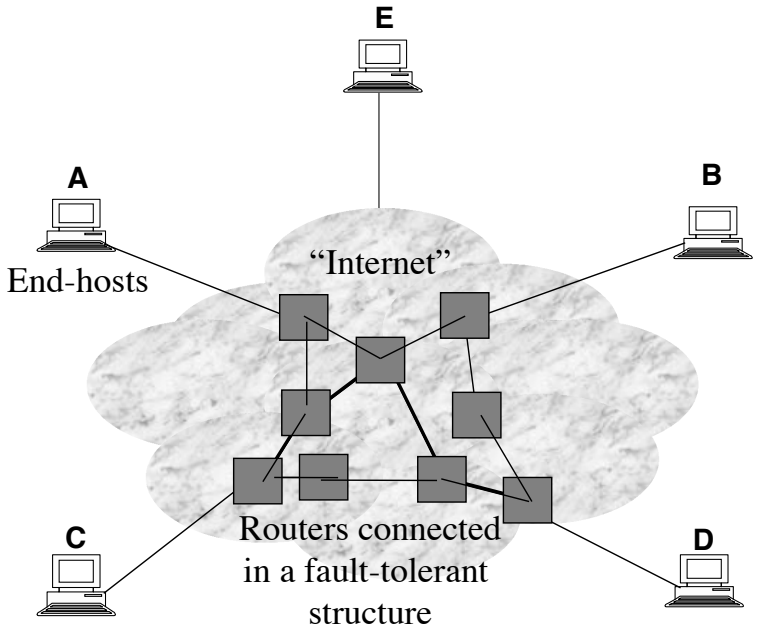
Today's Focus

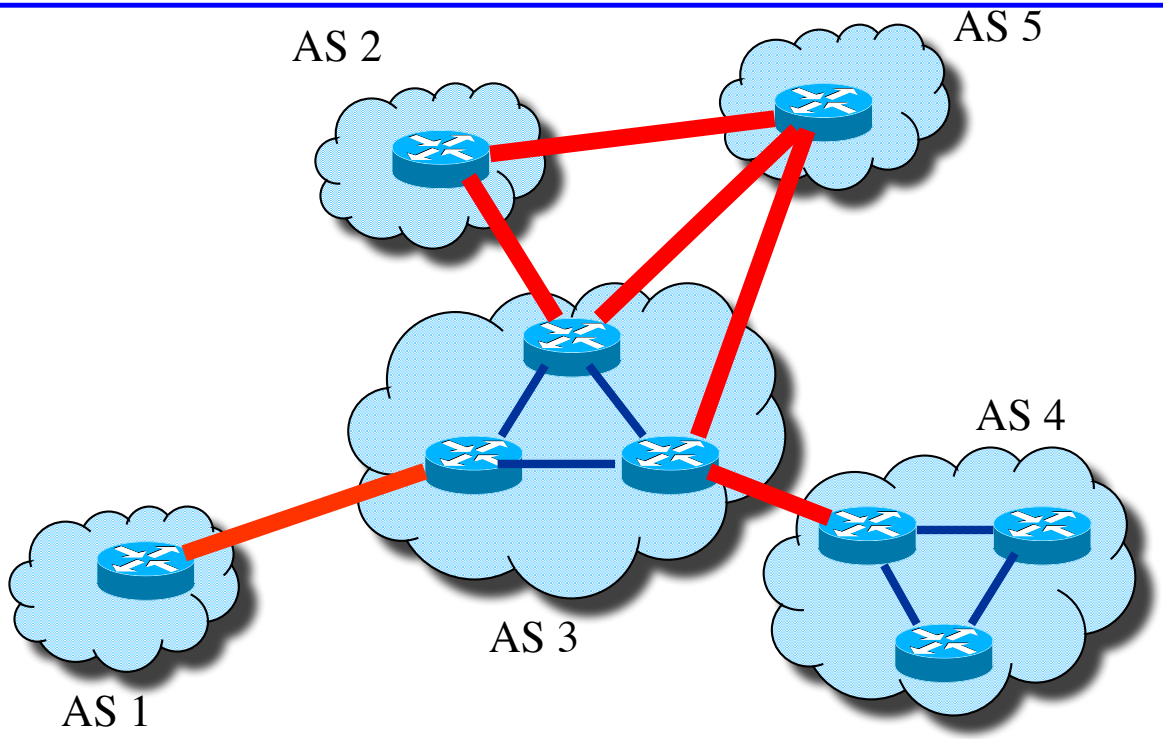
How routing between different administrative domains works in Internet?

Idealized View of the Internet



- This abstraction is quite misleading
- The TRUE story
  - The Internet service is provided by a large number of commercial enterprises, generally in competition with each other.
  - Global connectivity is achieved through cooperation between profitable commercial enterprises.

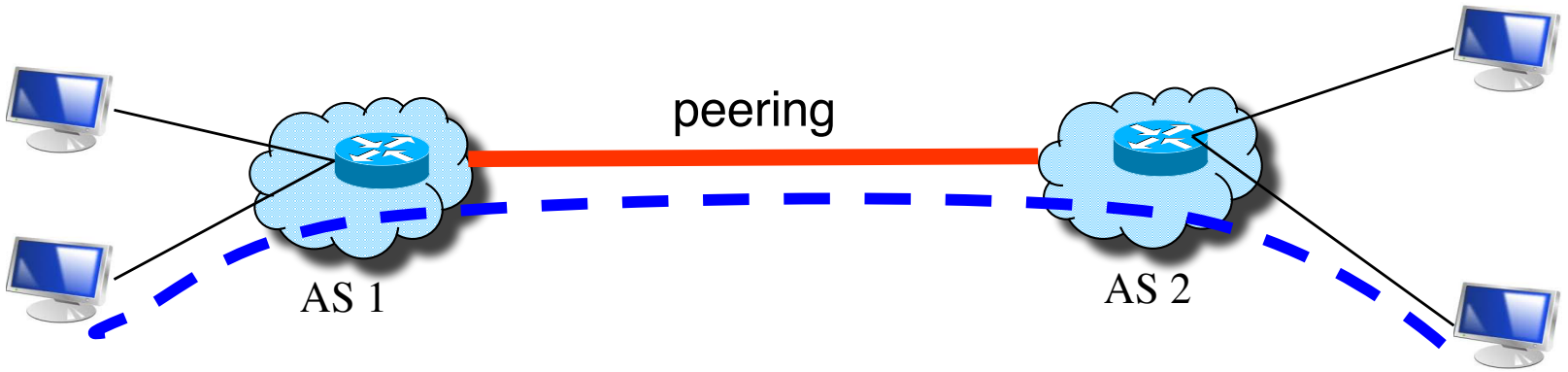
The Real Internet Structure



- Internet is composed of over 50000 Autonomous Systems (ASs)
  - Superlinear growth
- Each public AS is identified a globally unique number
  - IANA allocates AS Numbers to Regional Internet Registries (RIRs)
  - The RIRs further allocate or assign AS Numbers to network operators
  - 16 bit values

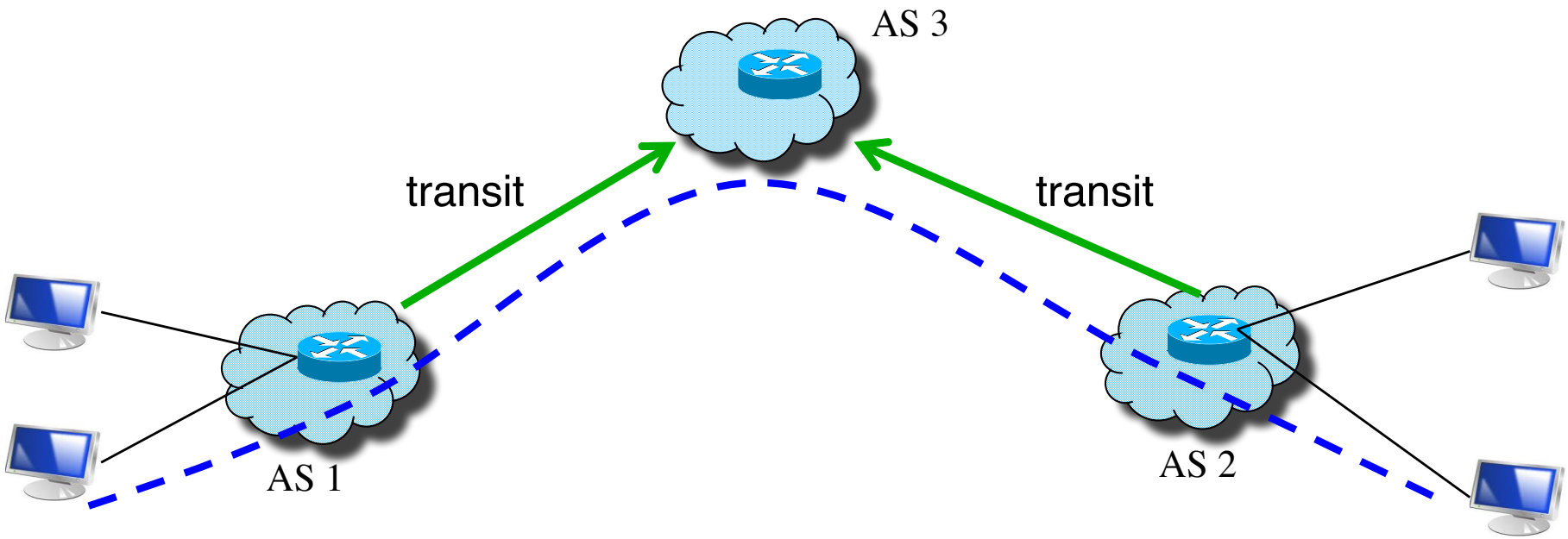
Inter-AS Relationships (1)

- **Peering**: two or more ASs interconnect directly with each other to exchange traffic
  - often done without charging for the interconnection or the traffic.



Inter-AS Relationships (2)

- **Transit**: one AS agrees to carry the traffic that flows between ASs
  - The transit provider receives a "transit fee" for the service

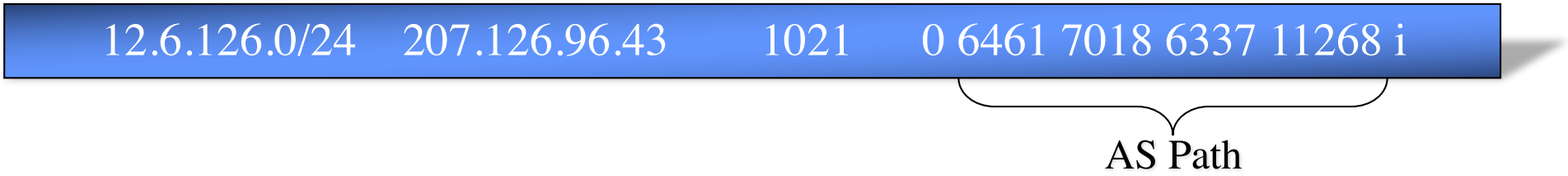


Routing between ASs

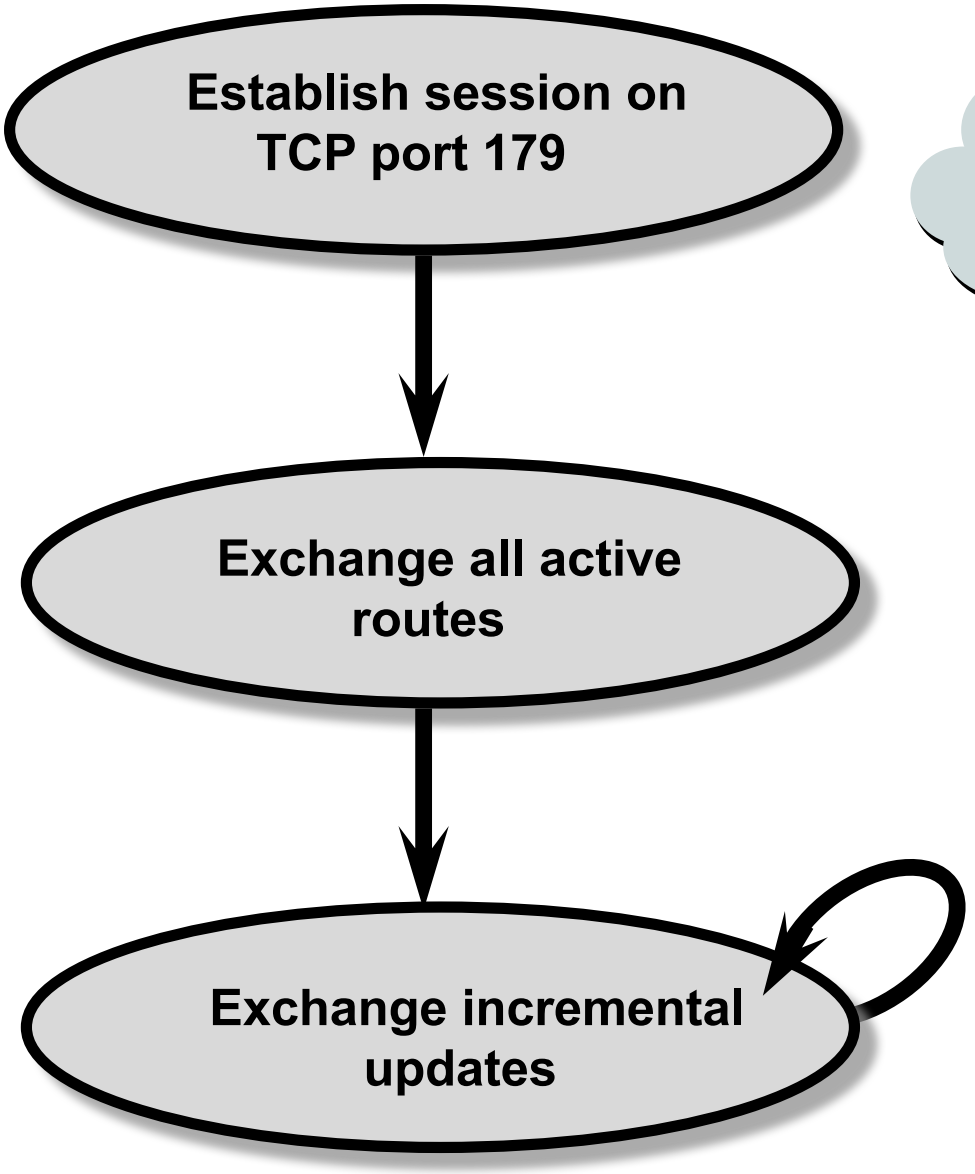
- Distance vector or link state?
  - No universal routing metric
- Problems with distance vector
  - Bellman-Ford algorithm may not converge
- Problems with link state
  - Metric used by routers not the same – loops
  - LS database too large – entire Internet
  - May expose policies to other ASs

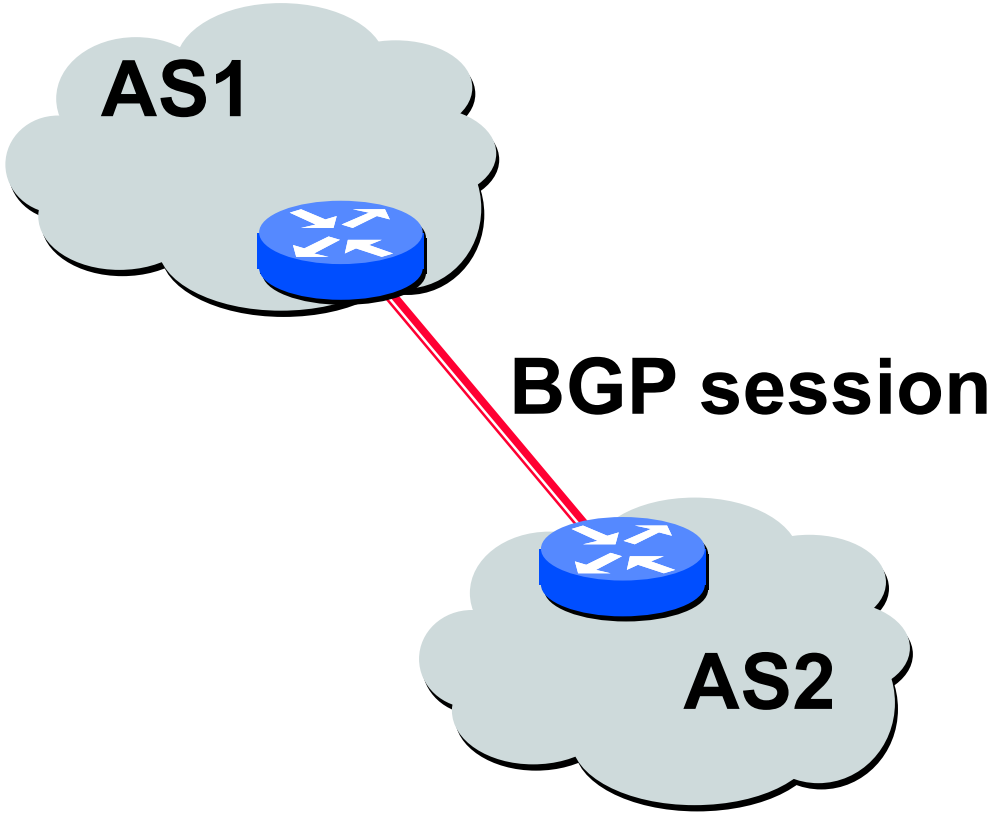
BGP

- Border Gateway Protocol
  - Is a **Policy-Based** routing protocol
  - Is the **de facto inter-domain routing protocol** of today's global Internet (current version BGP4)
- BGP is classified as a path vector routing protocol
  - makes routing decisions based on paths, network policies, or rule-sets configured by a network administrator
  - defines a route as a pairing between a destination and the attributes of the path to that destination.



BGP Operations





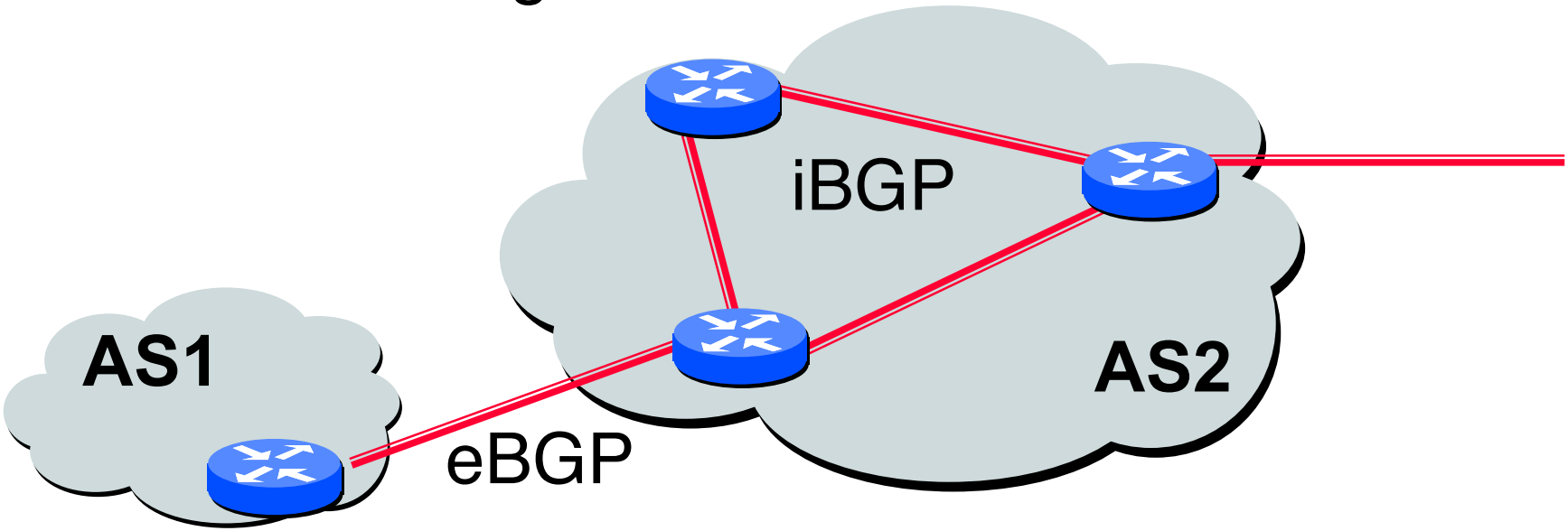
While connection is ALIVE exchange route UPDATE messages

Four Types of BGP Messages

- Open
  - Establishes a peering session on port 179.
- Keep Alive
  - sends 19-byte keep-alive messages every 60 seconds to maintain the connection
- Notification
  - Used for error notification
  - Shuts down a peering session
- Update
  - Announces new routes or withdraws previously announced routes.

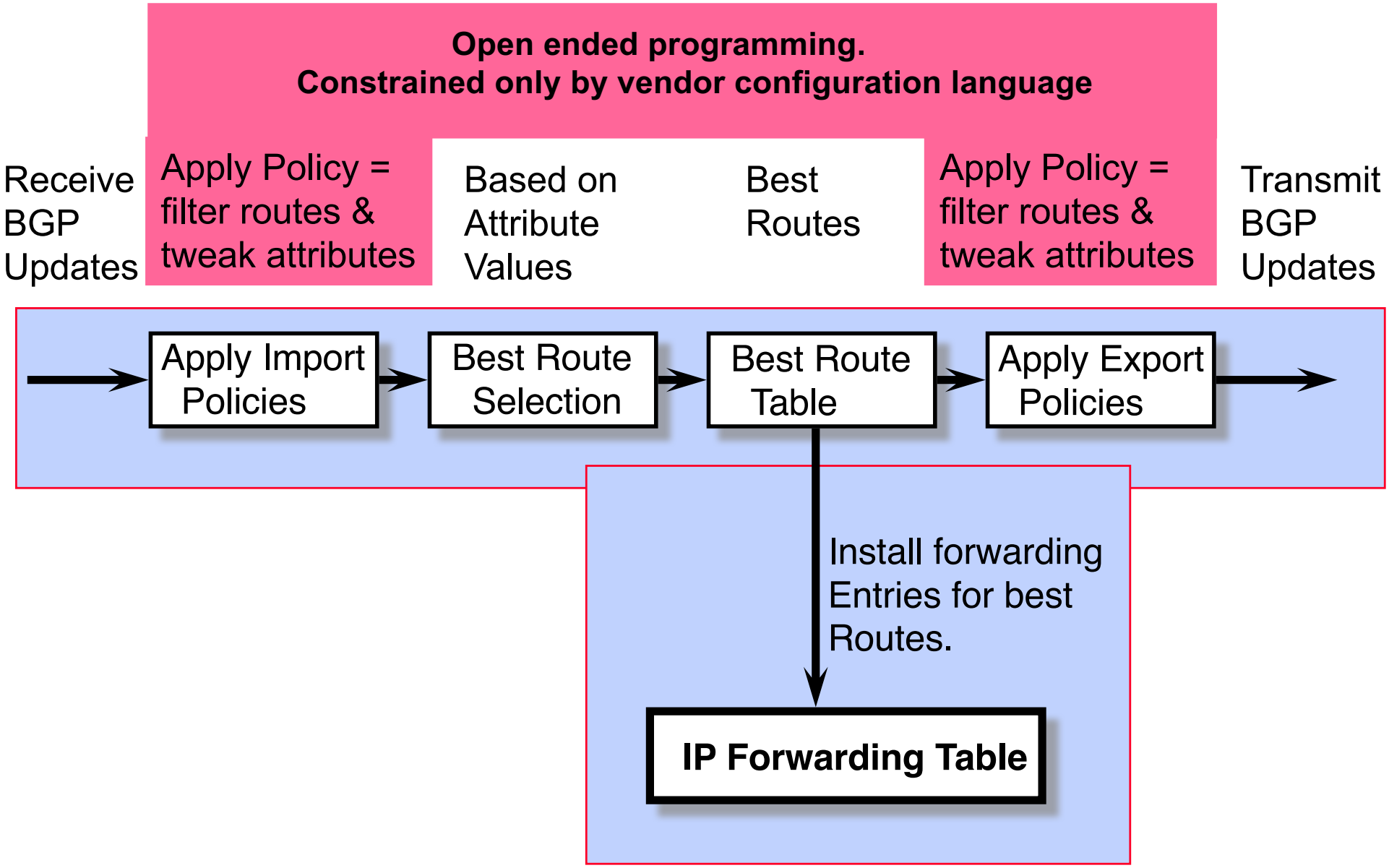
Two Types of BGP Neighbour Relationships

- eBGP: External Neighbor in a different AS
- iBGP: Internal Neighbor in the same AS



- The main difference is the way to propagate routes
  - New routes from an eBGP is typical redistributed to all other iBGP and eBGP peers.
  - New routes learned by an iBGP are advertised to only iBGP peers.

BGP Route Processing

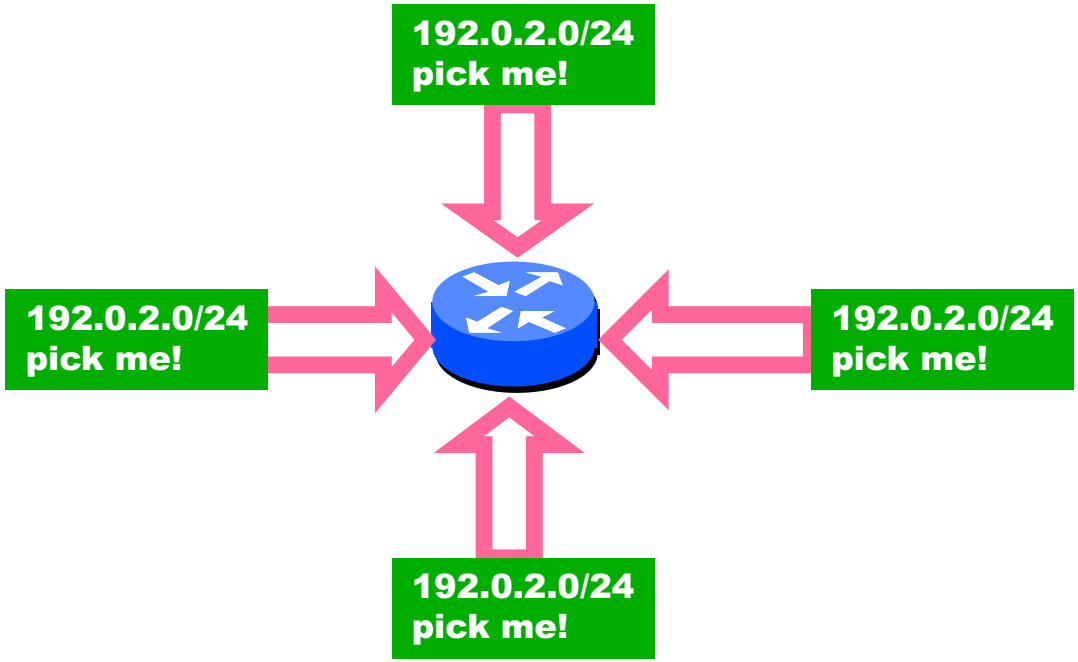


Import/Export Routes

- Import Routes
  - When a router hears many possible routes to a destination network, it needs to decide which route to install in its forwarding tables.
  - Order of route preference: customer > peer > provider
- Export Routes
  - Each AS needs to make decisions on which routes to export to its neighboring ISPs using BGP.
    - No ISP wants to act as transit for packets that it isn't somehow making money on.
  - Transit customer routes: Highest priority
  - Transit provider routes: Most likely not (no money earned)
  - Peer routes: only selected routes to other peering ISPs.

Best Route Selection

- Use BGP attributes



Given multiple routes to the same prefix, a BGP speaker must pick at most <u>one</u> best route

BGP Attributes

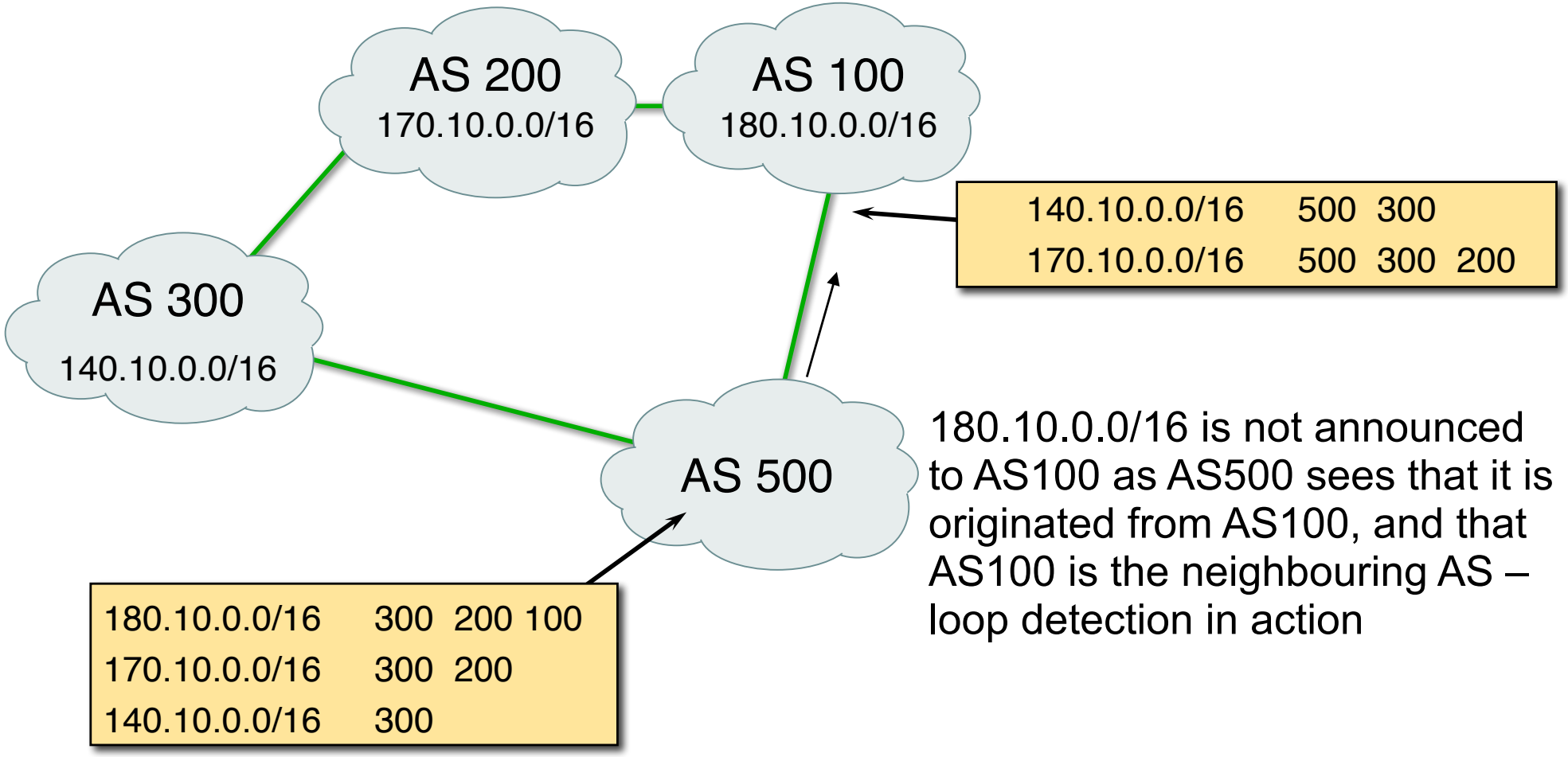
Value	Code	Reference
1	ORIGIN	[RFC1771]
2	AS_PATH	[RFC1771]
3	NEXT_HOP	[RFC1771]
4	MULTI_EXIT_DISC	[RFC1771]
5	LOCAL_PREF	[RFC1771]
6	ATOMIC_AGGREGATE	[RFC1771]
7	AGGREGATOR	[RFC1771]
8	COMMUNITY	[RFC1997]
9	ORIGINATOR_ID	[RFC2796]
10	CLUSTER_LIST	[RFC2796]
11	DPA	[Chen]
12	ADVERTISER	[RFC1863]
13	RCID_PATH / CLUSTER_ID	[RFC1863]
14	MP_REACH_NLRI	[RFC2283]
15	MP_UNREACH_NLRI	[RFC2283]
16	EXTENDED COMMUNITIES	[Rosen]
...		
255	reserved for development	

From IANA: http://www.iana.org/assignments/bgp-parameters

Most important attributes

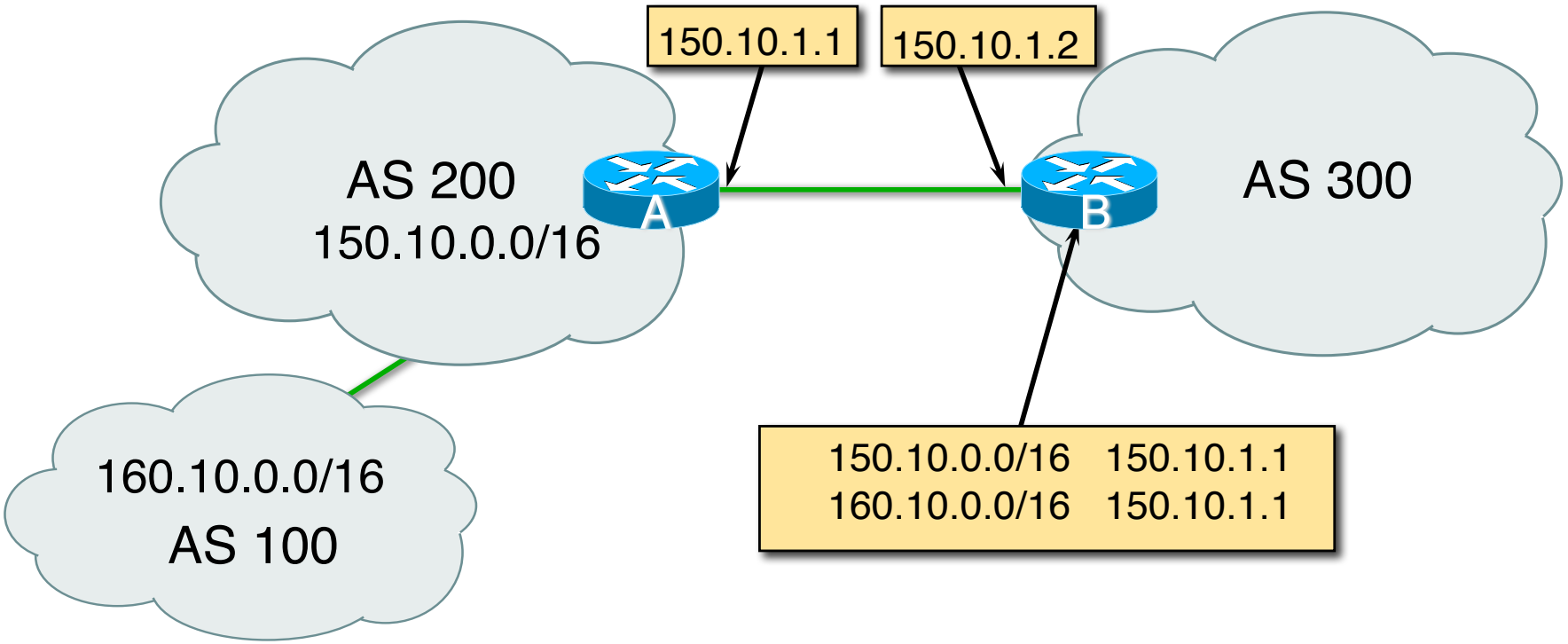
AS-Path and Loop Detection

- AS_PATH: sequence of AS identifiers that the route advertisement has traversed.



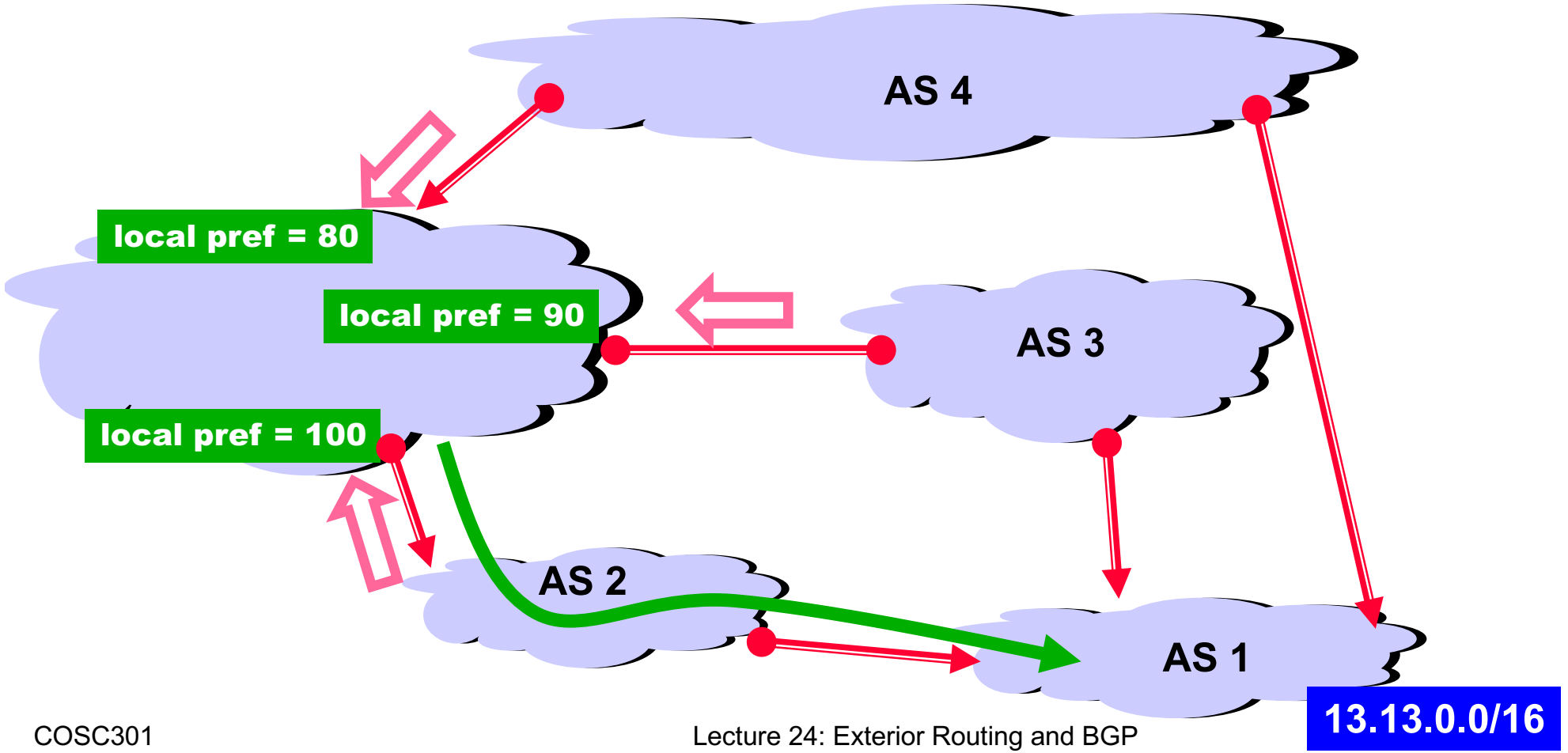
Next_Hop

- IP address of the next-hop router along the path to the destination.
  - On eBGP sessions, the next hop is set to the IP address of the border router.
  - On iBGP sessions, the next hop is not modified.



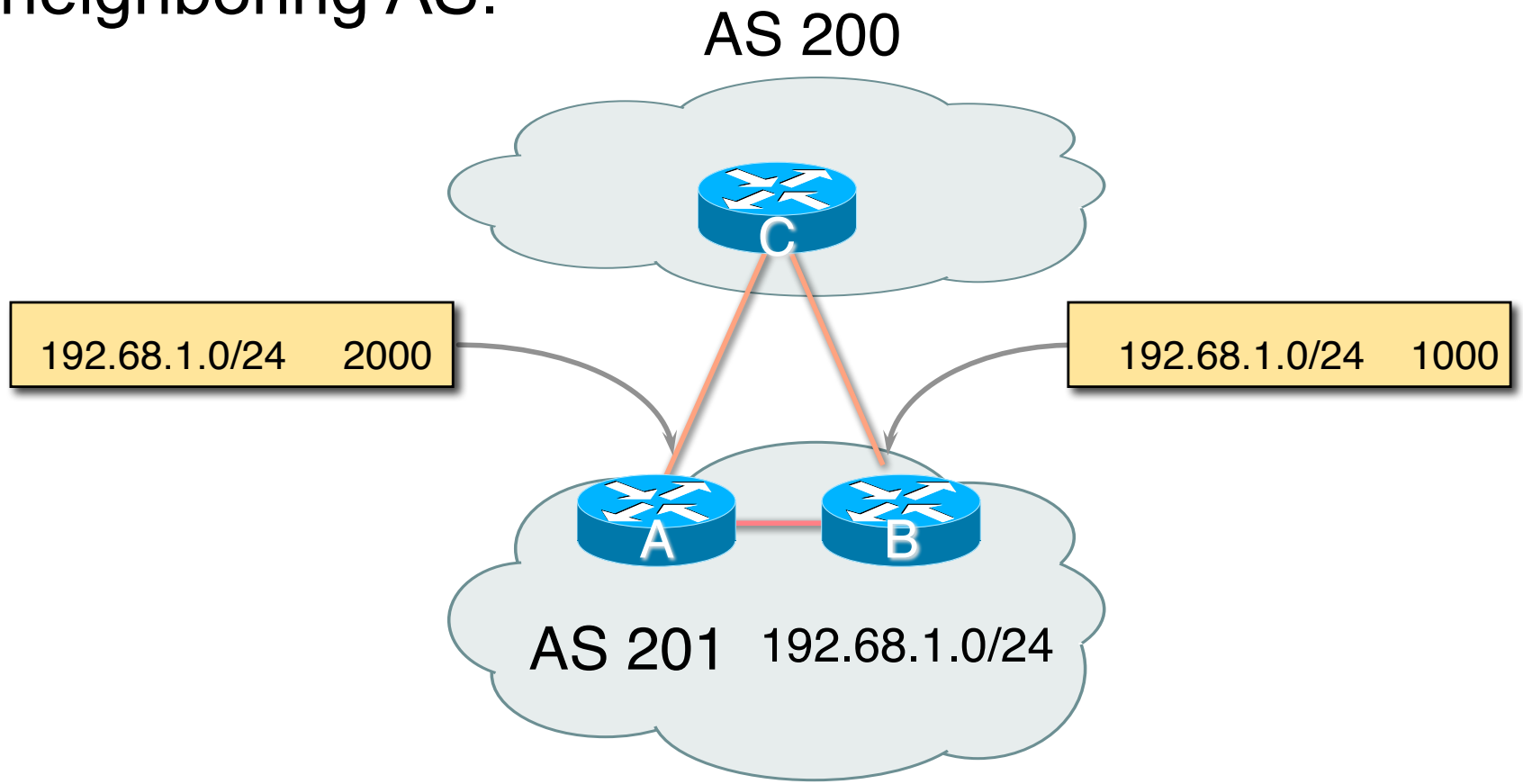
Local Preference

- The first criteria used to select routes
- Not attached on routes learned via eBGP sessions, but assigned by the import policy of these sessions.

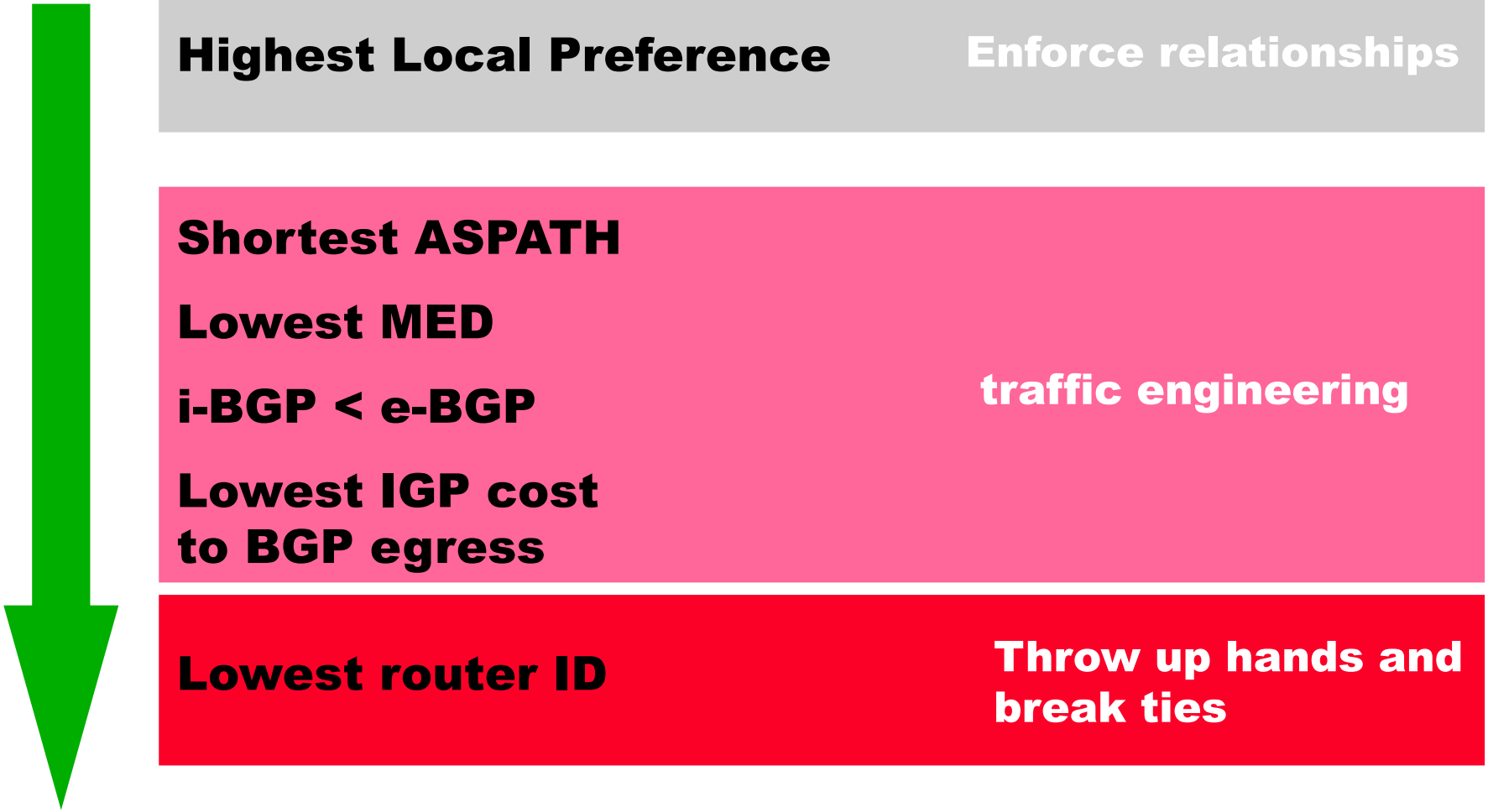


Multi-Exit Discriminator (MED)

- Neighboring AS sets the MED values to indicate which router it prefers to receive traffic for destination.
- Used for comparing two or more routes from the same neighboring AS.



Best Route Selection Criteria



BGP Problem and Migration

- Internal BGP scalability
  - Full mesh connectivity
  - Route reflectors and confederations.
- Instability
  - The routing tables are adjusted continually to reflect actual changes
  - Route flap damping
- Routing table growth
  - Route summarization
- Load-balancing
  - Locater/Identifier Separation Protocol

Resources

- Hari Balakrishnan, and Nick Feamster, Interdomain Internet Routing, http://nms.csail.mit.edu/6.829-f05/lectures/L4-routing.pdf

- Mike Pennington, BGP Deployment & Scalability, www.pennington.net/tutorial/bgp_001/BGP_Overview.ppt

- Timothy G. Griffin, An Introduction to Interdomain Routing and the Border Gateway Protocol (BGP),
  http://www.research.att.com/~griffin