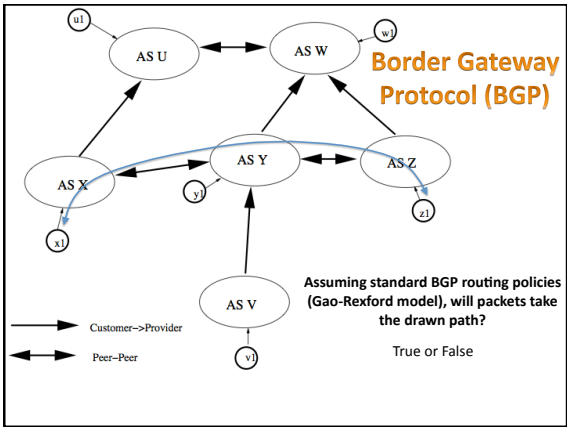
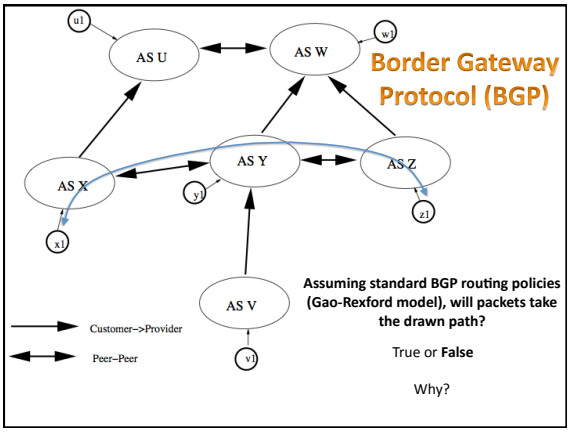
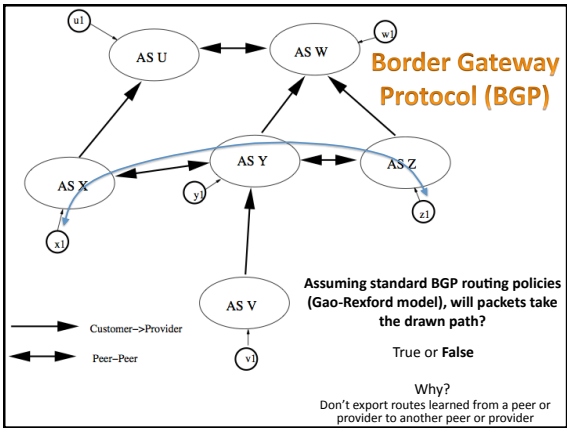
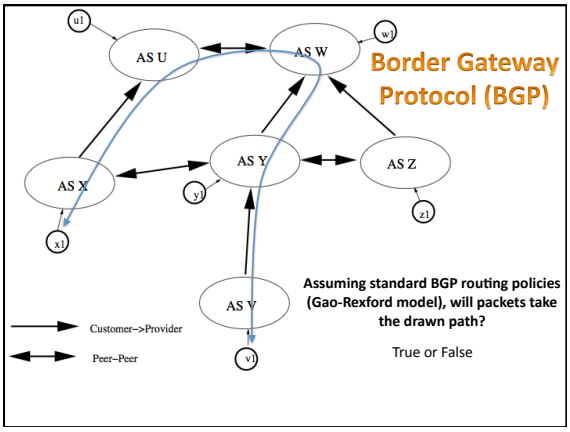
Recitation 5

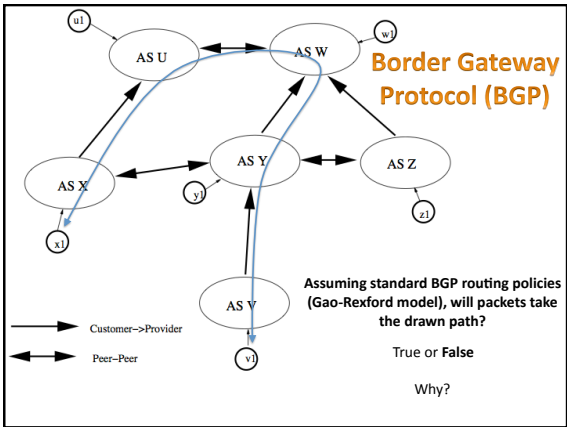
COS 461

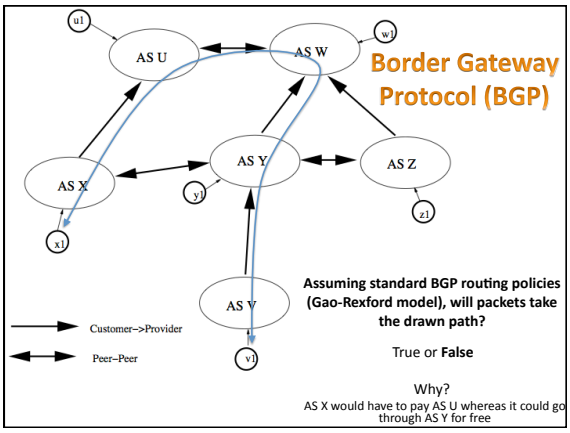


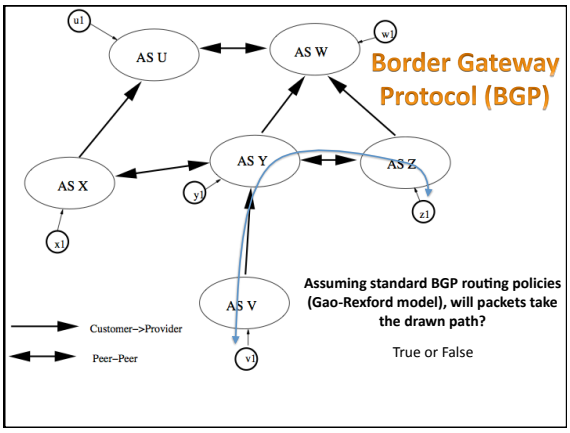









Border Gateway Protocol (BGP)
AS U
AS W
AS X
AS Y
AS Z
AS V
u1
w1
x1
y1
z1
v1
Customer–>Provider
Peer–Peer
Assuming standard BGP routing policies (Gao-Rexford model), will packets take the drawn path?
True or False
Why?
AS X would have to pay AS U whereas it could go through AS Y for free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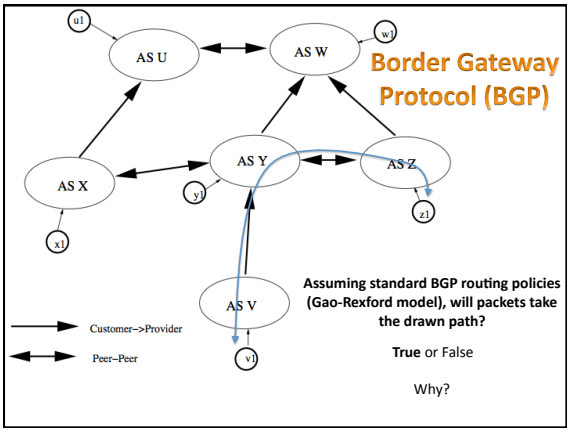
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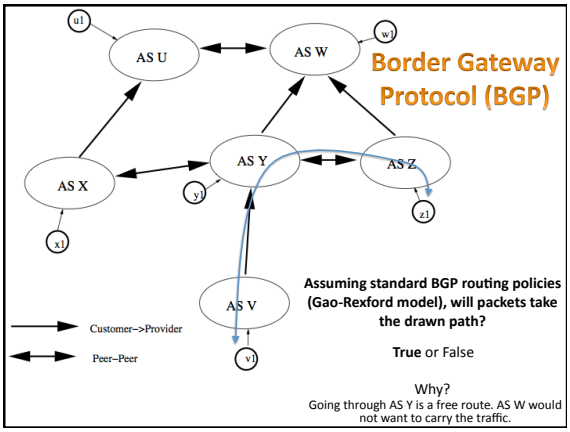
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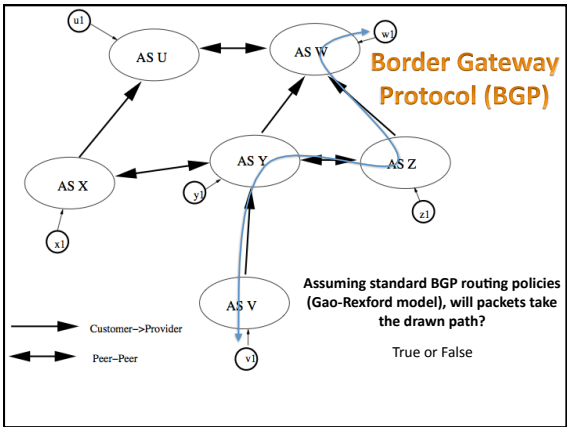
True or False
Why?
Going through AS Y is a free route. AS W would not want to carry the traffic.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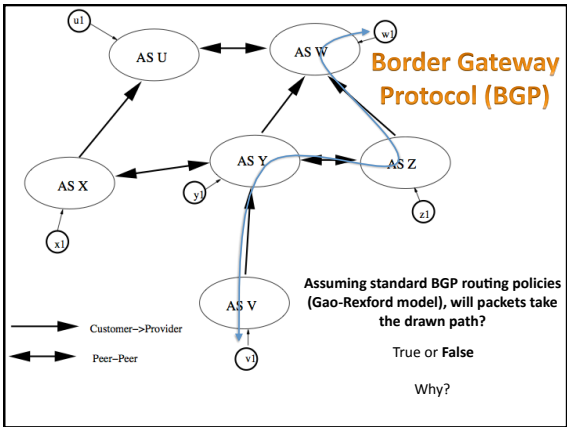
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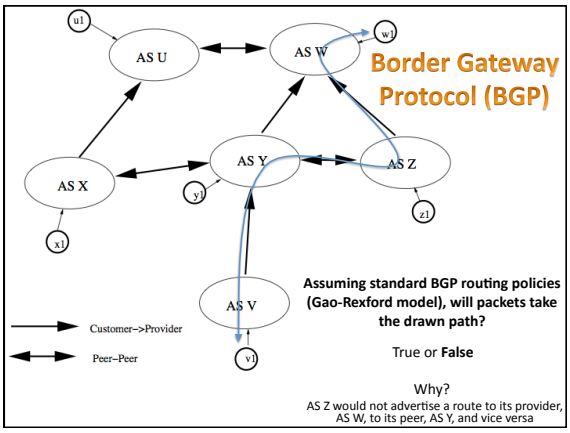
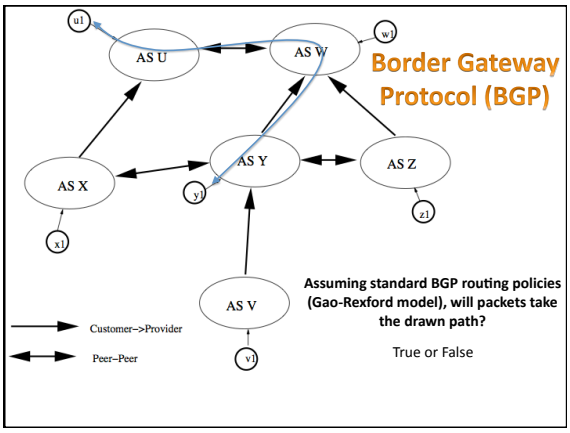
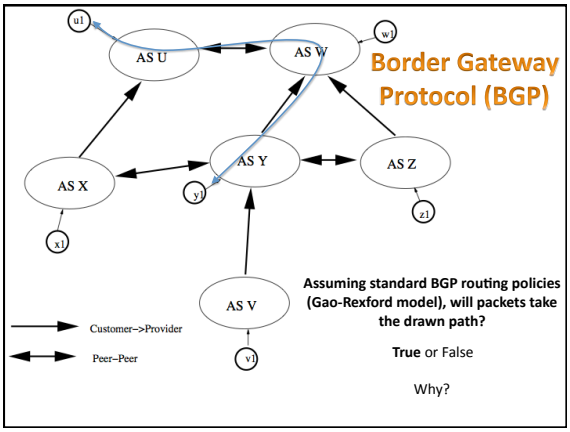
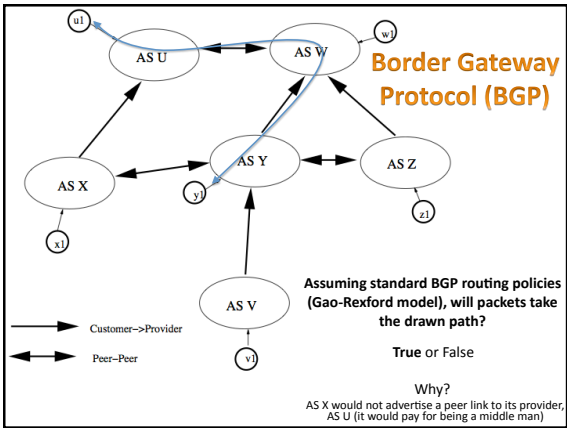
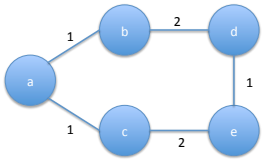






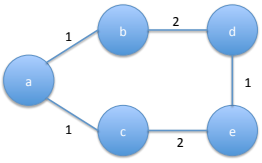


Routing Loops



If the link (c – e) fails, and the nodes run a link-state routing protocol, can a *temporary* forwarding loop occur? If so, which node pairs may see their traffic loop?

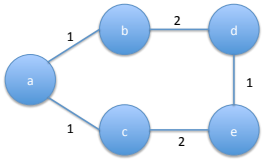
Routing Loops



Nodes *a*, *c*, *d*, and *e* could potentially see their outgoing packets loop.

a → e c <-> e d → c

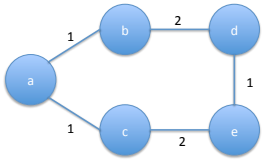
Routing Loops



Suppose network operator Olivia decides to bring down the link c – e for maintenance. Olivia figures she can issue a series of link weight changes in the network to shift traffic away from c – e such that no *temporary* forwarding loops occur.

She's right; what series of changes to c – e's weight would achieve this?

Routing Loops



Change c – e weight to 4.

a to e moves to a – b.

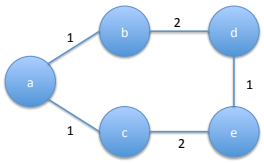
c to e remains on c – e.

d to c moves to d – b.

e to c remains on c – e.

c to d?

Routing Loops



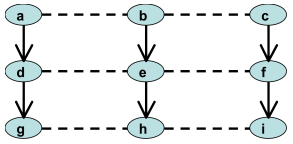
Change c – e weight to 6.

c to e moves to c – a.

e to c moves to e – d.

No traffic left on c – e. Olivia can bring down the link.

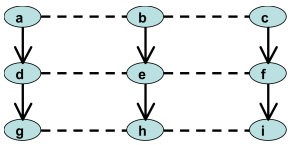
BGP Routing



1. Which of the following paths to d are valid?

(a) b->a->d
(b) h->e->d
(c) f->e->d
(d) c->b->e->d

BGP Routing



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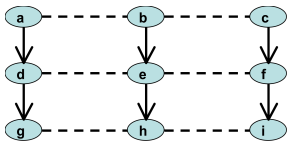
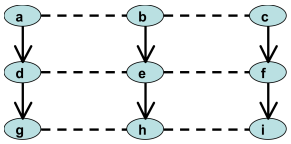


2. Which path does e take to reach i ?

(a) e->h->i
(b) e->f->i
(c) e->b->c->f->i
(d) e->d->g->h->i

BGP Routing



Peer ----- Peer
Provider -> Customer

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(a) e->h->i
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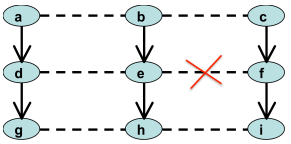
(c) e->b->c->f->i
(d) e->d->g->h->i

BGP Routing



Peer ----- Peer
Provider -> Customer

3. If the link e-f is removed then which path does e take to reach i ?

(a) e->h->i
(b) e->f->i
(c) e->b->c->f->i
(d) e->d->g->h->i

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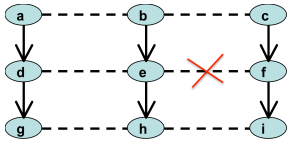

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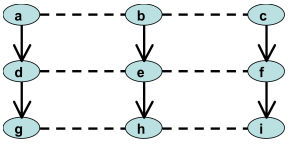
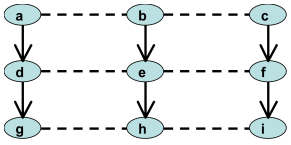


Peer ----- Peer
Provider -> Customer

4. Suppose AS b provides a dump of all BGP routes they learn for every destination and we use them to reconstruct the AS-level topology, which of the following business relations will be missing ?

(a) e->h
(b) e->f
(c) f->i
(d) d->g
(e) c->f

BGP Routing



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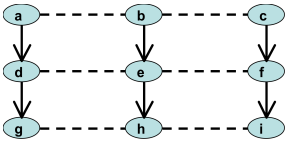
BGP Routing

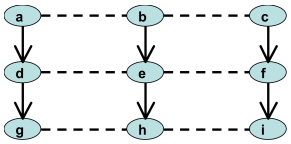


Peer ----- Peer
Provider -> Customer

5. What is the minimum set of ASes that must provide "dumps" of every AS path they learn for every edge in the graph to be visible in at least one dump?

(a) a and h
(b) a and c
(c) a, b and h
(d) a, b and c
(e) h

BGP Routing



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(d) a, b and c
(e) h

BGP Routing

6. BGP supports flexible routing policies. Internet Service Providers (ISPs) often have a "prefer customer" policy where they prefer to route through a customer, even if a shorter route exists through a peer or provider. Why? How is this policy realized in BGP?

BGP Routing

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Directing traffic through a customer generates revenue, whereas sending through a peer or provider is (at best) revenue neutral and may, in fact, cost money.

The policy is realized in BGP by having an import policy that assigns a higher local-preference value to routes learned from customer ASes.