Handout #25
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Winter 98-99

EE384A: Network Protocols and Standards
Homework #4 - Solutions
OSPF

Question 1

1a) RT10 link state advertisements (without configured areas)

RT10: Router Links Advertisements

LS age = 0
Options = T | E
LS type = 1
Link State ID = 192.1.5.10
Advertising Router = 192.1.5.10
bit E = 0
bit B = 0
links = 4

Link ID = 192.1.5.10 ;link to N6
Link Data = 192.1.5.10
Type = 2;
# other metrics = 0
TOS 0 metric = 1

Link ID = 192.1.7.11 ;link to N8
Link Data = 192.1.7.10
Type = 2;
# other metrics = 0
TOS 0 metric = 3

Link ID = 18.10.0.6 ;p-p to RT6
Link Data = 0.0.0.10
Type = 1;
# other metrics = 0
TOS 0 metric = 5

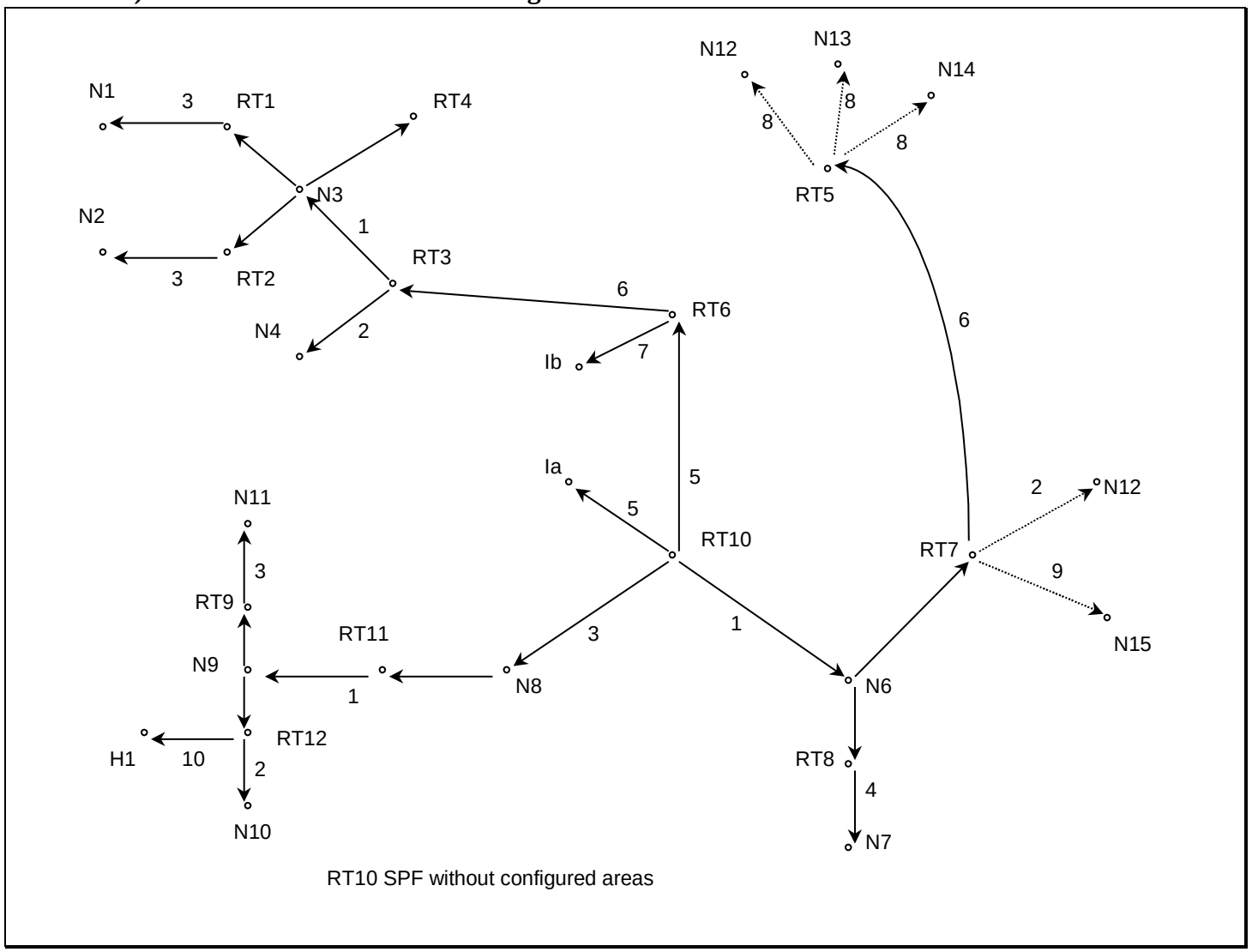
Link ID = Ia's IP address ;link to a stub network
Link Data = 0xffffff00
Type = 3;
# other metrics = 0
TOS 0 metric = 5

RT10: Network Link Advertisement for N6

LS age = 0
Options = T | E
LS type = 2
Link State ID = 192.1.5.10
Advertising Router = 192.1.5.10
Network mask = 0xffffff00
Attached Router = 192.1.5.10
Attached Router = 192.1.5.7
Attached Router = 192.1.5.8

No Summary link advertisements sent by RT10 since there is no configured area.
No External link advertisements either since RT10 is not a AS boundary router.

1b) SPF tree for RT10 without configured area



RT10 SPF without configured areas

1c) RT10's Routing Table without area configuration

Type	Destination	Area	Path-Type	Cost	Next Hop	Advertising Router
N	N1	0	intra-area	15	RT6	*
N	N2	0	intra-area	15	RT6	*
N	N3	0	intra-area	12	RT6	*
N	N4	0	intra-area	13	RT6	*
N	N6	0	intra-area	1	*	*
N	N7	0	intra-area	5	RT8	*
N	N8	0	intra-area	3	*	*
N	N9	0	intra-area	4	RT11	*
N	N10	0	intra-area	6	RT11	*
N	N11	0	intra-area	7	RT11	*
N	Ia	0	intra-area	5	*	*
N	Ib	0	intra-area	12	RT6	*
N	H1	0	intra-area	14	RT11	*
ASBR	Rt5	0	intra-area	7	RT7	*
ASBR	Rt7	0	intra-area	1	*	*
N	N12	*	Type-1 Ext	3	*	RT7
N	N13	*	Type-1 Ext	15	RT7	RT5
N	N14	*	Type-1 Ext	15	RT7	RT5
N	N15	*	Type-1 Ext	10	*	RT7

Question 2

2a) RT10 link state advertisements (with configured areas)

RT10: Router Links Advertisements into Area 2

```
LS age = 0
Options = T | E
LS type = 1
Link State ID = 192.1.5.10
Advertising Router = 192.1.5.10
bit E = 0
bit B = 1
# links = 2
        Link ID = 192.1.5.10        ;link to N6
        Link Data = 192.1.5.10
        Type = 2;
        # other metrics = 0
        TOS 0 metric = 1

        Link ID = 192.1.7.11        ;link to N8
        Link Data = 192.1.7.10
        Type = 2;
        # other metrics = 0
        TOS 0 metric = 3
```

RT10: Router Links Advertisements into backbone

```
LS age = 0
Options = T | E
LS type = 1
Link State ID = 192.1.5.10
Advertising Router = 192.1.5.10
bit E = 0
bit B = 1
# links = 3
        Link ID = 18.10.0.6         ;p-p link to RT6
        Link Data = 0.0.0.10
        Type = 1;
        # other metrics = 0
        TOS 0, metric = 5

        Link ID = Ia's IP address   ;link to Ia
        Link Data = 0xffffff00
        Type = 3;
        # other metrics = 0
        TOS 0, metric = 5

        Link ID = 192.1.7.11        ;virtual link to RT11
        Link Data = 192.1.7.10
        Type = 4;
        # other metrics = 0
        TOS 0, metric = 3
```

RT10: Network Link Advertisement for N6 into Area2

LS age = 0
Options = T | E
LS type = 2
Link State ID = 192.1.5.10
Advertising Router = 192.1.5.10
Network mask = 0xffffff00
Attached Router = 192.1.5.10
Attached Router = 192.1.5.7
Attached Router = 192.1.5.8

RT10: Summary Links Advertisements

Network Links into backbone:

- for N6 into the backbone
  LS age = 0
  Options = T | E
  LS Type = 3
  LS ID = 192.1.5.0
  Advertising Router = 192.1.5.10
  TOS = 0, Metric = 1
- for N7 into the backbone
  LS age = 0
  Options = T | E
  LS Type = 3
  LS ID = 192.1.6.0
  Advertising Router = 192.1.5.10
  TOS = 0, Metric = 5
- for N8 into the backbone
  LS age = 0
  Options = T | E
  LS Type = 3
  LS ID = 192.1.7.0
  Advertising Router = 192.1.5.10
  TOS = 0, Metric = 3

ASBRs into Area 2

- for ASBR RT5 into Area 2
  LS age = 0
  Options = T | E
  LS Type = 4
  LS ID = RT5's ID
  Advertising Router = 192.1.5.10
  TOS = 0, Metric = 7 // Note that RT10 uses its link to RT7 through N6 to reach RT5

- for ASBR RT7 into Area 2
  LS age = 0
  Options = T | E
  LS Type = 4
  LS ID = RT7's ID
  Advertising Router = 192.1.5.10
  TOS = 0, Metric = 1 // Note that RT10 is using Area2 as a transit area to reach RT7

Network Links into Area 2

- for N1 into Area 2
  LS age = 0
  Options = T | E
  LS Type = 3
  LS ID = 192.1.2.0
  Advertising Router = 192.1.5.10
  TOS = 0, Metric = 15

- for N2 into Area 2
  LS age = 0
  Options = T | E
  LS Type = 3
  LS ID = 192.1.3.0
  Advertising Router = 192.1.5.10
  TOS = 0, Metric = 15

- for N3 into Area 2
  LS age = 0
  Options = T | E
  LS Type = 3
  LS ID = 192.1.1.0
  Advertising Router = 192.1.5.10
  TOS = 0, Metric = 12

- for N4 into Area 2
  LS age = 0
  Options = T | E
  LS Type = 3
  LS ID = 192.1.4.0
  Advertising Router = 192.1.5.10
  TOS = 0, Metric = 13

- for Ia and Ib into Area 2
  LS age = 0
  Options = T | E
  LS Type = 3
  LS ID = 18.10.0.6, 18.10.1.10 // The exact format is not given in the standard. But you can refer to the paragraph in summary link in the RFC regarding the condensation.
  Advertising Router = 192.1.5.10
  TOS = 0
  Metric = 5

- for N9-N11, H1 into Area 2
  LS age = 0
  Options = T | E
  LS Type = 3
  LS ID = H1 IP address
  192.1.8.0,
  192.1.9.0,
  192.1.10.0 // The exact format is not given in the RFC.
  Advertising Router = 192.1.5.10
  TOS = 0, Metric = 4

2b) Database for the three areas

Note that the database for Area 1 and the backbone are as given in the standard.

		FROM						
		RT1	RT2	RT3	RT4	RT5	RT7	N3
	RT1							0
	RT2							0
	RT3							0
*	RT4							0
*	RT5			14	8			
T	RT7			20	14			
O	N1	3						
*	N2		3					
*	N3	1	1	1	1			
	N4			2				
	Ia,Ib			20	27			
	N6			16	15			
	N7			20	19			
	N8			18	18			
	N9-N11,H1			29	36			
	N12					8	2	
	N13					8		
	N14					8		
	N15						9	

Figure 7: Area 1's Database.

		FROM							
		RT3	RT4	RT5	RT6	RT7	RT10	RT11	
	RT3				6				
	RT4			8					
	RT5		8		6	6			
	RT6	8		7			5		
	RT7			6					
*	RT10				7			2	
*	RT11						3		
T	N1	4	4						
O	N2	4	4						
*	N3	1	1						
*	N4	2	3						
	Ia						5		
	Ib				7				
	N6					1	1	3	
	N7					5	5	7	
	N8					4	3	2	
	N9-N11,H1							11	
	N12			8		2			
	N13			8					
	N14			8					
	N15					9			

Figure 8: The backbone's database.

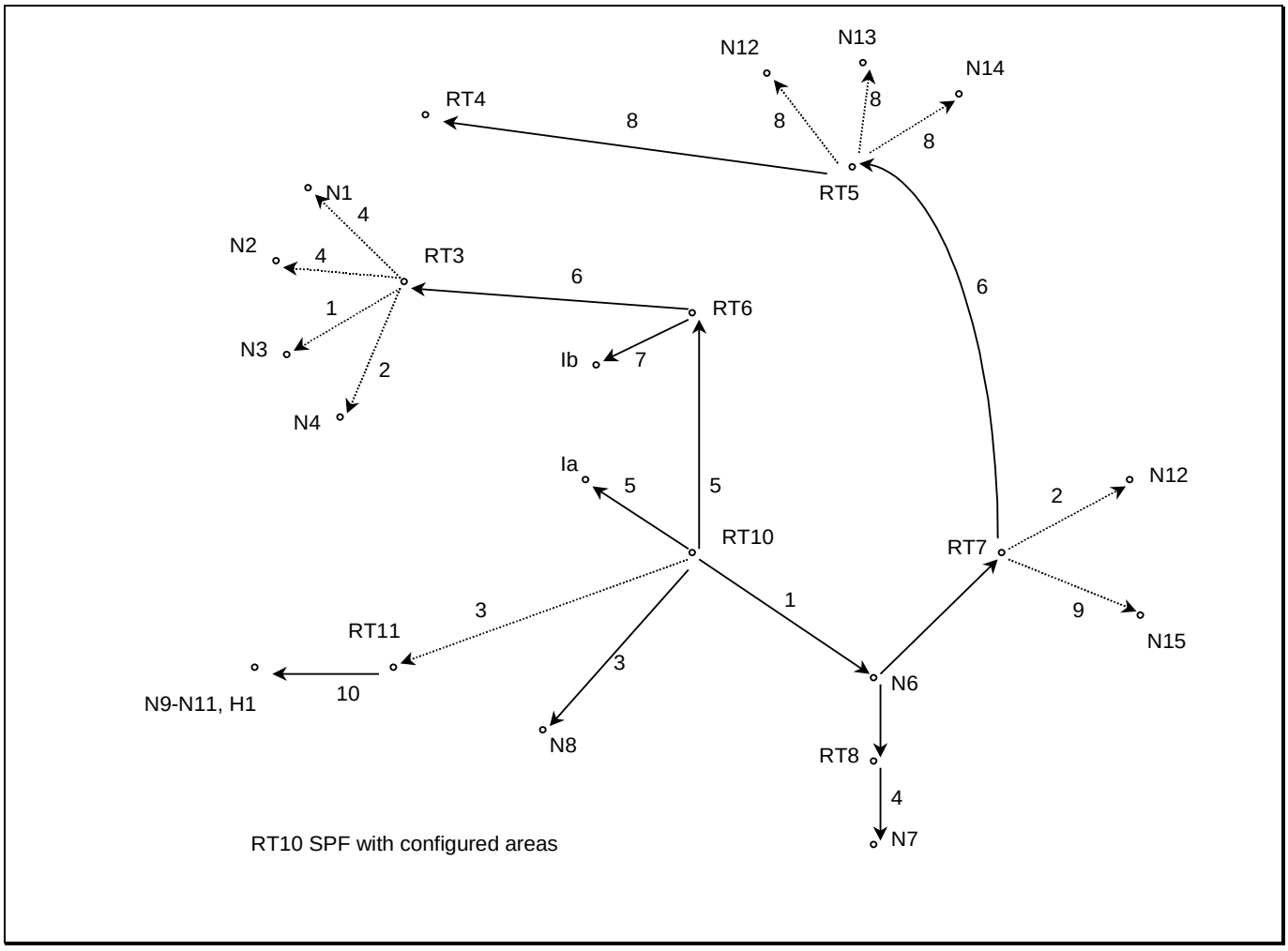
		FROM						
		RT5	RT7	RT8	RT10	RT11	N6	N8
	RT5		6		11			
	RT7				17		0	
*	RT8						0	
*	RT10						0	0
T	RT11							0
O	N1		18		15			
*	N2		18		15			
*	N3		15		12			
	N4		17		13			
	Ia,Ib		20		5			
	N6		1	1	1			
	N7			4				
	N8				3	2		
	N9-N11,H1					10		
	N12		2					
	N13							
	N14							
	N15		9					

Area 2's database

		FROM						
		RT5	RT7	RT9	RT11	RT12	N9	
	RT5				9			
	RT7				3			
*	RT9						0	
*	RT11						0	
T	RT12						0	
O	N1				17			
*	N2				17			
*	N3				14			
	N4				15			
	Ia,Ib				7			
	N6				3			
	N7				7			
	N8				2			
	N9			1		1		
	N10					2		
	N11			3				
	H1					10		
	N12	8	2					
	N13	8						
	N14	8						
	N15		9					

Area 3's database

2c) SPF tree for RT10



2d) RT10's Routing Table with area configuration

Type	Destination	Area	Path-Type	Cost	Next Hop	Advertising Router
N	N6	2	intra-area	1	*	*
N	N7	2	intra-area	5	Rt8	*
N	N8	2	intra-area	3	*	*
BR	Rt7	2	intra-area	1	*	*
BR	Rt11	2	intra-area	3	*	*
N	Ia	0	intra-area	5	*	*
N	Ib	0	intra-area	12	Rt6	*
BR	Rt3	0	intra-area	11	Rt6	*
BR	Rt4	0	intra-area	15	Rt7	*
BR	Rt7	0	intra-area	17	Rt6	*
BR	Rt11	0	intra-area	3	*	*
ASBR	Rt5	0	intra-area	7	Rt7	*
ASBR	Rt7	0	intra-area	1	Rt7	*
N	N1	0	inter-area	15	Rt6	Rt3
N	N2	0	inter-area	15	Rt6	Rt3
N	N3	0	inter-area	12	Rt6	Rt3
N	N4	0	inter-area	13	Rt6	Rt3
N	N9-N11, H1	0	inter-area	4	Rt11	Rt11
N	N12	*	Typy-1 Ext	3	Rt7	Rt7
N	N13	*	Type-1 Ext	15	Rt7	Rt5
N	N14	*	Typy-1 Ext	15	Rt7	Rt5
N	N15	*	Type-1 Ext	10	Rt7	Rt7