Mitigating spoofing and replay attacks in MPLS-VPNs using label-hopping with TicToc

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Outline

Security issues in MPLS-VPN models

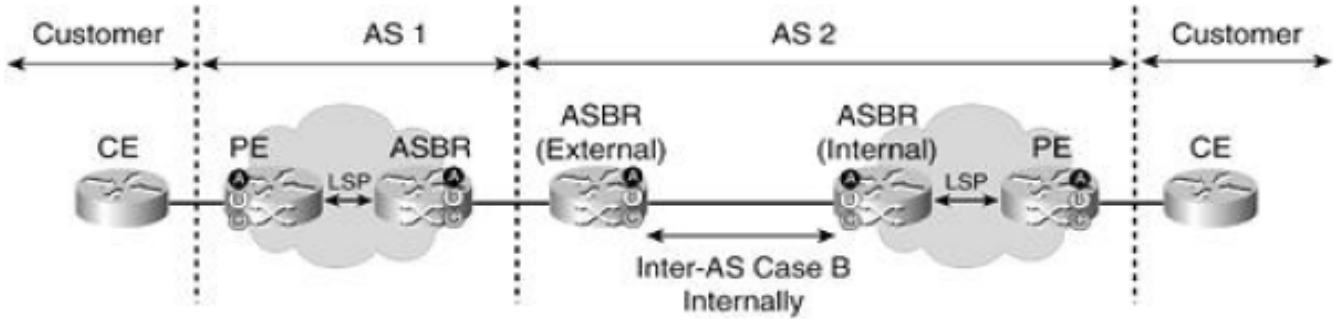
Label-hopping algorithms

Simulation and Implementation

MPLS VPN Security Issues

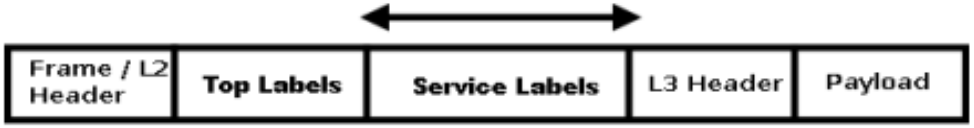
Model A: Highly secure, misconfiguration of ASBR can compromise security

Model B: Secure control plane, data plane security by adding an extra ASBR



Extra ASBR added for data security

Model C: Secure control plane, no data plane security,ISPs must trust each other



Service labels can be spoofed

Router Configuration

Algorithm 1	Algorithm 2		Algorithm m
1	2		m

Algorithm indices are exchanged

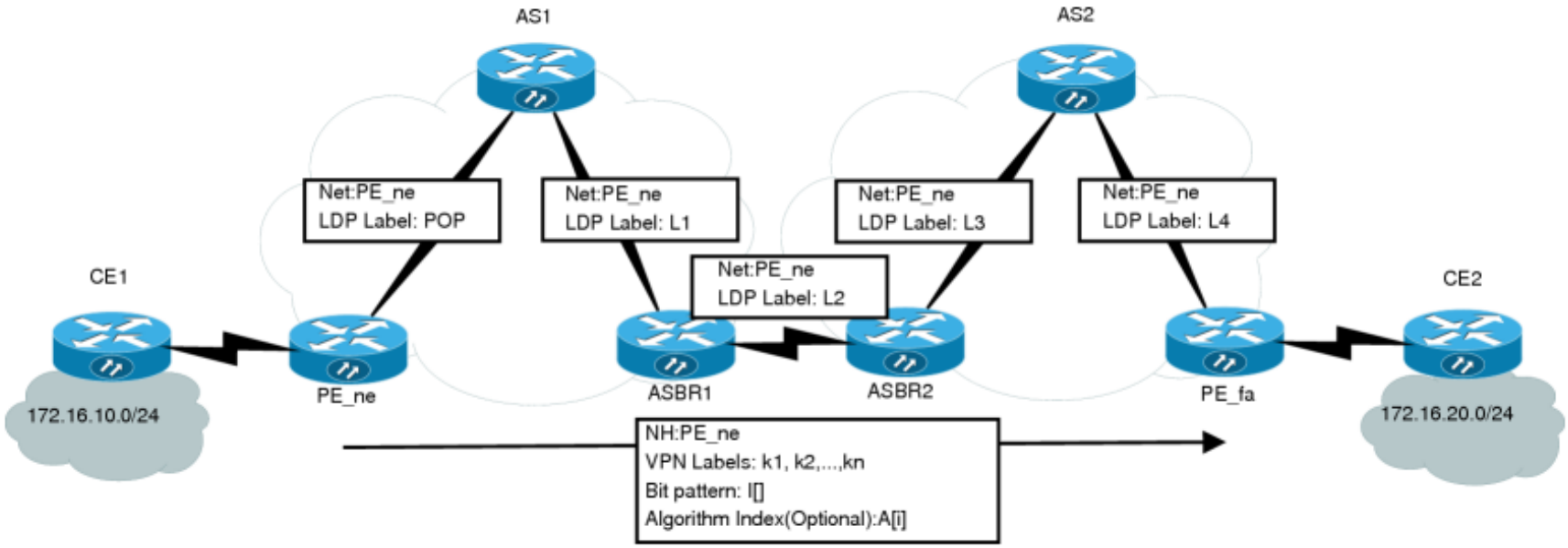
K11,.., K1i	K21,.., K2j		Kn1,.., Knk
FEC 1	FEC 2		FEC n

Keys for FECs

Bits Chosen 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23, 25, 27, 29, 31

16 bits chosen out of 32 bits

Secure Control Plane Exchange



Label hopping applied to data plane

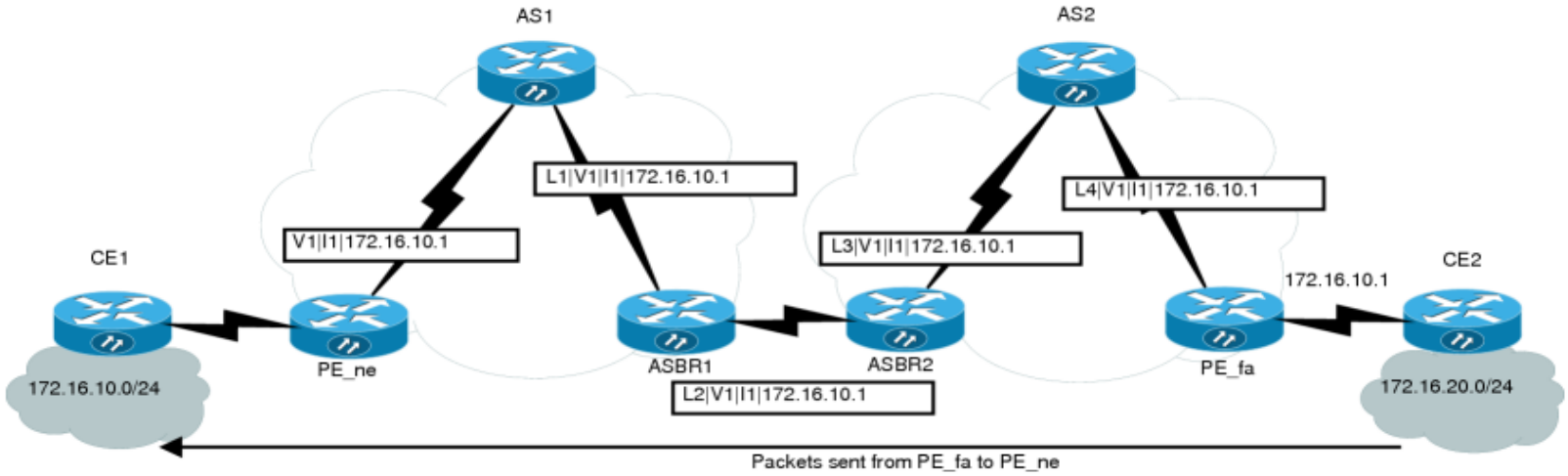


Illustration of data plane transfer

Label 1 = Outermost label

Label 2 = Label generated by the hash digest

Tic-Toc based Scheme

- Timing over IP Connection and Transfer of Clock (Tic-Toc) IEEE 1588,
- Exchange Time slices,
- Exchange labels during these time slices,

Control plane algorithms for PEne

```
Require:

* FEC[] Forward Equivalence Classes,
* K[] valid labels,
* TS[] valid time slices,
* A[i] hash algorithm instance,
* I[] the bit-selection pattern chosen for the inner label.
* Random seed "Rseed" which is used for generating the index into set
K (set of labels).
* PTP port and PTP LSP information

Begin
packet = makepacket(FEC,K, TS, A[i], I, Rseed);
CP-SendPacket(PEfa, MP-eBGP, packet);
End
```

Control plane algorithms for PEfa

```
Require: None
Begin
packet = CP-ReceivePacket(PEne); // from PEne
FEC[] = ExtractFEC(packet); // extract FECs
K[] = ExtractLabels(packet); // extract the labels
TS[] = ExtractTimeSlices(packet); // extract the time slices
Rseed = ExtractRandomSeed(packet); // extract the Rseed value.
selectHashAlgorithm(A[i]); // hash algorithm to use
RecordValues(FEC); // information for PEfa
RecordValues(K);
RecordValues(TS);
RecordValues(I); // bit-selection pattern to be used
RecordValue(Rseed);
End
```

Data Plane Algorithm for PEfa

```
Begin
Initialization :

One Time Init :

BeginInit

CurrentTimeSliceIndex = 0;

CurrentMasterClock = PTP LSP Master Clock Timestamp;

CurrentTimeInstant = CurrentMasterClock;

NextTimeInstant = CurrentMasterClock + TS[CurrentTimeSliceIndex];

EndInit

packet = DP-ReceivePacket(Interface);
match = CheckFEC(packet); // Is the algorithm enabled?
if match == 0 then
     return; // no match
end if
hash-digest = calculateHash(A[i],packet);
if (CurrentTimeInstant <= NextTimeInstant ((+ or -) configured
seconds)) then
     // do nothing;
else
     CurrentTimeSliceIndex++;
     if CurrentTimeSliceIndex == n then // check to wrap around
               CurrentTimeSliceIndex = 0;
     end if
     CurrentTimeInstant = NextTimeInstant;
     NextTimeInstant = CurrentTimeInstant + TS[CurrentTimeSliceIndex];
end if
first-label = K[GenerateRandom(Rseed) MOD n(K)];
end if
additional-label = process(hash-digest,I)
DP-SendPacket(PEne, first-label, additional-label, packet);
End
```

Data Plane Algorithm for PEne

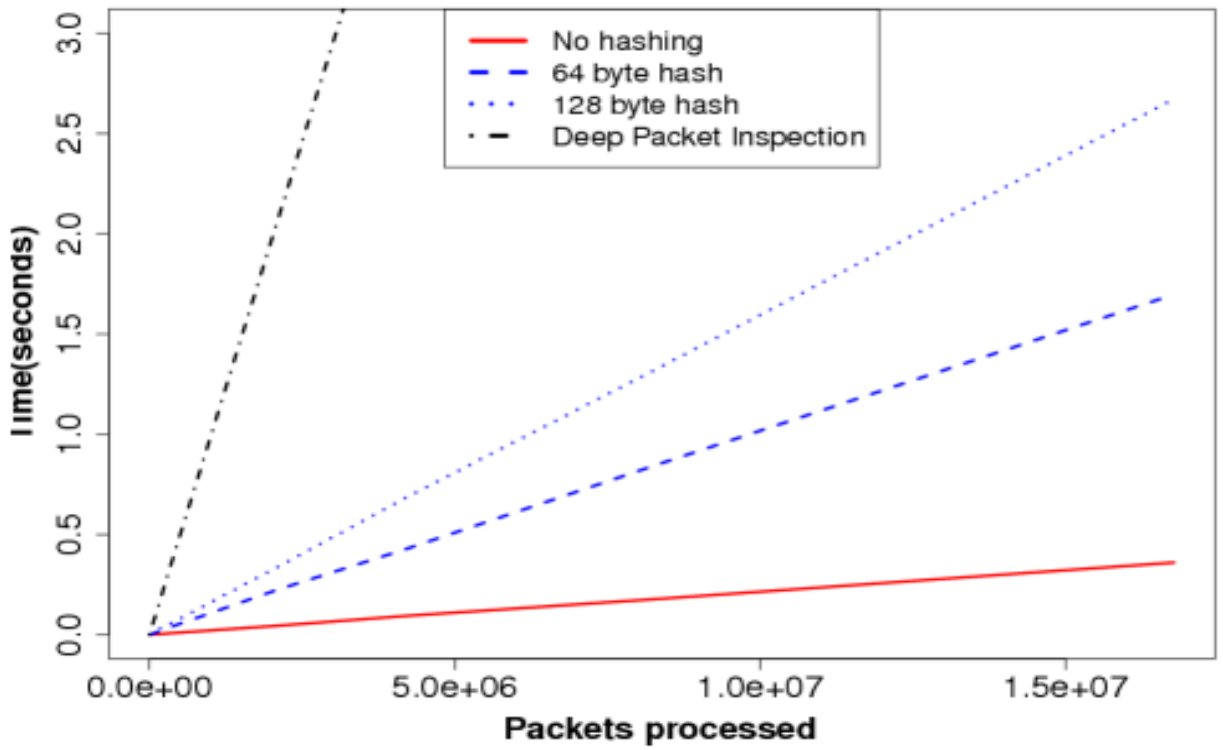
```
Begin
packet = DP-ReceivePacket(Interface);
match = CheckFEC(packet);
if match == 0 then
      return; //no match
end if

label-in-packet=extractPacket(packet, LABEL);
inner-label=extractPacket(packet, INNER-LABEL);
hash-digest=calculateHash(A[i],packet);
if (CurrentTimeInstant <= NextTimeInstant ((+ or -) configured
seconds)) then
      // do nothing;
else
         CurrentTimeSliceIndex++;
         // Save the old RseedIndex into set K
         OldRseedIndex = RseedIndex;
         RseedIndex = (GenerateRandom(Rseed) MOD n(K));
         NextRseedIndex =
           LookAheadRseedIndex(GenerateRandom(Rseed) MOD n(K));
         RollbackRseed(Rseed by 1);
         if CurrentTimeSliceIndex == n then // check to wrap around
              CurrentTimeSliceIndex = 0;
         end if
      CurrentTimeInstant = NextTimeInstant;
      NextTimeInstant = CurrentTimeInstant + TS[CurrentTimeSliceIndex];
end if
// Check if label used before in the previous | current or future
// time slot can be used
// Check with OldRseedIndex, RseedIndex and NextRseedIndex
first-label-range = K[RseedIndex (+or- 1)];
additional-label = process(hash-digest,I)
if label-in-packet ! in first-label-range then
      error(); return;
end if
```

Avoiding replay attacks

- Exchange the seed
- Use Pseudo Random Number Generation algorithm
- Use the Random Number generated to choose the labels at various time slices

Simulation and Implementation



- Quagga open source software on an desktop machine,
- Payload is used as the random source was a concern,
- Fragmentation of packets - path discovery MTU.

Conclusion

- Security solution for MPLS-VPN Model “C” using label-hopping
- We make a case of deployment of Model “C”

Thank you

QUESTIONS?