

## Lecture 2 Internet and Datacenter

### Internet

#### What's "Internet"

The **Internet** (or **internet**) is the global system of interconnected [computer networks](#) that uses the [Internet protocol suite](#) (TCP/IP) to communicate between networks and devices.

#### Internet is a "Network of network"

- Campus Networks
- Enterprise Networks
- Internet Service Providers (ISP)

#### Each network is owned and managed

### Autonomous Systems

#### Internet is divided into Autonomous Systems

- Node: Autonomous System (AS)
- Edge: Two ASes connect to each other

### Autonomous System Numbers

AS Numbers are 16bit values.

### Internet Service Provider (ISP)

In fact, there are grades for ISPs in Internet

#### Ties of ISPs

#### The Relation Between Neighboring Nodes

- Neighboring ASes have business contracts
  - How much traffic to carry
  - Which destination to reach
  - How much
- Common business relationships
  - Customer-Provider
  - Peer-Peer

### Customer-Provider Relationship

#### Customer needs to be reachable from everyone

#### Customer doesn't want to provide transit service

### Multi-Homing: Two or More Providers

- Motivations for multi-homing
  - Higher reliability, survive single ISP failure
  - Better performance by selecting better path
  - Financial leverage through competition
  - Gaming the 95th-percentile billing

## Peer-Peer Relationship

### How to Connect ASes?

#### Internet eXchange Points (IXPs)

- In fact, the connection between ISPs is not  $C_n^2$
- Many networks connect in one location  $\Rightarrow$  IXP

#### Tier-1 Providers

##### Tier-1 Provider

- has no upstream provider of its own
- Typically has a national or international backbone
- Usually no fee between each Tier-1 Providers

##### Top of the Internet Hi

#### Tier-2 Providers

#### Characteristics of AS Pathes

- AS Path may be longer than shortest path
- Router Path may be longer than shortest path

## Routing

inter-domain routing: Find paths *between* networks  $\Rightarrow$  BGP

intra-domain routing: Find paths *within* a network  $\Rightarrow$  OSPF / RIP / ISIS

#### Intra Domain Routing

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#### Inter Domain Routing

$\Rightarrow$  BGP  $\Rightarrow$  very complex !

##### BGP is Path Vector Protocol

- BGP announcement carry **complete path information** instead of distances.
- Every "node" inherits the "Prefix" and put its own Node\_Num into it, so that it can realize the "complete path information"
- Complete path enables
- Each AS is free to select and use any path preferably, maybe the cheapest one.
- BGP is Policy Based (very flexible)

##### The Common Used BGP Policy

- Prefer the path with the highest WEIGHT.
  - Prefer the path with the highest LOCAL\_PREF.
  - Prefer the path that was locally originated via a **network** or **aggregate** BGP subcommand or through redistribution from an IGP. Local paths that are sourced by the **network** or **redistribute** commands are preferred over local aggregates that are sourced by the **aggregate-address** command.
  - Prefer the path with the shortest AS\_PATH. (judged by length of AS\_PATH)
  - Prefer the path with the lowest origin type. (IGP / EGP)
  - Prefer the path with the lowest **multi-exit discriminator (MED)**.
- .....

More information is listed in [CISCO\\_BGPAlgorithm](#)

##### It's so complex that many issues are caused by BGP

- Globally issues
- The configuration is of great significance and is hard to config for people.

- SDN is excellent but we still use old-system mostly now.
- Therefore, if SDN is commonly used in social life, the BGP can be discarded !