Exercise
for Lecture "P2P Systems"

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Exercise No. 7
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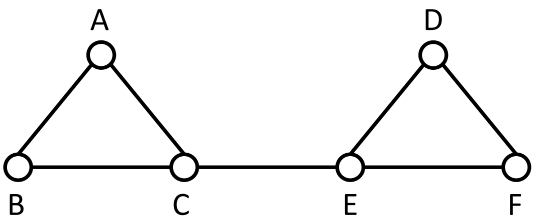
– Example Solution –

Problem 7.1 - Ad hoc On Demand Distance Vector Routing (AODV)

For this assignment, a topology of AODV nodes is given. Fill in the routing tables of each node for the given subtasks based on the sheet below.

A) A sends a Route Request asking for a route to node D. What do the routing tables look like after the Route Reply has arrived at node A?

B) Additionally, B sends a Route Request asking for a route to node D. What do the routing tables look like after the Route Reply has arrived at node B?



Node A			
Req-ID: 2		Loc. Seq. #: 5	
Dest.	Link	Hops	Seq. #
B	B	1	8
C	C	1	3

Node B			
Req-ID: 5		Loc. Seq. #: 8	
Dest.	Link	Hops	Seq. #
A	A	1	5
C	C	1	3

Node C			
Req-ID: 1		Loc. Seq. #: 3	
Dest.	Link	Hops	Seq. #
A	A	1	5
B	B	1	8
E	E	1	4

Node D			
Req-ID: 6		Loc. Seq. #: 12	
Dest.	Link	Hops	Seq. #
E	E	1	4
F	F	1	7

Node E			
Req-ID: 2		Loc. Seq. #: 4	
Dest.	Link	Hops	Seq. #
C	C	1	3
D	D	1	12
F	F	1	7

Node F			
Req-ID: 3		Loc. Seq. #: 7	
Dest.	Link	Hops	Seq. #
D	D	1	12
E	E	1	4

Solution:

After subtask A):
A increments Req.-ID and Loc. Seq. Number
A sends RREQ(IPA, 3, IPD, 6, 0, 0)
E increments Loc. Seq. Number
E sends RREP(IPA, IPD, 12, 1)
A and C add route

Node A			
Req-ID: 3		Loc. Seq. #: 6	
Dest.	Link	Hops	Seq. #
B	B	1	8
C	C	1	3
D	C	3	12

Node B			
Req-ID: 5		Loc. Seq. #: 8	
Dest.	Link	Hops	Seq. #
A	A	1	5
C	C	1	3

Node C			
Req-ID: 1		Loc. Seq. #: 3	
Dest.	Link	Hops	Seq. #
A	A	1	5
B	B	1	8
E	E	1	4
D	E	2	12

Node D			
Req-ID: 6		Loc. Seq. #: 12	
Dest.	Link	Hops	Seq. #
E	E	1	4
F	F	1	7

Node E			
Req-ID: 2		Loc. Seq. #: 5	
Dest.	Link	Hops	Seq. #
C	C	1	3
D	D	1	12
F	F	1	7

Node F			
Req-ID: 3		Loc. Seq. #: 7	
Dest.	Link	Hops	Seq. #
D	D	1	12
E	E	1	4

After subtask B):
B increments Req.-ID and Loc. Seq. Number
B sends RREQ(IPB, 6, IPD, 9, 0, 0)
A increments Loc. Seq. Number
A sends RREP(IPB, IPD, 12, 3)
C increments Loc. Seq. Number
C sends RREP(IPB, IPD, 12, 2)
B adds route from C (fewer number of hops)

Node A			
Req-ID: 3		Loc. Seq. #: 7	
Dest.	Link	Hops	Seq. #
B	B	1	8
C	C	1	3
D	C	3	12

Node B			
Req-ID: 6		Loc. Seq. #: 9	
Dest.	Link	Hops	Seq. #
A	A	1	5
C	C	1	3
D	C	3	12

Node C			
Req-ID: 1		Loc. Seq. #: 4	
Dest.	Link	Hops	Seq. #
A	A	1	5
B	B	1	8
E	E	1	4
D	E	2	12

Node D			
Req-ID: 6		Loc. Seq. #: 12	
Dest.	Link	Hops	Seq. #
E	E	1	4
F	F	1	7

Node E			
Req-ID: 2		Loc. Seq. #: 5	
Dest.	Link	Hops	Seq. #
C	C	1	3
D	D	1	12
F	F	1	7

Node F			
Req-ID: 3		Loc. Seq. #: 7	
Dest.	Link	Hops	Seq. #
D	D	1	12
E	E	1	4

Problem 7.2 - MADPastry

Given is a MADPastry network as shown below. The outer ring shows the Pastry ring, the inner nodes represent the physical topology of the network. Every node has an identifier (A|B), where A is the Pastry overlay ID (base 16) and B is the AODV ID (base 10) of the node. Nodes filled with equal patterns belong to the same cluster.

A) Mark the landmark nodes in the network shown below.

B) In the network, node 75A1 sends a message to node B822. The route taken by the message is marked with arrows. Mark the relevant routing table entries needed by node 75A1, B379, and 87A0 to determine the next hop.

Solution:

Pastry Routing Table (75A1)

Row 0				
	4	5	6	7
	-	-	-	78A2|10
	8	9	A	B
	88B1|53	-	-	~~B379|128~~

Leaf Set (75A1)

smaller	larger
7111|14	76B2|12

AODV Table (75A1)

Destination	NextHop
14	10
53	12
~~128~~	~~12~~

Pastry Routing Table (87A0)

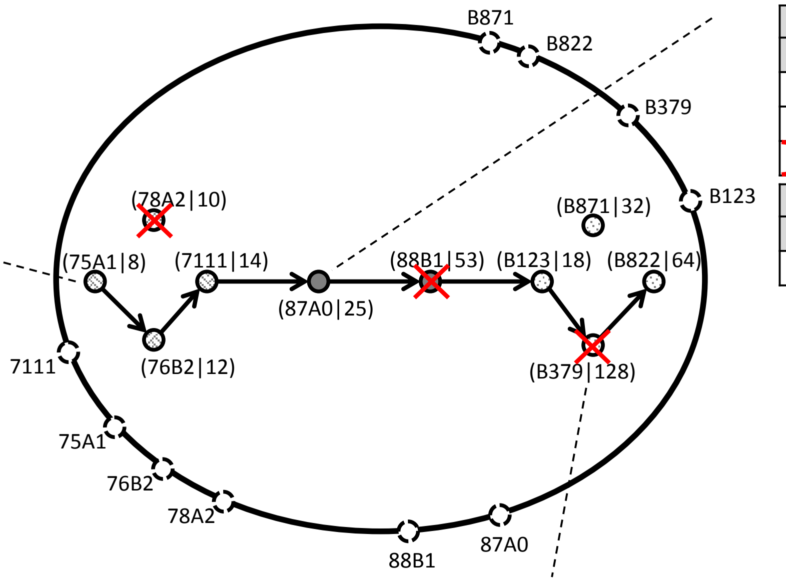
Row 0				
	4	5	6	7
	-	-	-	78A2|10
	8	9	A	B
	88B1|53	-	-	B379|128

AODV Table (87A0)

Destination	NextHop
18	53
10	14
~~128~~	~~53~~

Leaf Set (87A0)

smaller	larger
88B1|53	B123|18



Pastry Routing Table (B379)

Row 0				
	4	5	6	7
	-	-	-	78A2|10
	8	9	A	B
	88B1|53	-	-	B379|128

Leaf Set (B379)

smaller	larger
B123|18	~~B822|64~~

AODV Table (B379)

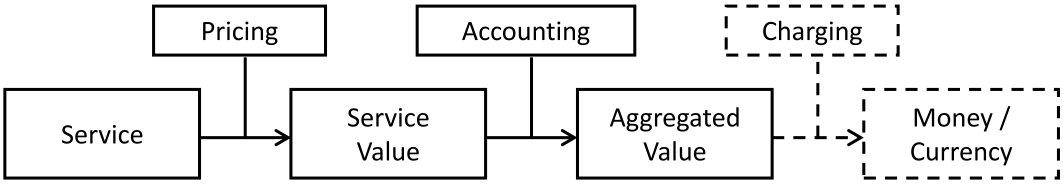
Destination	NextHop
18	18
53	18
~~64~~	~~64~~

Problem 7.3 - Incentive Patterns

A) Discuss advantages and disadvantages of barter trade patterns compared to bond based patterns with respect to trust and scalability.

Solution:
In the case of trade patterns, there is no need to trust third parties. Bond based patterns are usually based on trusted entities (e.g. Mojo Nation) or rely heavily on cryptography (e.g. Bit Coin), thus causing high overhead. Barter based patterns usually provide a better scalability, as the state can be kept local. Bond based patterns usually have to prevent double spending and forgery and have thus high transaction costs.

B) Describe the economic mechanisms depicted below. What is their respective purpose, how do they interact with each other.



Solution:
Pricing: Map service onto generic value representation
Accounting: Keep track of peer's balance over several transactions
Charging: Enable monetary settlement between peers and map aggregated value onto a monetary charge
Together, these mechanisms allow to price services, to pay for services, to aggregate value and to convert value into money.

Problem 7.4 - P2P Economics

In the lecture you learned about the *Prisoner's Dilemma* and how defective behavior might be the most rational choice to maximize a peer's own benefit under certain conditions.

Hint: For a prisoner's dilemma, the following condition holds: $T > R > P > S$ (T,R,P,S were defined in the lecture).

A) Consider a two peer scenario as introduced in the lecture. Assume a peer's utility $U_F = 5$ and costs $C_F = 2$.

   A) What would be the payoff matrix in this case?
   B) What would be the dominant strategy?

Solution:

A) Payoff matrix:

P_1; P_2	Cooperate	Defect
Cooperate	$R_1 = 3$; $R_2 = 3$	$S_1 = -2$; $T_2 = 5$
Defect	$T_1 = 5$; $S_2 = -2$	$P_1 = 0$; $P_2 = 0$

B) The dominant strategy would be defection as this maximizes the payoff for both peers. This is still a prisoner's dilemma.

B) Consider a scenario where a peer is paid from some third party for sharing/uploading a file. In this case, the costs could be negative if the third party pays enough. Assume the following values for a peer's utility and costs: $U_F = 2$ and $C_F = -1$.

   A) What would be the payoff matrix in this case?
   B) What would be the dominant strategy?
   C) Can this example be classified as prisoner's dilemma?

Solution:

A) Payoff matrix:

P_1; P_2	Cooperate	Defect
Cooperate	$R_1 = 3$; $R_2 = 3$	$S_1 = 1$; $T_2 = 2$
Defect	$T_1 = 2$; $S_2 = 1$	$P_1 = 0$; $P_2 = 0$

B) The dominant strategy would be cooperation as this maximizes the payoff for both peers.
C) No. The condition $T > R > P > S$ does not hold.