

Announcements

- Project proposals due today --- reviewed by Monday
- Lab time Monday and Tuesday for project development
- Implementation plans due after Thanksgiving

Review

- Server programming
 - ✓ Accessing files
 - ✓ Catching Exceptions
 - ✓ Web server
 - ✓ IM server
 - ✓ Webmail

Today's Plan

- Routing protocols and algorithms
 - ✓ Representing network maps
 - ✓ Distributing routing information
 - ✓ Dijkstra's shortest path first algorithm
 - ✓ Representing network maps



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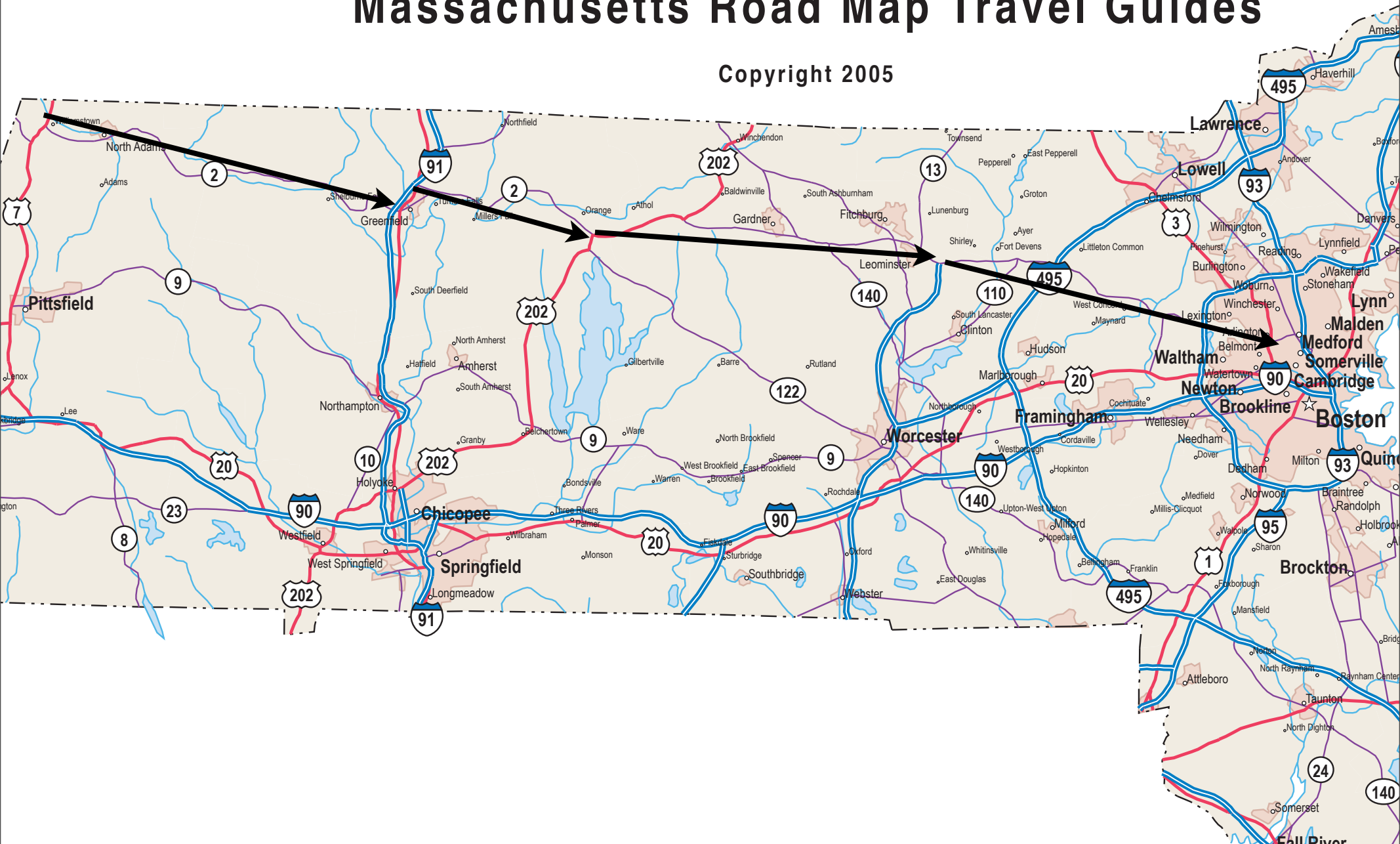


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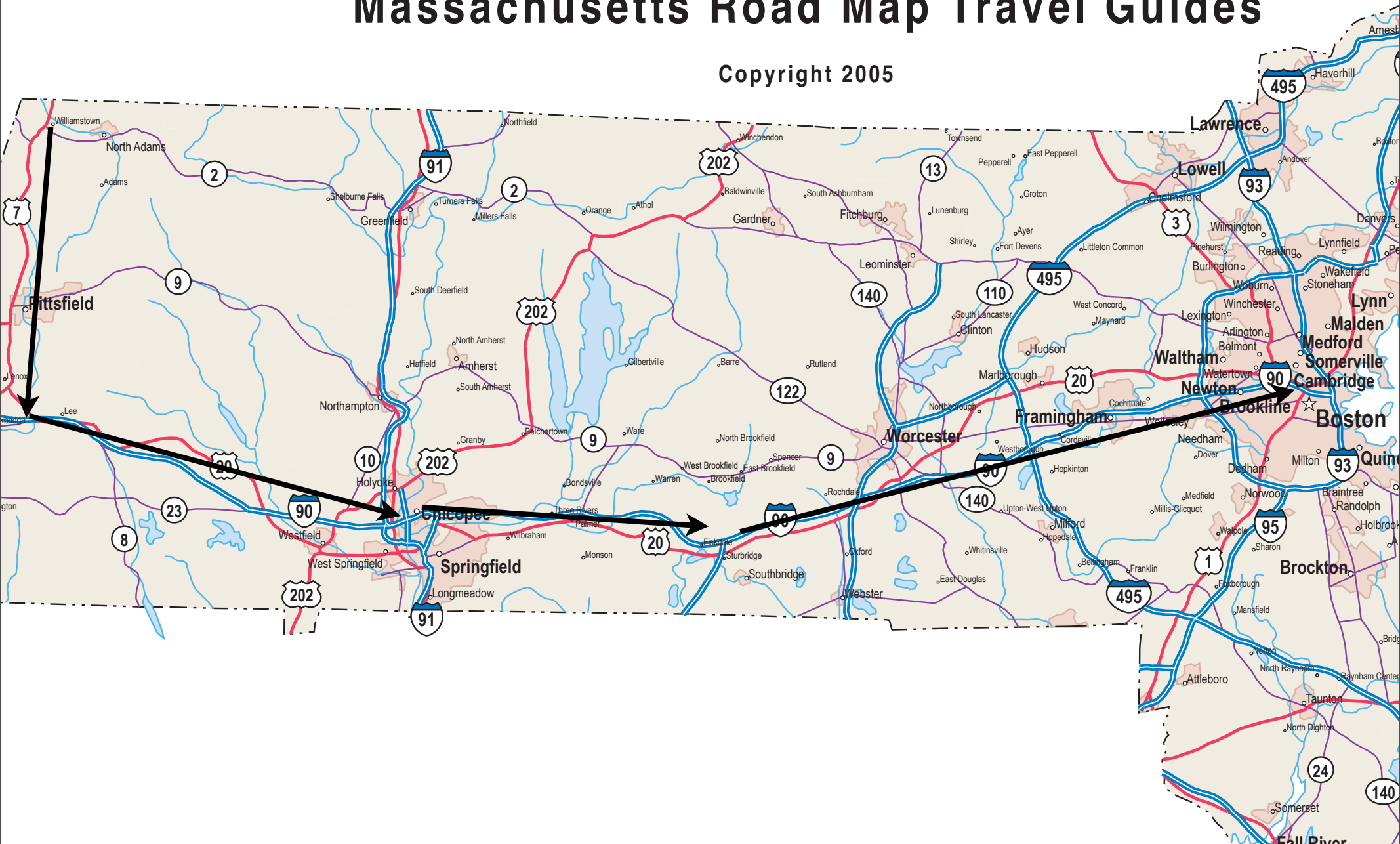


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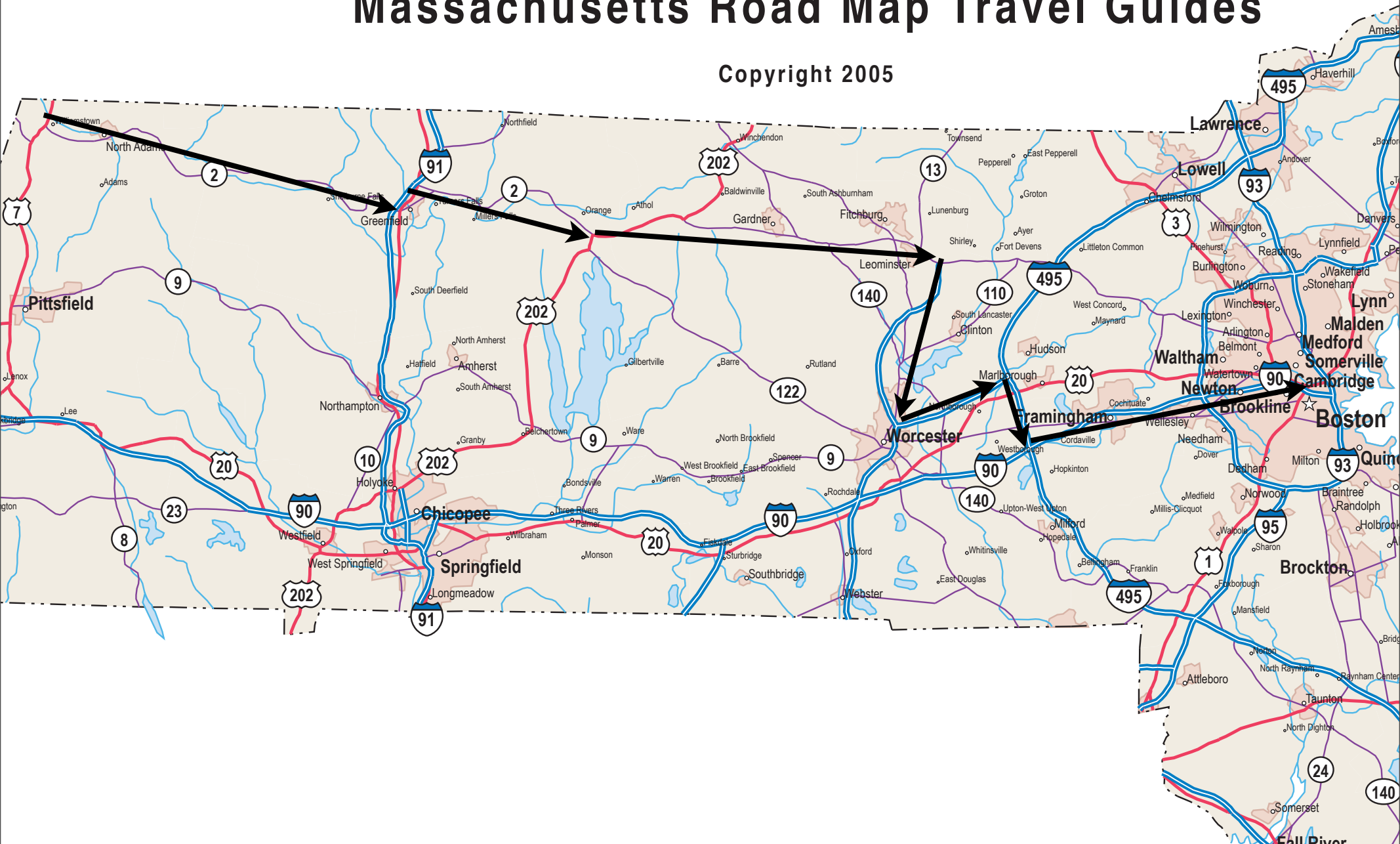


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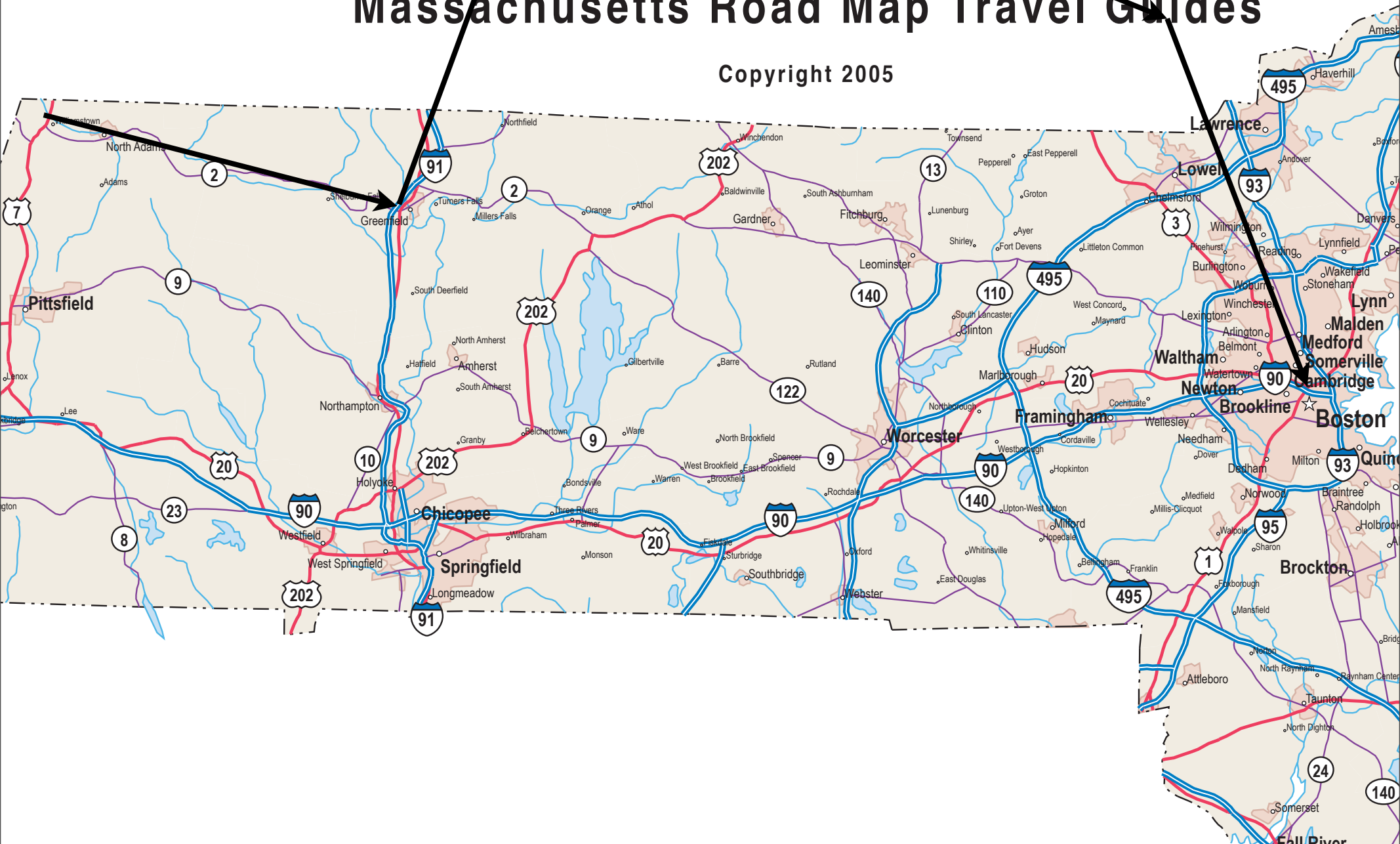




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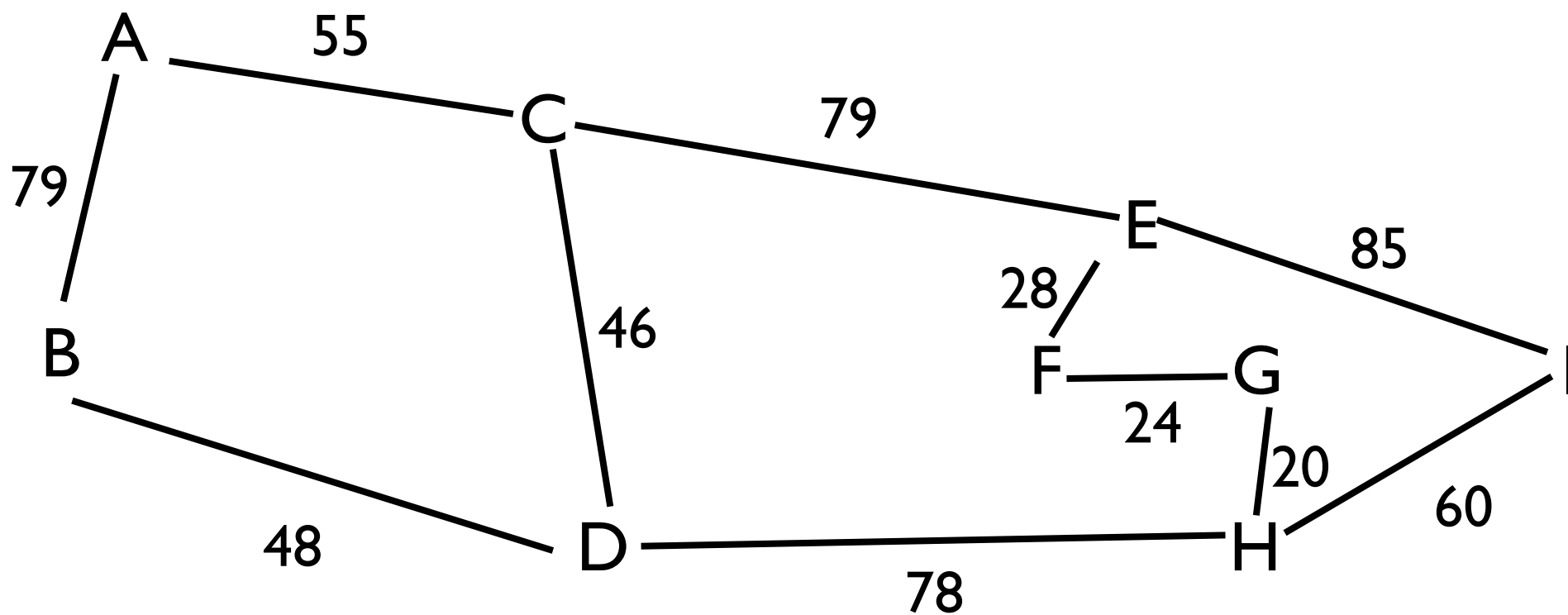
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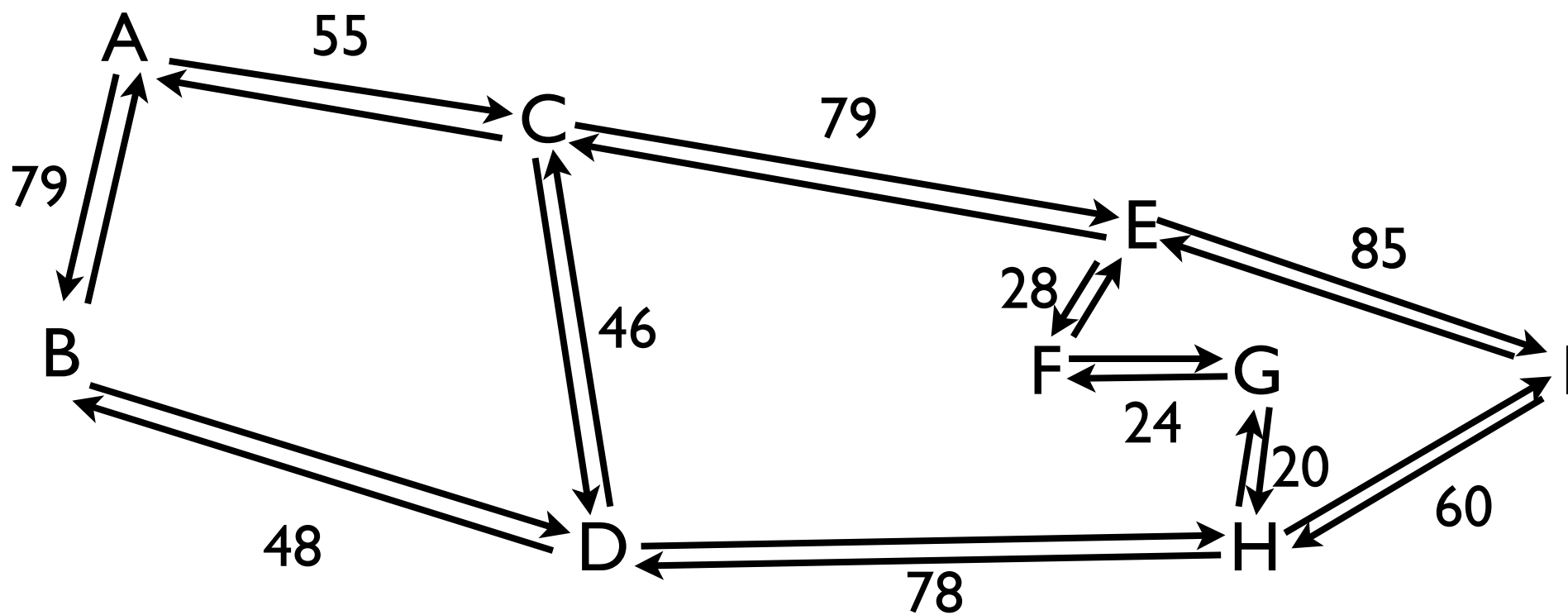
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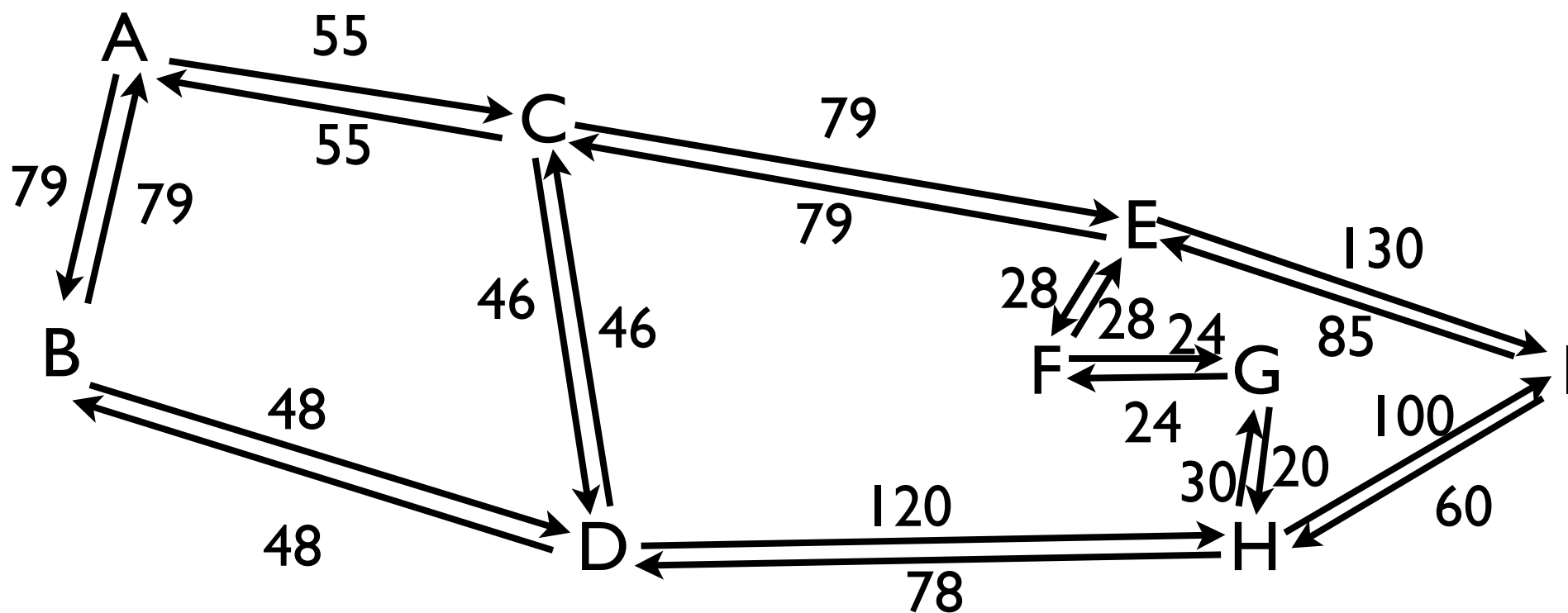


Cities	Neighbors		
Williamstown	Lee 55	Greenfield 79	
Lee	Williamstown 55	Springfield 48	
Greenfield	Williamstown 79	Springfield 46	Leominster 79
Springfield	Greenfield 46	Lee 48	Framingham 78
Leominster	Greenfield 79	Boston 85	Worcester 28
Worcester	Leominster 28	Marlboro 24	
Marlboro	Worcester 24	Framingham 20	
Framingham	Springfield 78	Boston 60	
Boston	Framingham 34	Leominster 85	

Cities	Neighbors		
A	B 55	C 79	
B	A 55	D 48	
C	A 79	D 46	E 79
D	C 46	B 48	H 78
E	C 79	I 85	F 28
F	E 28	G 24	
G	F 24	H 20	
H	D 78	I 60	
I	H 34	E 85	

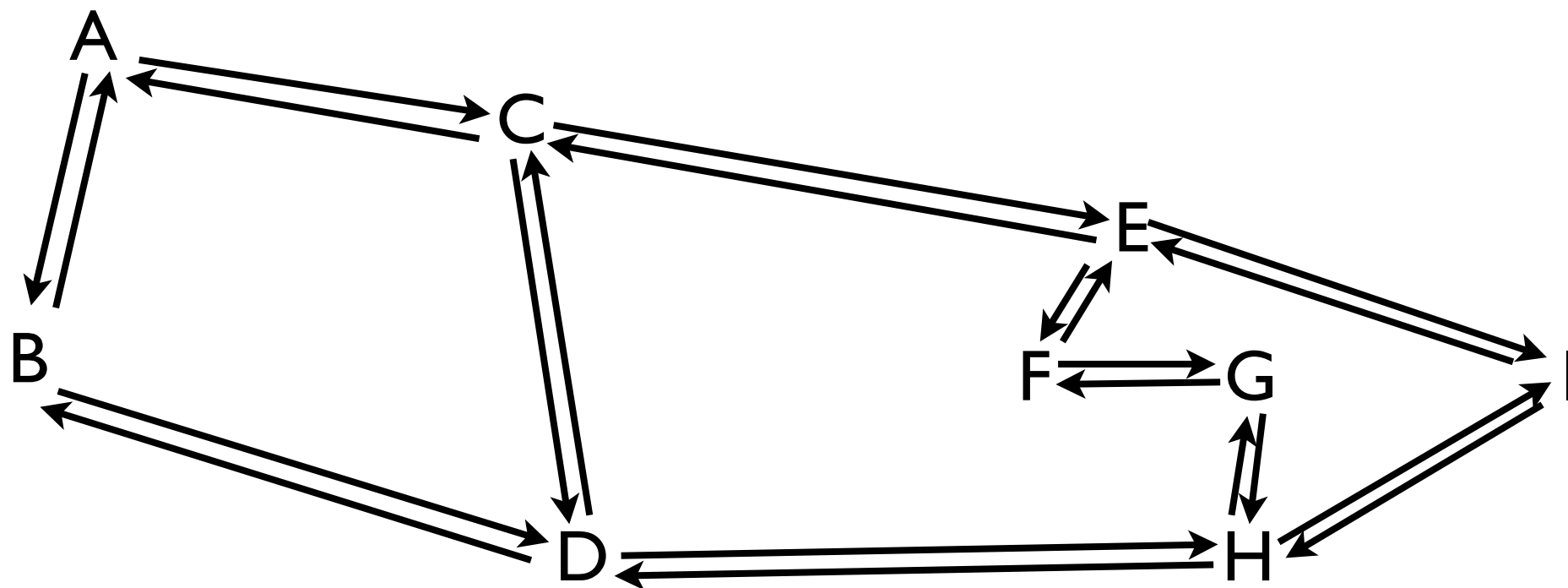


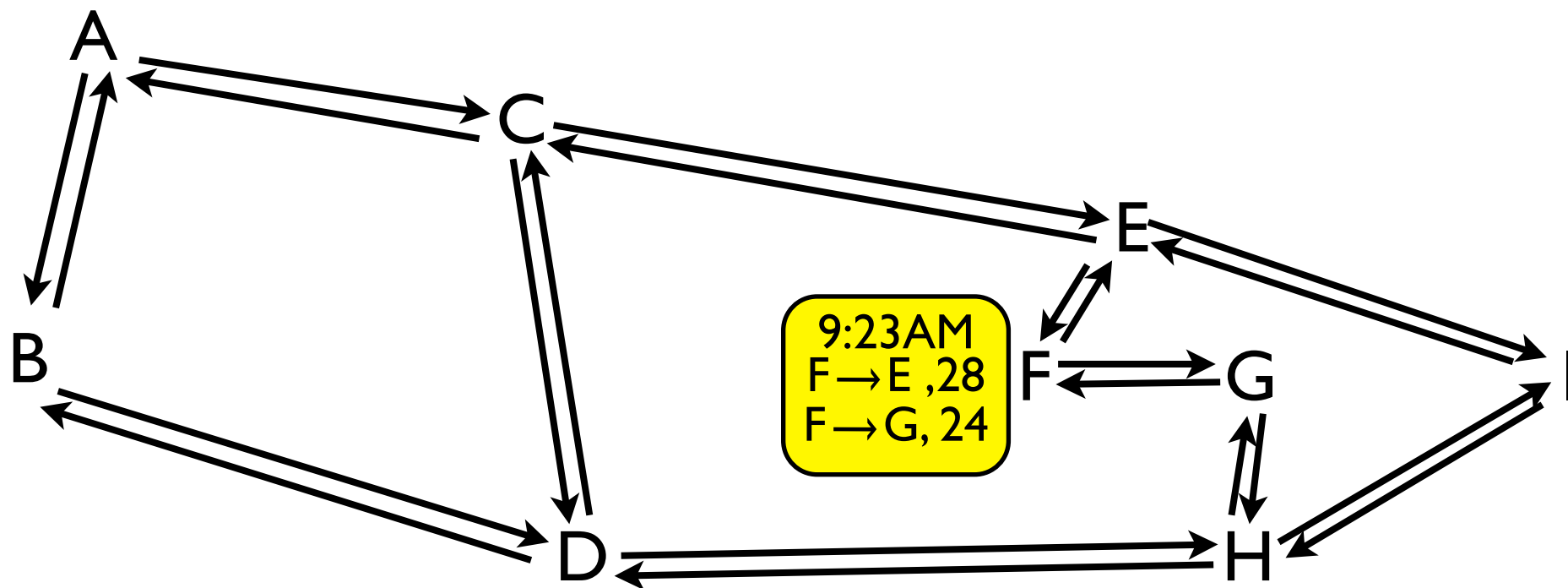




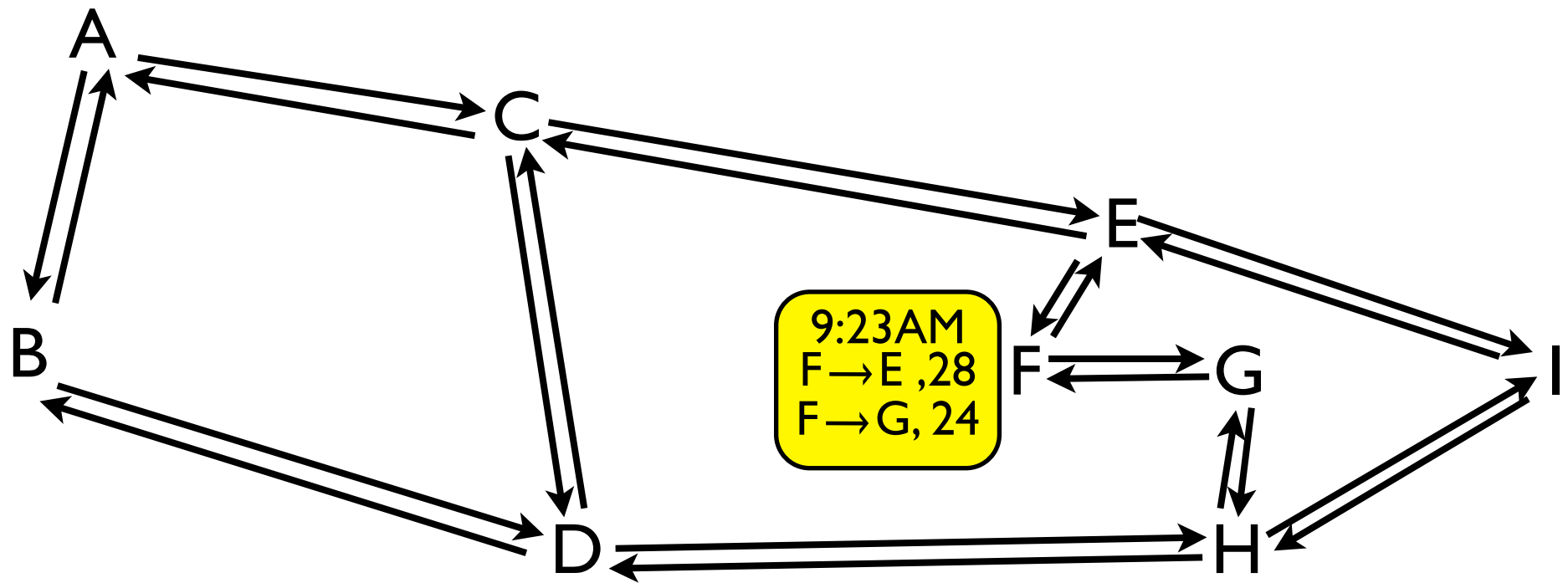
Link State Routing

- Two ongoing processes
 - Intelligent flooding – Each router sends packets to all other routers telling them what it knows about its local topology:
 - Who are its neighbors
 - How long it takes to reach them
 - Path calculation – Each router then computes the best path through the network

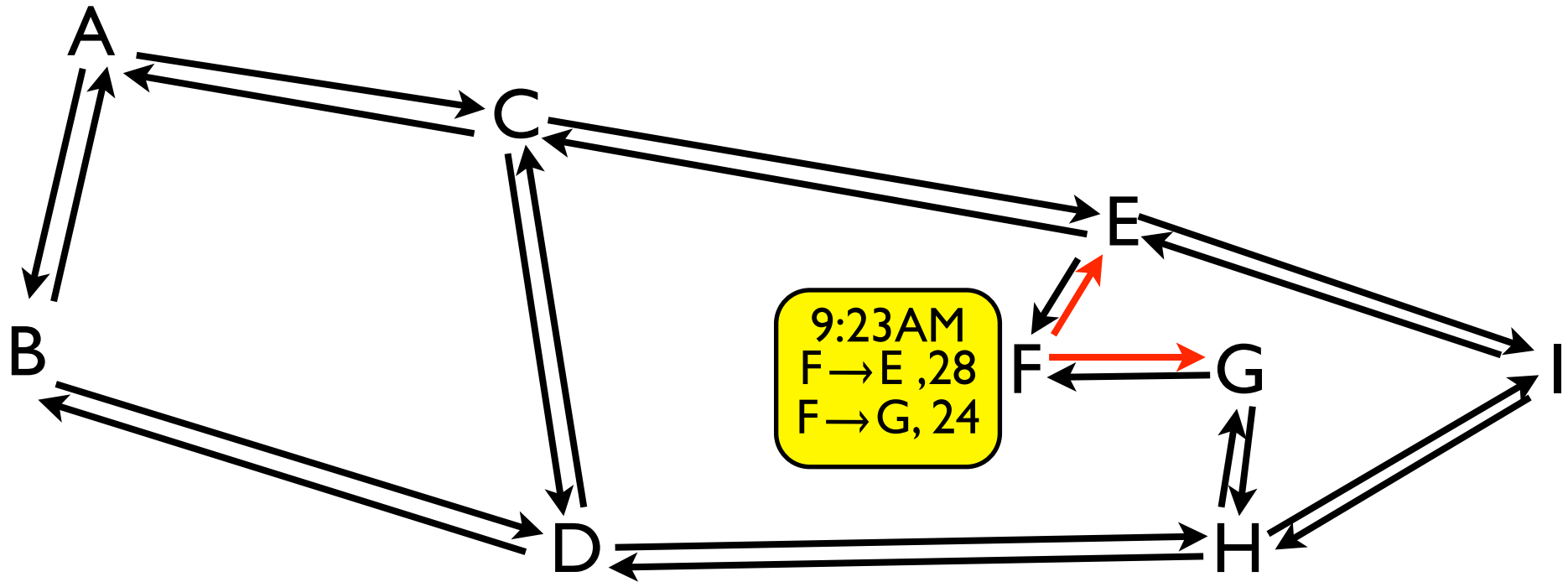




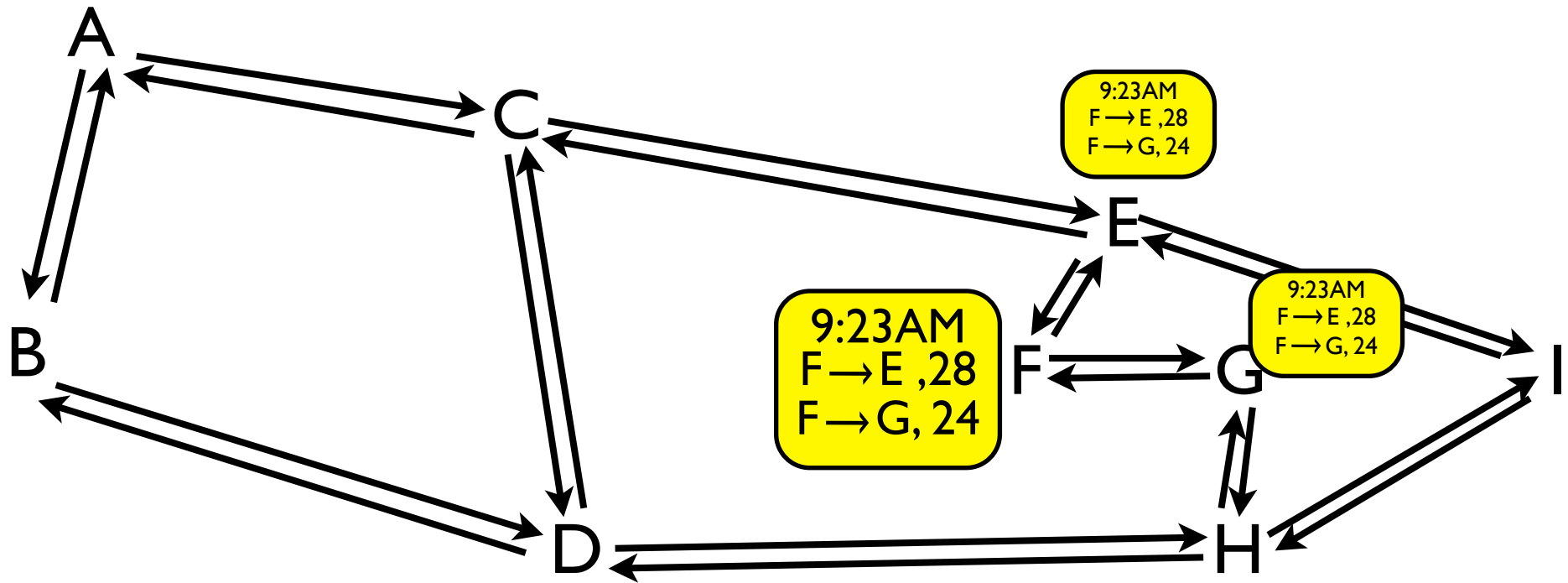
Cities	Neighbors		
A	B 55	C 79	
B	A 55	D 48	
C	A 79	D 46	E 79
D	C 46	B 48	H 78
E	C 79	I 85	F 28
F	E 28	G 24	
G	F 24	H 20	
H	D 78	I 60	
I	H 34	E 85	



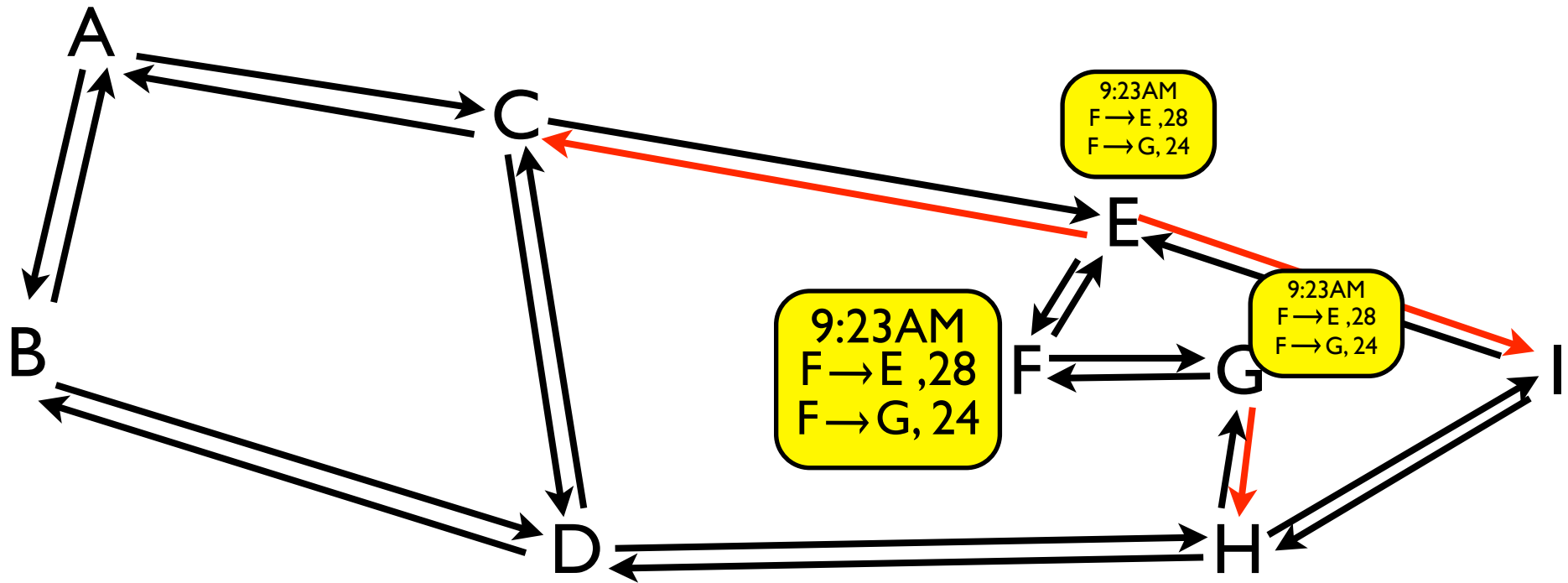
FLOODING



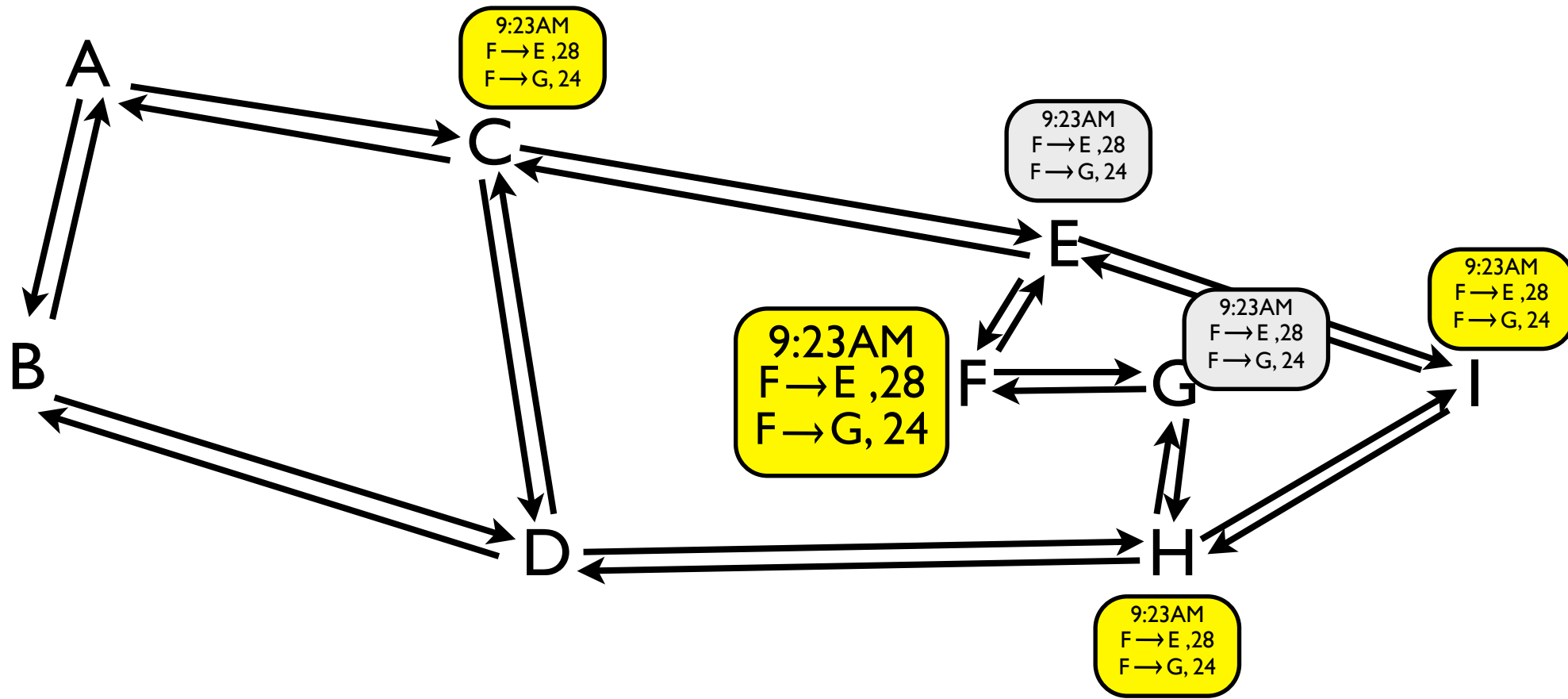
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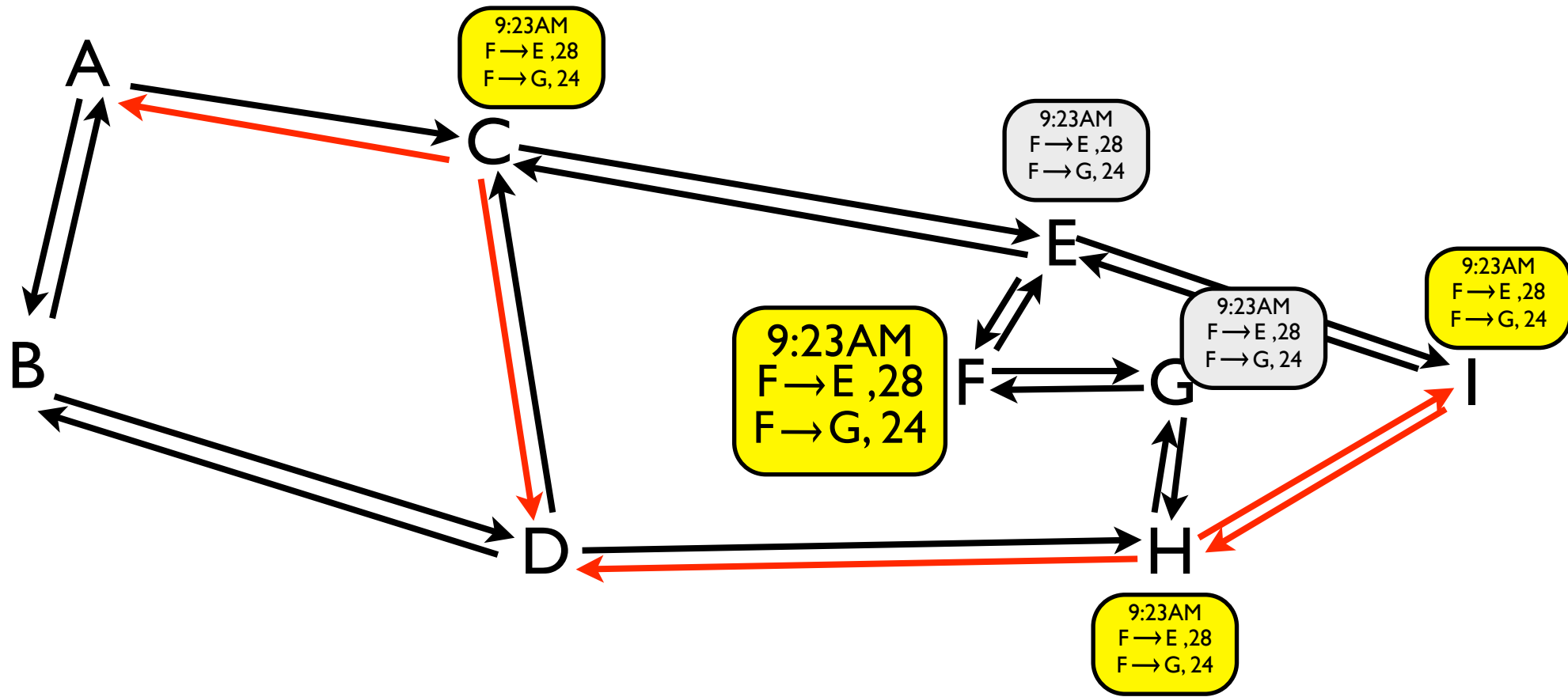
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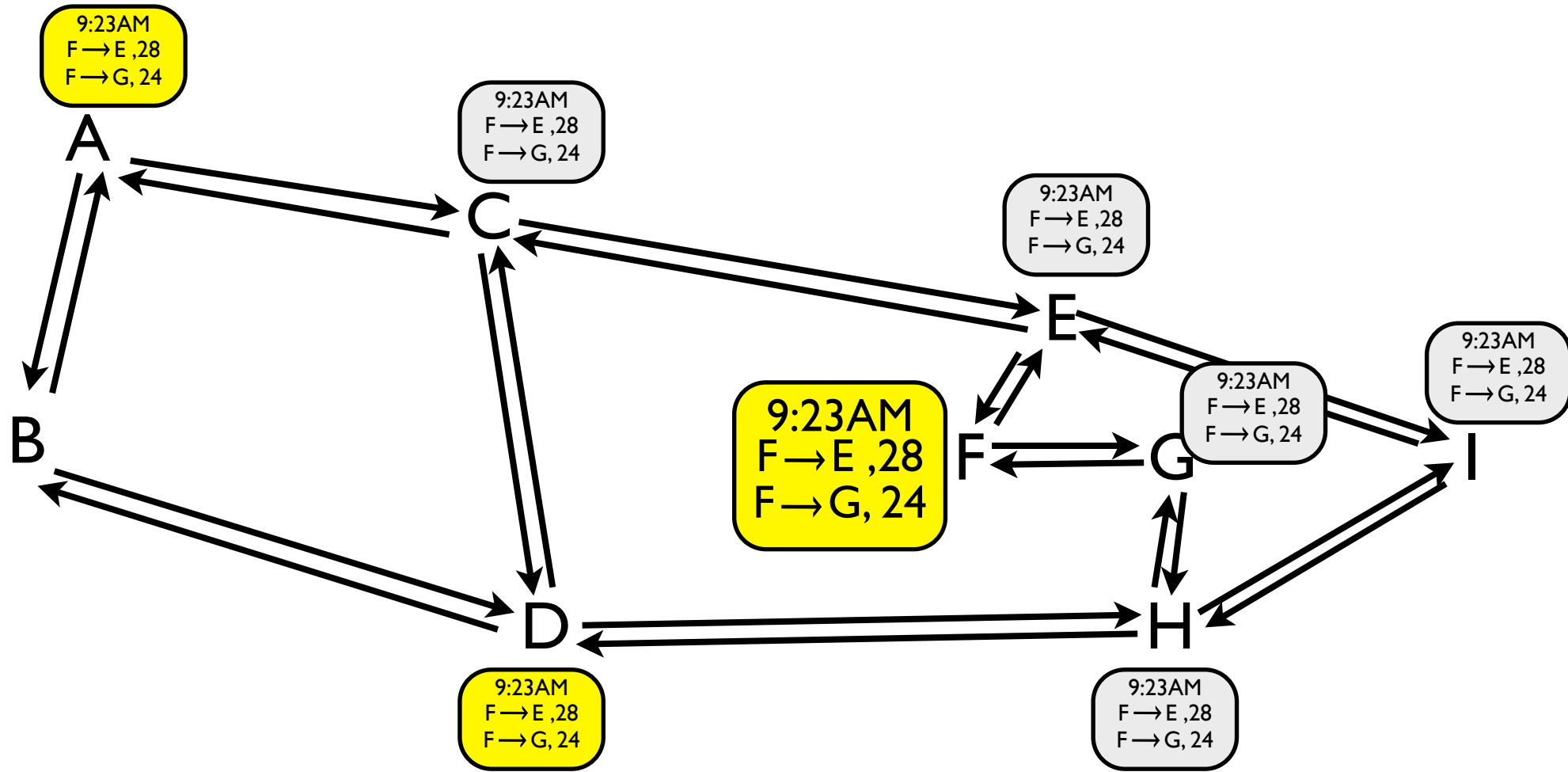
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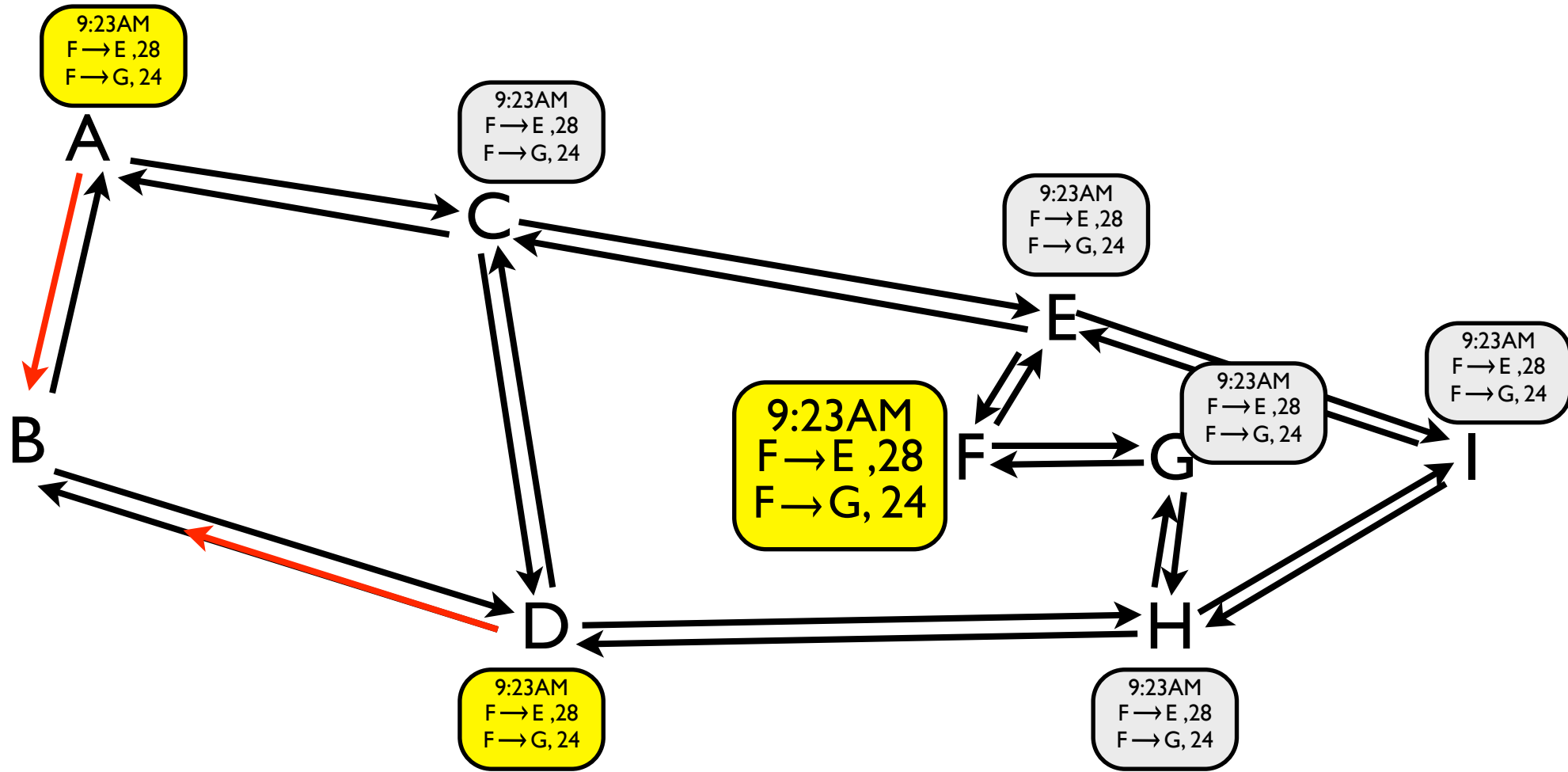
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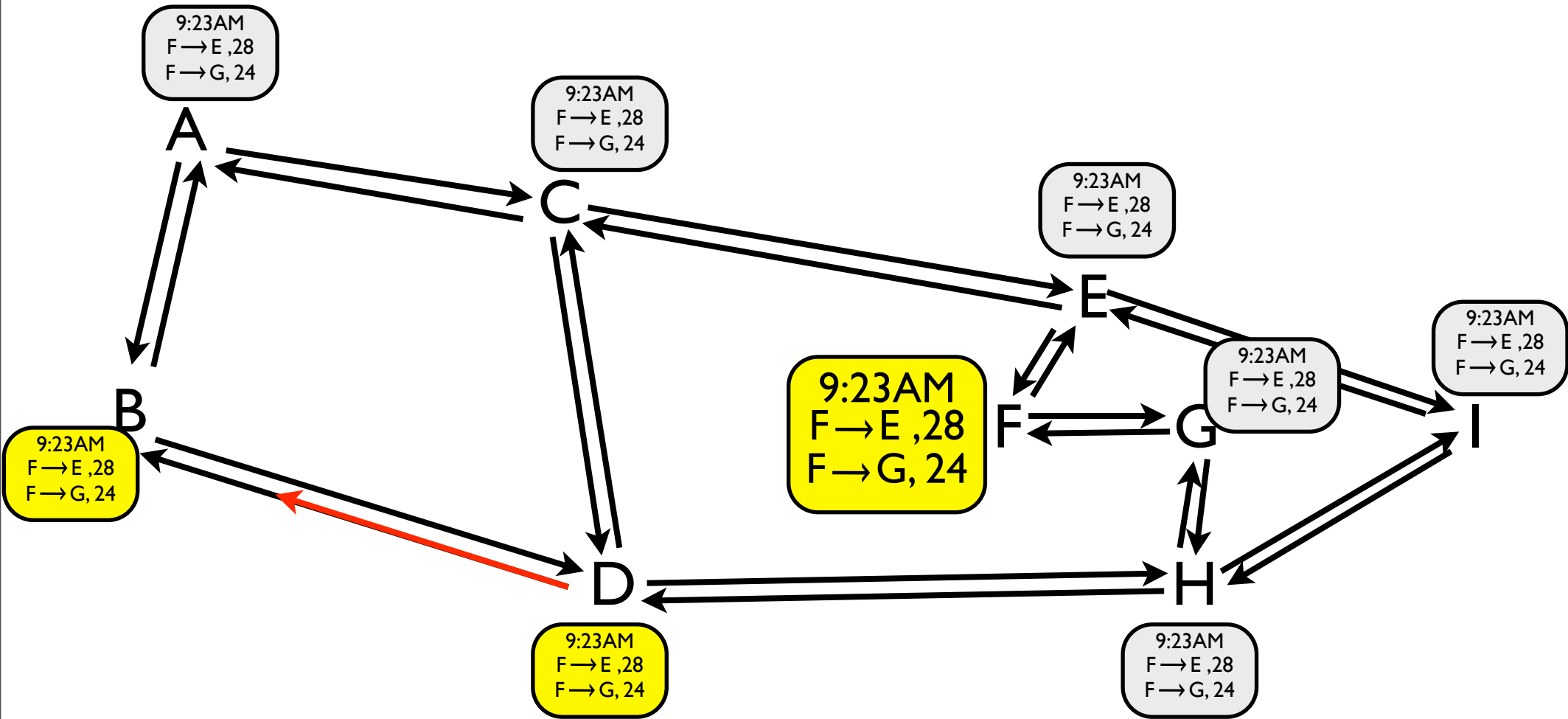
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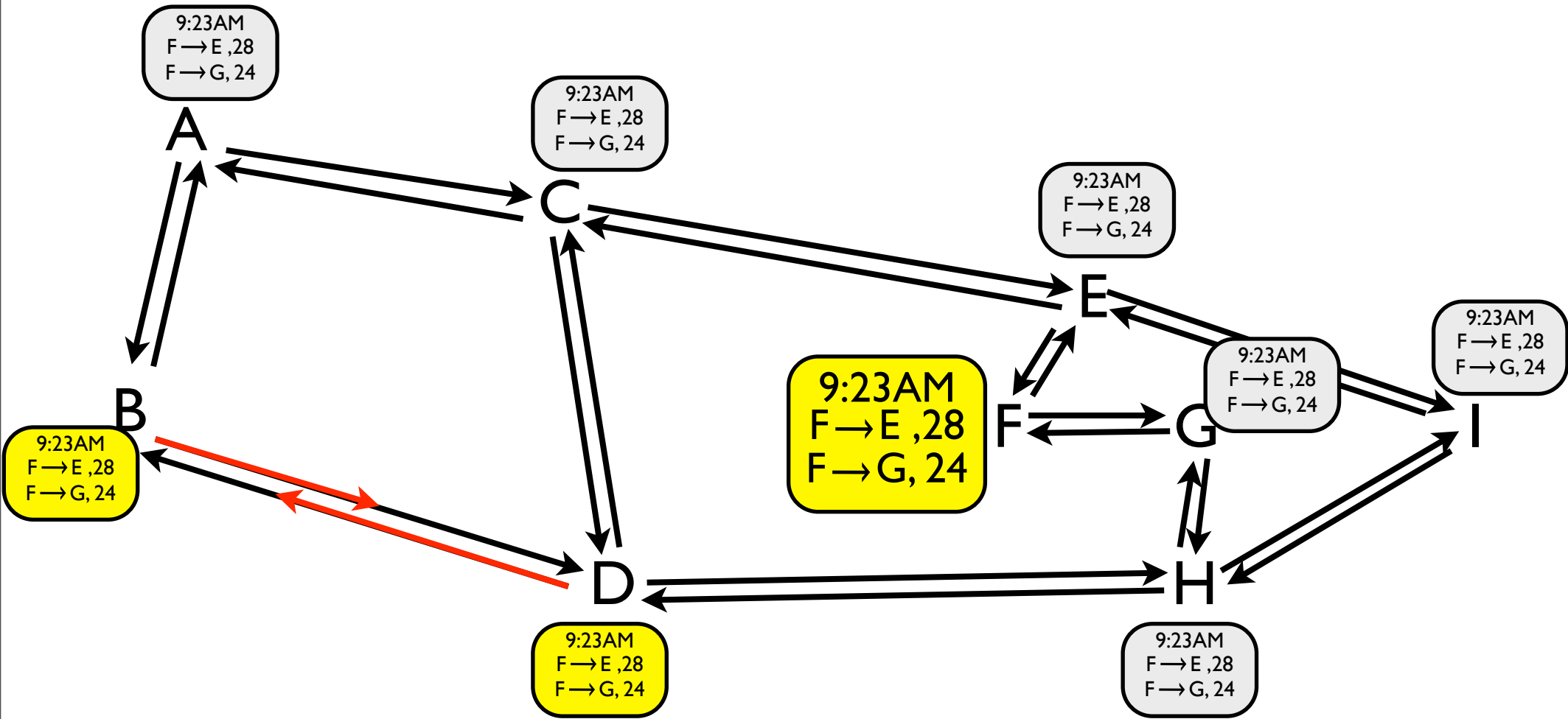
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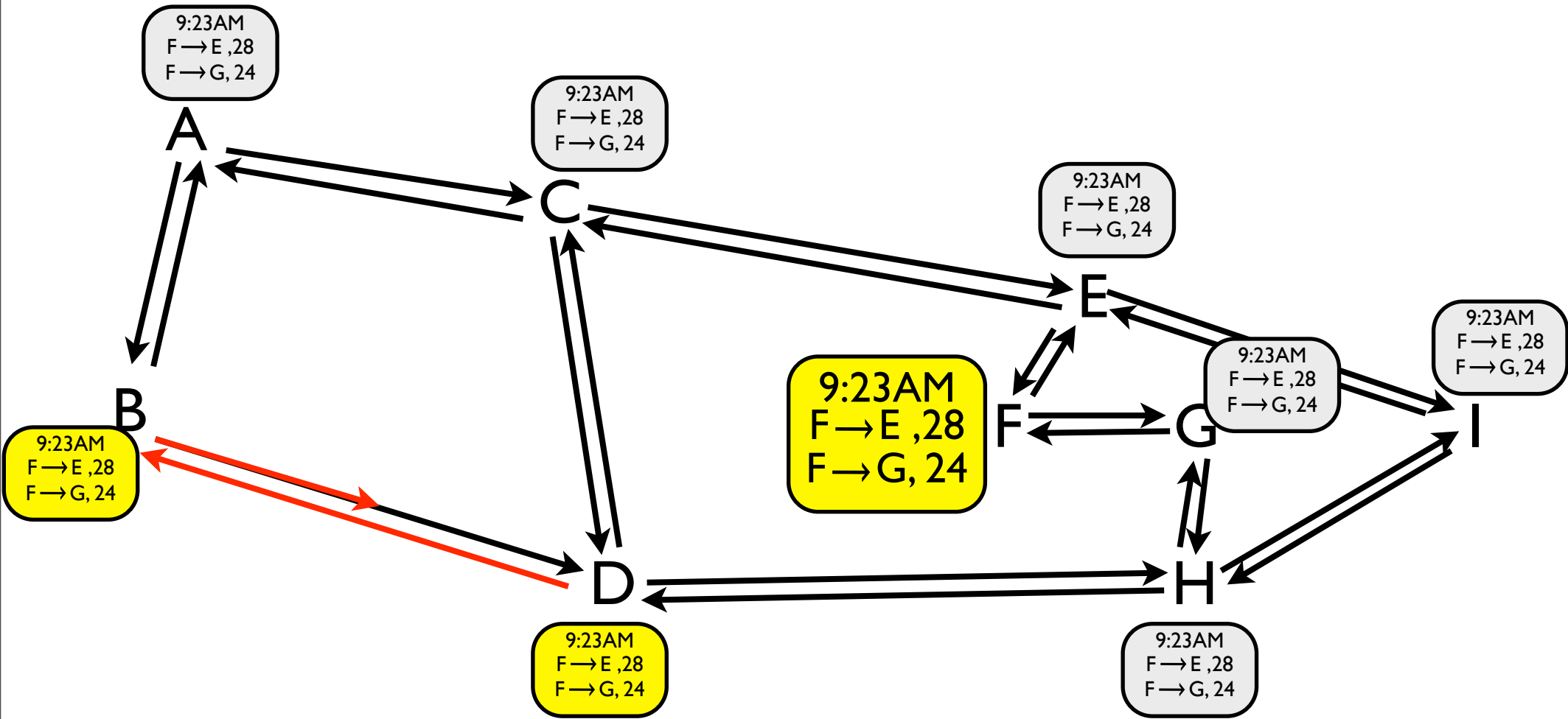
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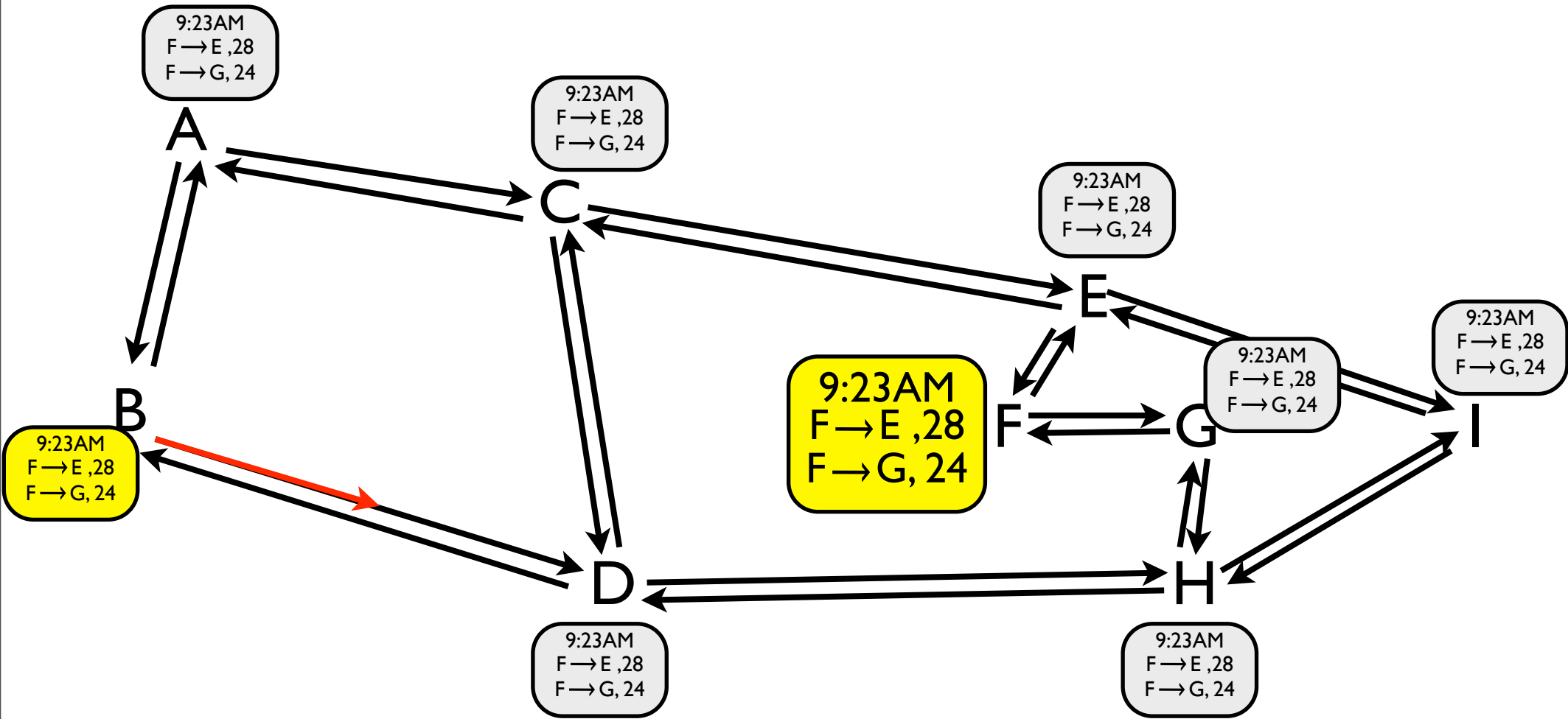
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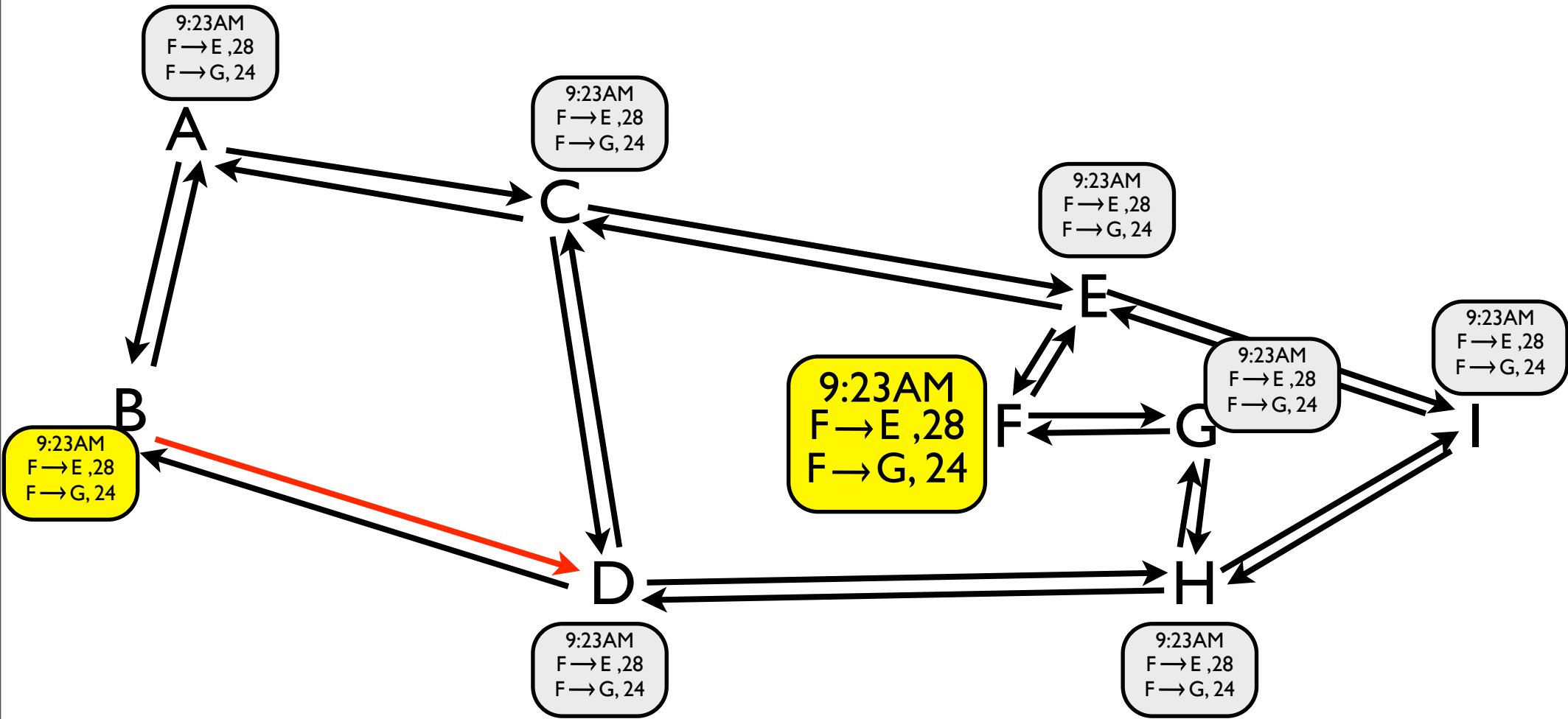
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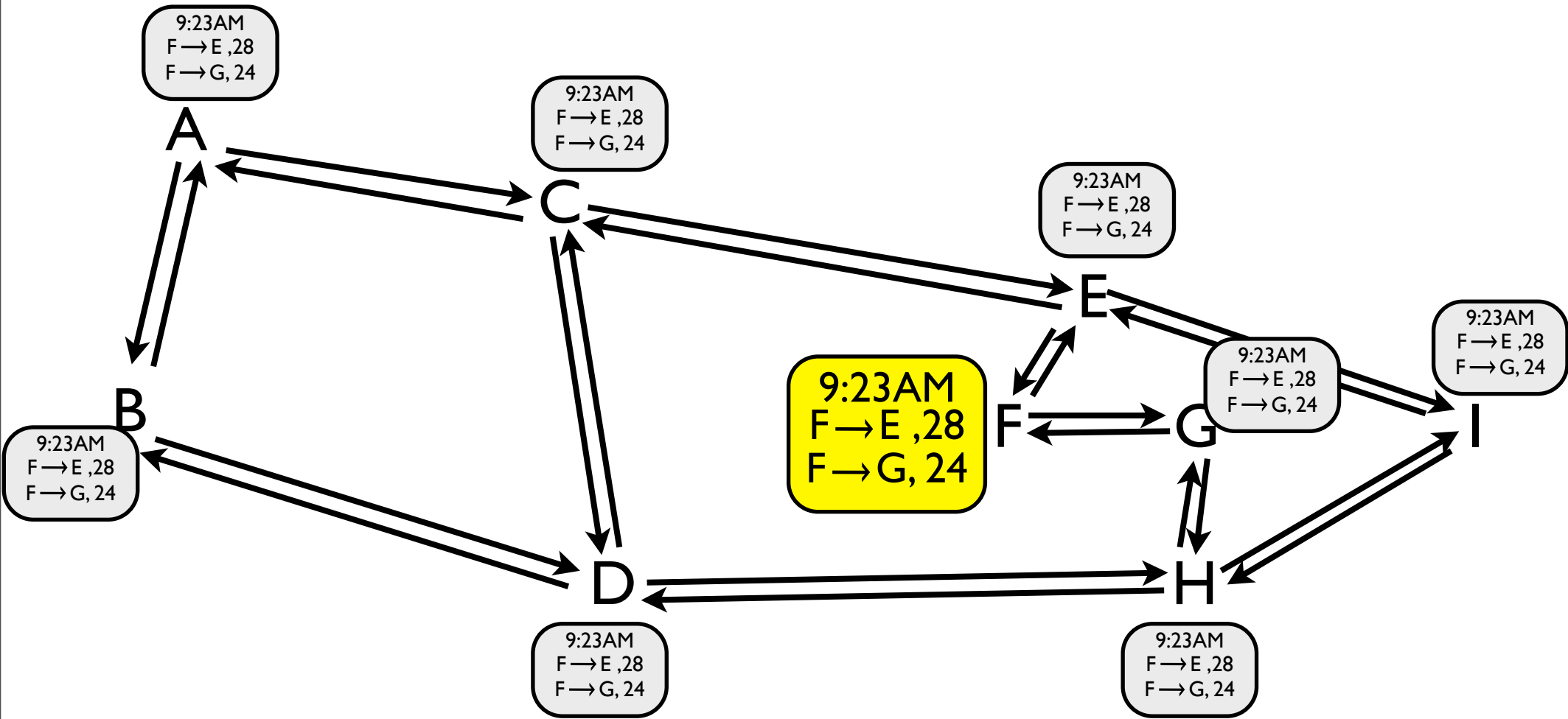
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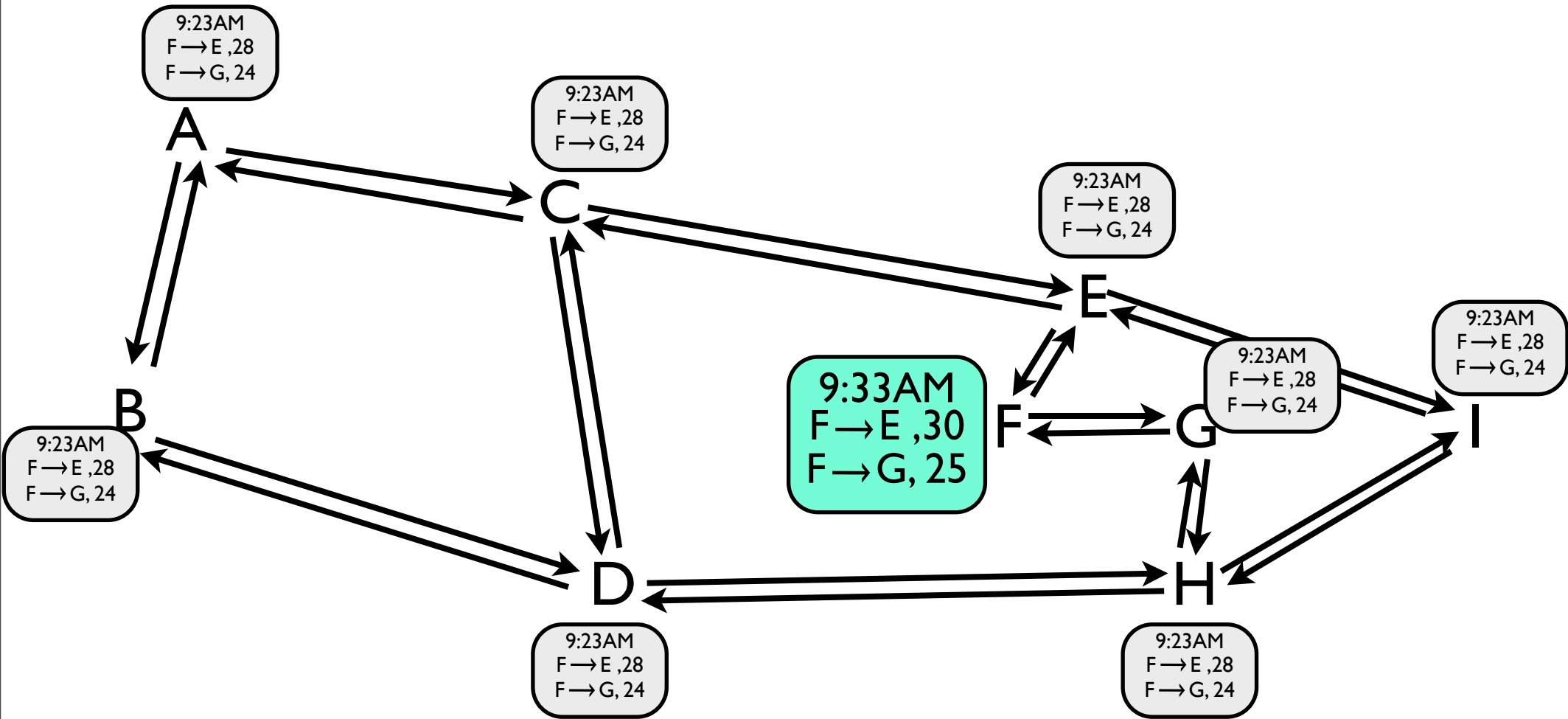
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Cities	Neighbors		
A	B 55	C 79	
B	A 55	D 48	
C	A 79	D 46	E 79
D	C 46	B 48	H 78
E	C 79	I 85	F 28
F	E 28	G 24	
G	F 24	H 20	
H	D 78	I 60	
I	H 34	E 85	

Edsger W. Dijkstra



Cities/ Routers	Best route length	First step	Status (Distant, Adjacent, Known)	Neighbors		
A			Distant	B 55	C 79	
B			Distant	A 55	D 48	
C			Distant	A 79	D 46	E 79
D			Distant	C 46	B 48	H 78
E			Distant	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	

Dijkstra's Shortest Path First Algorithm

- Mark starting point as “Known” with length 0.
- Identify each neighbor of start as “Adjacent”.
- Set first step of each neighbor of start to itself.
- Set route length of each neighbor to one step distance.
- While you don't know how to reach all destinations:
 - ▶ Select adjacent destination with shortest route.
 - ▶ Identify adjacent dest. with shortest route as “Known”.
 - ▶ For each neighbor of new “Known” destination:
 - Mark neighbors that were “Distant” as “Adjacent” and update path lengths and first steps.

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B			Distant	A 55	D 48	
C			Distant	A 79	D 46	E 79
D			Distant	C 46	B 48	H 78
E			Distant	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	

Adjacent = where you can get in one step from “known”.

Routers	Best route length	First step	Status	Neighbors		
A*	0	-	Known	B 55	C 79	
B			Distant Adjacent	A 55	D 48	
C			Distant Adjacent	A 79	D 46	E 79
D			Distant	C 46	B 48	H 78
E			Distant	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	

Record how long these one step paths would take.

Routers	Best route length	First step	Status	Neighbors		
A*	0	-	Known	B 55	C 79	
B	55		Adjacent	A 55	D 48	
C	79		Adjacent	A 79	D 46	E 79
D			Distant	C 46	B 48	H 78
E			Distant	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	

Record first step along each of these paths.

Routers	Best route length	First step	Status	Neighbors		
A*	0	-	Known	B 55	C 79	
B	55	B	Adjacent	A 55	D 48	
C	79	C	Adjacent	A 79	D 46	E 79
D			Distant	C 46	B 48	H 78
E			Distant	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	

Select adjacent destination with shortest route

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Adjacent	A 55	D 48	
C	79	C	Adjacent	A 79	D 46	E 79
D			Distant	C 46	B 48	H 78
E			Distant	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	

Select adjacent destination with shortest route

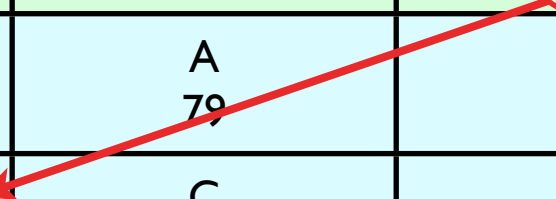
Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B*	55	B	Adjacent	A 55	D 48	
C	79	C	Adjacent	A 79	D 46	E 79
D			Distant	C 46	B 48	H 78
E			Distant	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	

Identify adjacent dest. with shortest route as “Known”

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B*	55	B	Known	A 55	D 48	
C	79	C	Adjacent	A 79	D 46	E 79
D			Distant	C 46	B 48	H 78
E			Distant	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	

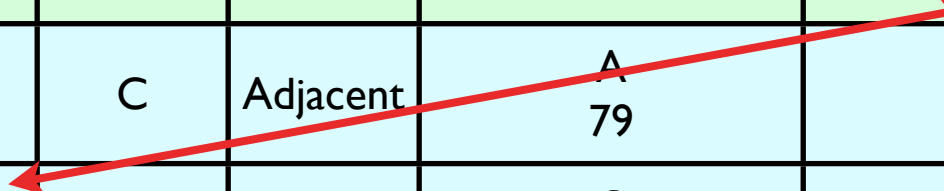
Adjacent = where you can get in one step from “known”.

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B*	55	B	Known	A 55	D 48	
C	79	C	Adjacent	A 79	D 46	E 79
D			Distant Adjacent	C 46	B 48	H 78
E			Distant	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	



Update path length by adding path length and last step.

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B*	55	B	Known	A 55	D 48	
C	79	C	Adjacent	A 79	D 46	E 79
D	55 + 48		Adjacent	C 46	B 48	H 78
E			Distant	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	



Record first step of path.

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B*	55	B	Known	A 55	D 48	
C	79	C	Adjacent	A 79	D 46	E 79
D	103	B	Adjacent	C 46	B 48	H 78
E			Distant	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	

Select adjacent destination with shortest route

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Adjacent	A 79	D 46	E 79
D	103	B	Adjacent	C 46	B 48	H 78
E			Distant	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	

Select adjacent destination with shortest route

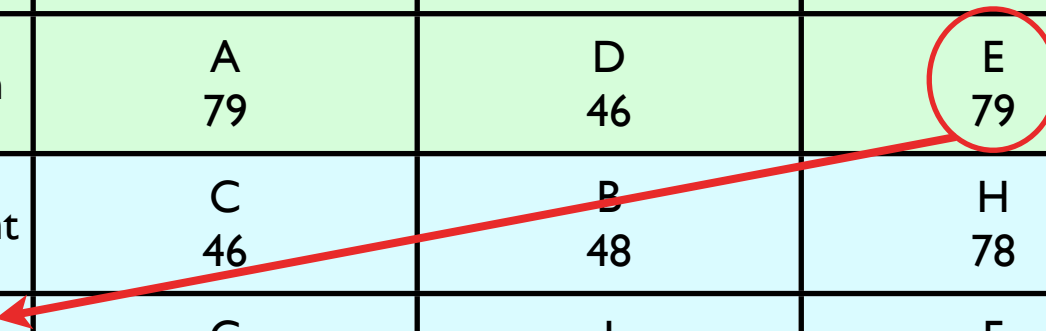
Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C*	79	C	Adjacent	A 79	D 46	E 79
D	103	B	Adjacent	C 46	B 48	H 78
E			Distant	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	

Identify adjacent dest. with shortest route as “Known”

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C*	79	C	Adjacent Known	A 79	D 46	E 79
D	103	B	Adjacent	C 46	B 48	H 78
E			Distant	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	

Adjacent = where you can get in one step from “known”.

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C*	79	C	Known	A 79	D 46	E 79
D	103	B	Adjacent	C 46	B 48	H 78
E			Distant Adjacent	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	



Record path length and record first step.

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C*	79	C	Known	A 79	D 46	E 79
D	103	B	Adjacent	C 46	B 48	H 78
E	79 + 79	C	Adjacent	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	

Check lengths to other “Adjacent” neighbors ($103 < 79+46$).

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C*	79	C	Known	A 79	D 46	E 79
D	103	B	Adjacent	C 46	B 48	H 78
E	158	C	Adjacent	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	



Select adjacent destination with shortest route

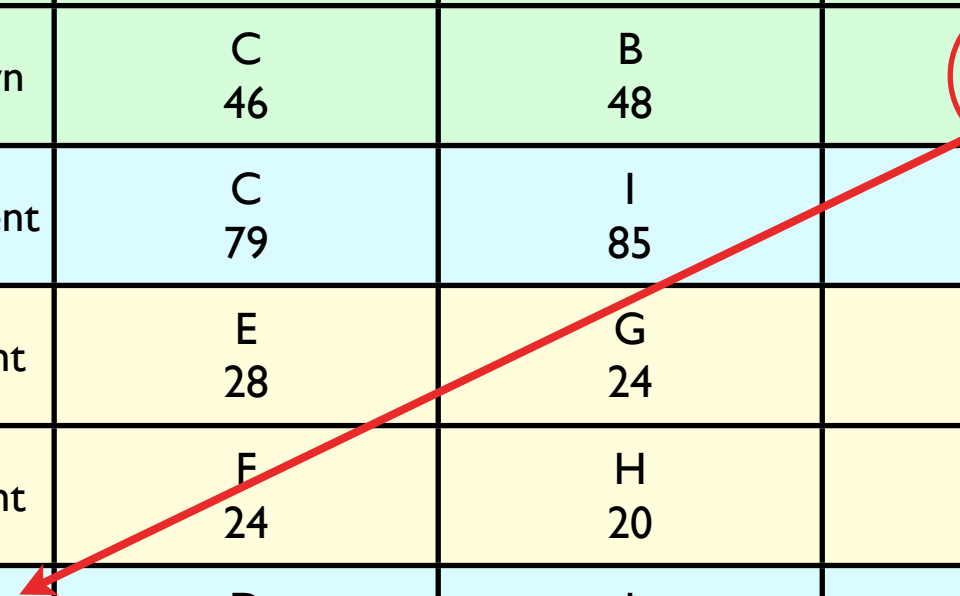
Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Adjacent	C 46	B 48	H 78
E	158	C	Adjacent	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	

Identify adjacent dest. with shortest route as “Known”

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D*	103	B	Adjacent Known	C 46	B 48	H 78
E	158	C	Adjacent	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant	D 78	I 60	
I			Distant	H 34	E 85	

Adjacent = where you can get in one step from “known”.

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D*	103	B	Known	C 46	B 48	H 78
E	158	C	Adjacent	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H			Distant Adjacent	D 78	I 60	
I			Distant	H 34	E 85	



Record path (s) and record first step(s).

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D*	103	B	Known	C 46	B 48	H 78
E	158	C	Adjacent	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H	103+78	B	Adjacent	D 78	I 60	
I			Distant	H 34	E 85	

Select adjacent destination with shortest route

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E	158	C	Adjacent	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H	181	B	Adjacent	D 78	I 60	
I			Distant	H 34	E 85	

Identify adjacent dest. with shortest route as “Known”

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E*	158	C	Adjacent Known	C 79	I 85	F 28
F			Distant	E 28	G 24	
G			Distant	F 24	H 20	
H	181	B	Adjacent	D 78	I 60	
I			Distant	H 34	E 85	

Adjacent = where you can get in one step from “known”.

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E*	158	C	Known	C 79	I 85	F 28
F			Distant Adjacent	E 28	G 24	
G			Distant	F 24	H 20	
H	181	B	Adjacent	D 78	I 60	
I			Distant Adjacent	H 34	E 85	

Record path lengths and record first steps.

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E*	158	C	Known	C 79	I 85	F 28
F	158+28	C	Adjacent	E 28	G 24	
G			Distant	F 24	H 20	
H	181	B	Adjacent	D 78	I 60	
I	158+85	C	Adjacent	H 34	E 85	

The diagram illustrates the process of calculating the best route length and determining the first step for each router. Red arrows show the path from router A (0) to E* (158) to F (158+28) to I (158+85). Blue arrows show the first step for each router: A (-), B (B), C (C), D (B), E* (C), F (C), G (empty), H (B), I (C).

Select adjacent destination with shortest route

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E	158	C	Known	C 79	I 85	F 28
F	186	C	Adjacent	E 28	G 24	
G			Distant	F 24	H 20	
H	181	B	Adjacent	D 78	I 60	
I	243	C	Adjacent	H 34	E 85	

Identify adjacent dest. with shortest route as “Known”

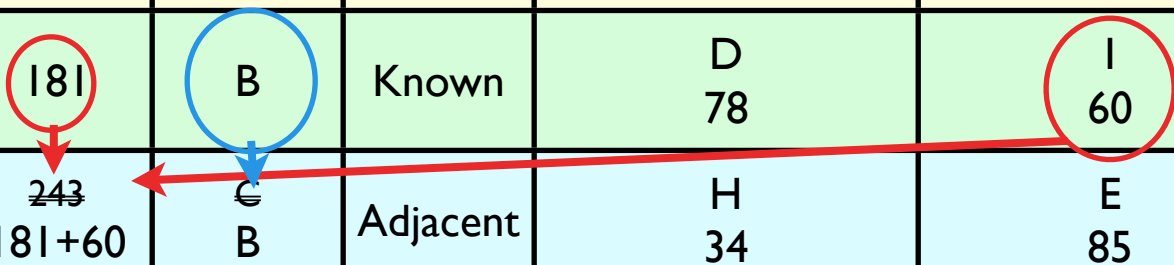
Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E	158	C	Known	C 79	I 85	F 28
F	186	C	Adjacent	E 28	G 24	
G			Distant	F 24	H 20	
H*	181	B	Adjacent Known	D 78	I 60	
I	243	C	Adjacent	H 34	E 85	

Adjacent = where you can get in one step from “known”.

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E	158	C	Known	C 79	I 85	F 28
F	186	C	Adjacent	E 28	G 24	
G			Distant	F 24	H 20	
H*	181	B	Known	D 78	I 60	
I	243	C	Adjacent	H 34	E 85	

Record Update path lengths and record first steps.

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E	158	C	Known	C 79	I 85	F 28
F	186	C	Adjacent	E 28	G 24	
G			Distant	F 24	H 20	
H*	181	B	Known	D 78	I 60	
I	243 181+60	C B	Adjacent	H 34	E 85	



Select adjacent destination with shortest route

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E	158	C	Known	C 79	I 85	F 28
F	186	C	Adjacent	E 28	G 24	
G			Distant	F 24	H 20	
H	181	B	Known	D 78	I 60	
I	241	B	Adjacent	H 34	E 85	

Identify adjacent dest. with shortest route as “Known”

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E	158	C	Known	C 79	I 85	F 28
F*	186	C	Adjacent Known	E 28	G 24	
G			Distant	F 24	H 20	
H	181	B	Known	D 78	I 60	
I	241	B	Adjacent	H 34	E 85	

Adjacent = where you can get in one step from “known”.

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E	158	C	Known	C 79	I 85	F 28
F*	186	C	Known	E 28	G 24	
G			Distant Adjacent	F 24	H 20	
H	181	B	Known	D 78	I 60	
I	241	B	Adjacent	H 34	E 85	

Update path lengths and record first steps.

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E	158	C	Known	C 79	I 85	F 28
F*	186	C	Known	E 28	G 24	
G	186+24	C	Adjacent	F 24	H 20	
H	181	B	Known	D 78	I 60	
I	241	B	Adjacent	H 34	E 85	



Select adjacent destination with shortest route

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E	158	C	Known	C 79	I 85	F 28
F	186	C	Known	E 28	G 24	
G*	210	C	Adjacent	F 24	H 20	
H	181	B	Known	D 78	I 60	
I	241	B	Adjacent	H 34	E 85	

Identify adjacent dest. with shortest route as “Known”

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E	158	C	Known	C 79	I 85	F 28
F	186	C	Known	E 28	G 24	
G*	210	C	Adjacent Known	F 24	H 20	
H	181	B	Known	D 78	I 60	
I	241	B	Adjacent	H 34	E 85	

Adjacent = where you can get in one step from “known”.

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E	158	C	Known	C 79	I 85	F 28
F	186	C	Known	E 28	G 24	
G*	210	C	Known	F 24	H 20	
H	181	B	Known	D 78	I 60	
I	241	B	Adjacent	H 34	E 85	

Update path lengths and record first steps.

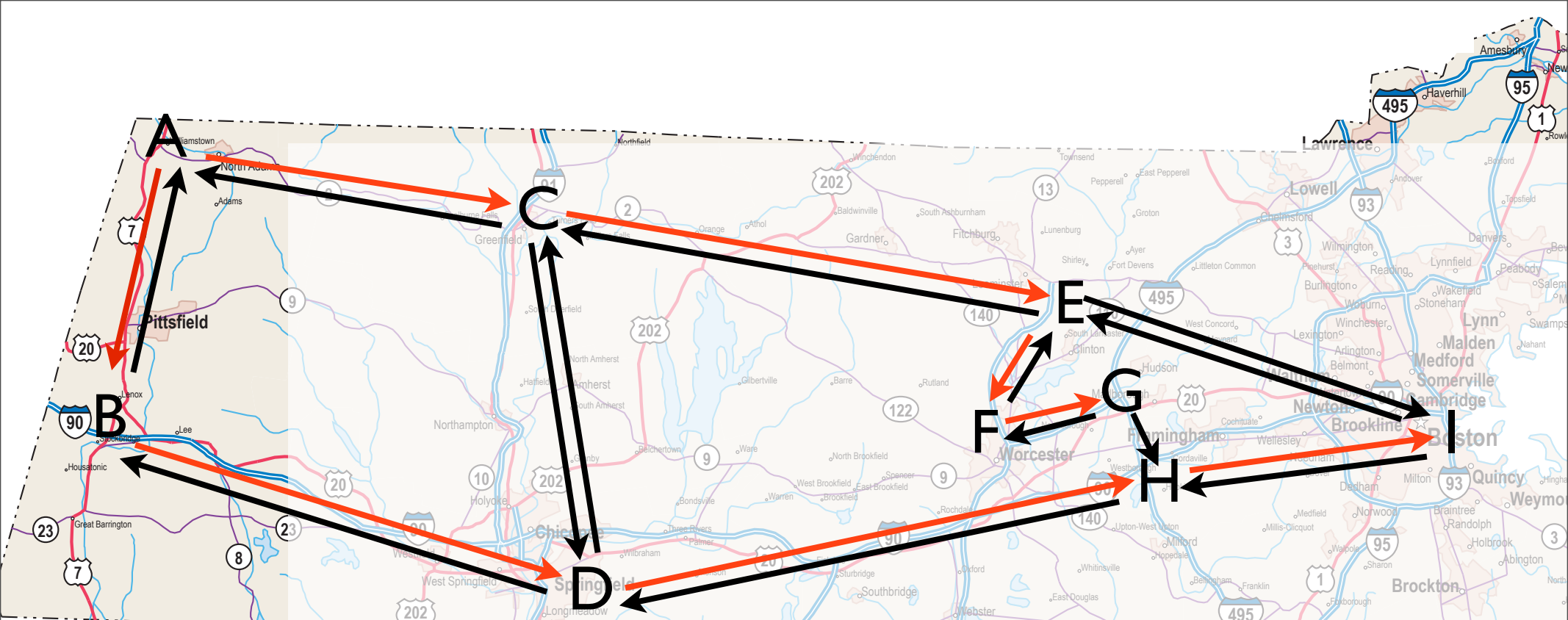
Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E	158	C	Known	C 79	I 85	F 28
F	186	C	Known	E 28	G 24	
G*	210	C	Known	F 24	H 20	
H	181	B	Known	D 78	I 60	
I	241	B	Adjacent	H 34	E 85	

Select adjacent destination with shortest route

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E	158	C	Known	C 79	I 85	F 28
F	186	C	Known	E 28	G 24	
G	210	C	Known	F 24	H 20	
H	181	B	Known	D 78	I 60	
I	241	B	Adjacent	H 34	E 85	

Identify adjacent dest. with shortest route as “Known”

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E	158	C	Known	C 79	I 85	F 28
F	186	C	Known	E 28	G 24	
G	210	C	Known	F 24	H 20	
H	181	B	Known	D 78	I 60	
I*	241	B	Adjacent Known	H 34	E 85	



Routers	Route length	First step	Status	Neighbors		
A	0	-	K	B 55	C 79	
B	55	B	K	A 55	D 48	
C	79	C	K	A 79	D 46	E 79
D	103	B	K	C 46	B 48	H 78
E	158	C	K	C 79	I 85	F 28
F	186	C	K	E 28	G 24	
G	210	C	K	F 24	H 20	
H	181	B	K	D 78	I 60	
I	241	B	K	H 34	E 85	

Routers	Best route length	First step	Status	Neighbors		
A	0	-	Known	B 55	C 79	
B	55	B	Known	A 55	D 48	
C	79	C	Known	A 79	D 46	E 79
D	103	B	Known	C 46	B 48	H 78
E	158	C	Known	C 79	I 85	F 28
F	186	C	Known	E 28	G 24	
G	210	C	Known	F 24	H 20	
H	181	B	Known	D 78	I 60	
I*	241	B	Adjacent Known	H 34	E 85	

Routers	Best route length	First step
A	0	-
B	55	B
C	79	C
D	103	B
E	158	C
F	186	C
G	210	C
H	181	B
I*	241	B

Routers	First step
A	-
B	B
C	C
D	B
E	C
F	C
G	C
H	B
I*	B

Dijkstra's Shortest Path First Algorithm

- Mark starting point as “Known” with length 0.
- Identify each neighbor of start as “Adjacent”.
- Set first step of each neighbor of start to itself.
- Set route length of each neighbor to one step distance.
- While you don't know how to reach all destinations:
 - ▶ Select adjacent destination with shortest route.
 - ▶ Identify adjacent dest. with shortest route as “Known”.
 - ▶ For each neighbor of new “Known” destination:
 - Mark neighbors that were “Distant” as “Adjacent” and update path lengths and first steps.