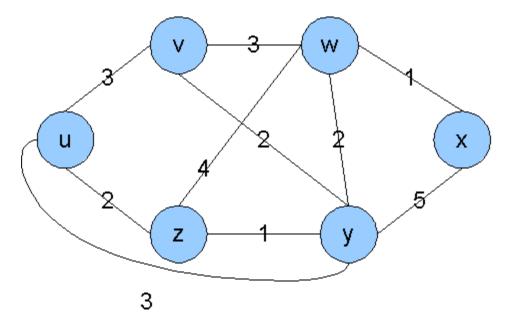
### Computer Networks Homework #5

#### David Koll December 1st 2011



## **Dijkstra's algorithm**

 Given the following network, use Dijkstra's algorithm to find the least cost paths from node u. Please provide a table showing the steps of the algorithm, a graph showing the resulting shortest-path tree from u and the final forwarding table of u.





# Dijkstra's algorithm (cont'd)

Step	N'	D(v), p(v)	D(w), p(w)	D(x), p(x)	D(y), p(y)	D(z), p(z)

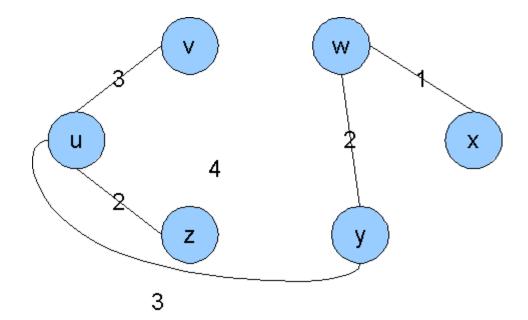


# Dijkstra's algorithm (cont'd)

Step	N'	D(v), p(v)	D(w), p(w)	D(x), p(x)	D(y), p(y)	D(z), p(z)
0	u	3,u	∞	×	3,u	2,u
1	uz	3,u	6,z	×	3,u	
2	uzy	3,u	5,y	8,y		
3	uzyv		5,y	6,w		
4	uzyvw			6,w		
5	uzyvwx					



### Dijkstra's algorithm (cont'd)

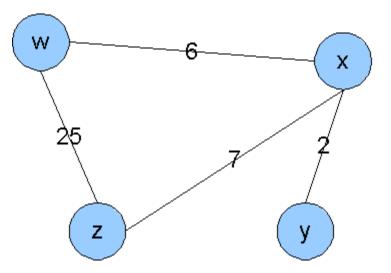


Dest.	Link.
Z	Z
у	у
V	V
W	у
х	у



### **Distance Vector algorithm**

 Given the following network, use the Distance Vector algorithm to find the least cost paths for all nodes. Fill the provided tables and indicate with arrows between the tables when a node sends a distance vector to another node.





### **Distance Vector algorithm**

Node w			cos	t to	
		w	x	у	z
	w				
from	x				
ffro	у				
	z				

	Node w			cos	t to
			w	х	у
		w			
	from	x			
	fro	y			
		z			

		Node			COS	t to	
z		w		w	x	у	z
			w				
		îrom	x				
		fro	y				
			z				

Node w			cos	t to	
		w	x	у	z
	w				
rom	x				
ffo	y				
	z				

Node			cos	t to	
x		w	x	у	z
	w				
îrom	x				
f	y				
	z				

Node			cost to				
3	C I	w	x	у	z		
	w						
from	x						
ffc	y						
	z						

]	Node x			cost to			
]			w	x	у	z	
		w					
	rom	x					
	ffrc	<sup>g</sup> y					
	z						

Node x			cost to				
		w	x	у	z		
	w						
from	x						
ff	у						
	z						

No	Node y		cos	t to	
У			x	у	z
	w				
from	x				
ffo	y				
	z				

No	de		cos	t to	
у		w	x	у	z
	w				
rom	x				
fro	y				
	z				

No	Node		cos	t to	
У	Yode y w x	w	x	у	z
	w				
Е	x				
ffo	y				
	z				

No	Node y		cos	t to	
3			x	у	z
	w				
from	x				
ff	у				
	z				

No	Node z		cos	t to		
z			x	у	z	
	w					
from	x					
ffo	у					
	z					

No	Node		cos	t to	
2	z		x	у	z
	w				
H	x				
ffro	y				
	z				

No	de		cos	t to		N
2	5	w	x	у	z	
	w					
rom	x					1
ffro	y					4
	z					

Node			cos	t to	
z	:	w	x	у	z
	w				
rom	x				
fire	y				
	z				



#### **Distance Vector algorithm**

No	Node w		cos	t to	
v			x	у	z
	w	0	6	8	25
from	x	80	œ	8	8
ffro	у	8	æ	8	8
	z	œ	œ	8	8

						1
Node W			cos	t to		
		w	x	у	z	
	w	0	6	8	13	
į,	x	6	0	2	7	ŀ
Ŧ	у	8	œ	80	8	ľ
	z	25	7	œ	0	l
						1
6	[					

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.

No	Node		cos	t to	
w		w	x	у	z
	w	0	6	8	13
E	x	6	0	2	7
from	у	8	80	8	80
	z	13	7	9	0

Node w			cos	t to	
		w	x	у	z
	w				3
from	x				
firo	у				
	z				

Ned	Node x		cos	t to	
1400			х	у	z
	w	8	8	8	8
from	x	6	0	2	7
firo	у	8	8	8	8
	z	8	8	8	8

Λ	i –				
N			cos	t to	
140	de x	w	x	у	z
	w	0	6	8	25
8	x	6	0	2	7
đ	у	8	2	0	80
V	z	25	7	80	0
ر' ۱	•				

- 14				
			cos	t to
14000	le x	w	x	у
ſ	w	0	6	8
I.	x	6	0	2
₫.	у	8	2	0
¥1	z	13	7	9
14	•			

Node x		cost to			
		w	x	у	z
	w				
from	x				
ffro	у				
	z				

Nod	la 11		cos	t to	
1400	ie y	w	x	у	z
	w				
from	x				
ffro	у				
	z				

Nod	1		cos	t to	
1400	ie z	w	x	у	z
	w				
B	x				
from	у				
	z				

Nod	Node y		cost to				
1100			x	у	z		
	w	8	8	8	80		
E	x	80	œ	œ	œ		
from	у	8	2	0	œ		
	z	8	æ	8	œ		

Ned	Node z		cost to			
1400	le z	w	x	у	z	
	w	8	8	8	8	
from	x	8	8	8	8	
fro	у	8	8	8	8	
	z	25	7	8	0	

N-E

la v	cost to				
ie y	w	x	у	z	
w	8	8	8	8	
х	6	0	2	7	
у	8	2	0	9 '	
z	8	8	8	8	
	у	w ∞ x 6 y 8	w ∞ ∞ x 6 0 y 8 2	w      x      y        w      ∞      ∞      ∞        x      6      0      2        y      8      2      0	

ł		1		cos	t to	
	140	le z	w	x	у	z
F	L	w	0	6	8	25
	E	x	6	0	2	7
ľ	from	у	8	80	8	8
		z	13	7	9	0

íÅ	у	8	2	0	9
И	z	8	8	8	œ
1					
Ne			cos	t to	
Noe	εz	w	x	у	z
	w	0	6	8	13
from	x	6	0	2	7
£	y	8	8	8	œ

У œ 80 00 0 0

w      x      y      z        w      ∞      ∞      ∞      ∞      ∞        x      6      0      2      7        y      8      2      0      9	e y	cost to				
x 6 0 2 7 y 8 2 0 9		w	x	у	z	
y 8 2 0 9	w	8	8	8	8	
, <u></u>	х	6	0	2	7	
z တ တ တ တ	у	8	2	0	9	
-	z	8	8	80	80	

## **Comparison LV vs. DV**

#### Scalability

- LS uses broadcasts to disseminate complete knowledge about all links to entire network
- DV only sends (local) information to neighboring nodes. Convergence time and DV size still increase with network size

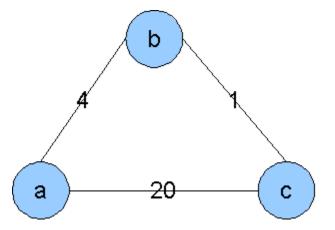
#### Robustness

- LS: every router does its own calculations
- DV: wrong DV will be used by neighboring nodes and further propagate the error



## **Count-to-infinity problem**

- Q: Explain the count-to-infinity problem using a simple example. How can this problem be avoided?
- Consider the following example:





# Count-to-infinity problem (con't)

- $\circ$  b sends DV (a,4) to c
- c computes that it can reach a in 5 hops via b and sends DV (a,5) to b
- $_{\odot}\,$  Now the cost of the a-b changes to 30
- b recomputes its DV to a
  - Using the (old) DV (a,5) from c it computes the DV (a,6) and sends it to c
- c recomputes its DV to a
  - Using the DV from b it computes the DV (a,7) and sends it to b



# Count-to-infinity problem (con't)

- The last two steps repeat with an increasing DV to reach a until b sends the DV (a,20)
- $_{\odot}\,$  c recomputes its DV to a
  - Using the DV from b it determies that DV (a,20) using the link c-a is less costly and sends it back to b
- $_{\odot}\,$  b recomputes ist DV to a
  - Using the DV (a,20) from c it computes the DV (a,21) and sends it to c
- Now the system is finally stable again



# Count-to-infinity problem (con't)

- Count-to-infinitiv problem can be avoided using the poisoned reverse technique.
  - Router A will advertise a distance as infinite to Router B if Router B is on the advertised path
  - In the example: In its advertisements to Router B, Router C will advertise the cost to reach Router A as infinite as long as it routes packets to A via B
  - Poisoned reverse will only prevent routing loops that involve just two gateways. It is still possible to end up with patterns in which three gateways are engaged in mutual deception. E.g. A may believe it has a route through B, B through C, and C through A.



# **Routing policies**

- Q: How are routing policies used in BGP.
  Give one example.
- Routing policies determine ...
  - $_{\circ}$  ... which BGP advertisements to regard
  - $_{\circ}$  ... which routes to advertise
- Example
  - $_{\circ}~$  AS x is connected to AS y and AS z
  - Policy : AS x does not want AS y to route traffic via AS x to AS z
  - Therefore, AS x does not advertise any route to reach AS z to AS y



## Intra- vs. inter-AS routing

- Q: Why are different inter-AS and intra-AS protocols used in the Internet?
- Different policies
  - Inter-AS: control over how (foreign) traffic is routed via the own network
  - Intra-AS: control over how traffic is routed within the the own network
- o Scale
  - Hierarchical routing saves table size, reduced update traffic



## Intra- vs. inter-AS routing

#### • Performance

- ∘ Intra-AS: can focus on performance
- Inter-AS: policy may dominate over performance



### Thank you

#### Any questions?

