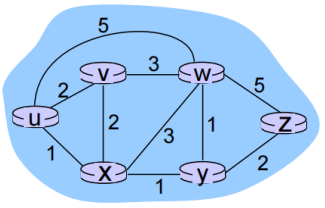
Ch5 Network layer control plane

- introduction
  - 网络层功能：forwarding(data plane) & routing(control plane=路由控制/集中控制)
- routing protocols
  - goal: 确定最优路径---least “cost”, “fastest”, “least congested”
  - link state(global)-----Dijkstra’s algorithm $O(n^2)$ 每个router都有所有的拓扑
    - notation
      - `c(x,y)` : cost
      - `D(v)` : 从src到v当前的cost
      - `p(v)` : 从src到v的前节点
      - `N'` : 目前已知least path的节点集
    - ex

Step	N'	D(v),p(v)	D(w),p(w)	D(x),p(x)	D(y),p(y)	D(z),p(z)
0	u	2,u	5,u	1,u	∞	∞
1	ux	2,u	4,x		2,x	∞
2	uxy	2,u	3,y			4,y
3	uxyv		3,y			4,y
4	uxyvw					4,y
5	uxyvwz					



  - distance vector (decentralized)--只知道邻居distributed
    - $d_x(y) = min\{c(x,v) + d_v(y)\}$
- intra-AS routing in the Internet: **OSPF Open Shortest Path First**
  - AS **autonomous systems**---domains
    - Gateway router & Interior router
    - 同一AS的router run相同内部路由协议——dst在内部--**interior gateway protocols (IGP)**
    - 不同AS可以有不同内部路由协议
    - 网关同时执行内部外部路由协议——dst在外部，由内外同时决定
  - **OSPF Open Shortest Path First** intra-AS
    - dijkstra
    - 每个node有topo，只知道到其他区域的shortest path/direction
    - reliable，用IP，link-state broadcast
    - 每个node

- routing among the ISPs: BGP
  - **BGP (Border Gateway Protocol): inter-domain routing protocol**: Decentralized, asynchronous, distance-vector
    - 从相邻AS获得子网可达信息 eBGP (TCP)
    - 将可达信息传给内部路由器 iBGP
    - prefix(dst)+attributes="route"
    - attribute: AS-PATH(经过的每一个AS), NEXT-HOP(进入每个AS前的interface ip)
  - Route selection: Hot Potato Routing--选择内部cost最小的local 网关，不管外部
  - IP-Anycast Service: CDN/DNS--收到多条path相同地址的信息，选best
  - BGP Routing Policy
- The SDN control plane
- ICMP: The Internet Control Message Protocol
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- Network management and SNMP