Physical Link Security Type of Service

Status of this Memo

Abstract

   This RFC documents an experimental protocol providing a Type of
   Service (TOS) to request maximum physical link security. This is an
   addition to the types of service enumerated in RFC 1349: Type of
   Service in the Internet Protocol Suite. The new TOS requests the
   network to provide what protection it can against surreptitious
   observation by outside agents of traffic so labeled. The purpose is
   protection against traffic analysis and as an additional possible
   level of data confidentiality. This TOS is consistent with all other
   defined types of service for IP version 4 in that it is based on link
   level characteristics and will not provide any particular guaranteed
   level of service.

1. Nature of Requirement

   This Internet Protocol addition addresses two potential security
   requirements: resistance to traffic analysis and confidentiality.
   These are described in the two subsections below followed by a
   discussion of why links have different levels of physical security so
   that it is meaningful to request that more secure links be used.

1.1 Traffic Analysis

   At this time all Internet Protocol (IP) packets must have most of
   their header information, including the "from" and "to" addresses, in
   the clear. This is required for routers to properly handle the
   traffic even if a higher level protocol fully encrypts all bytes in
   the packet after the IP header. This renders even end-to-end
   encrypted IP packets subject to traffic analysis if the data stream
   can be observed. While traffic statistics are normally less
   sensitive than the data content of packets, in some cases activities
   of hosts or users are deducible from traffic information.

It is essential that routers have access to header information, so it is hard to protect traffic statistics from an adversary with inside access to the network. However, use of more secure physical links will make traffic observation by entities outside of the network more difficult thus improving protection from traffic analysis.

No doubt users would like to be able to request a guaranteed level of link security, just as they would like to be able to request a guaranteed bandwidth or delay through the network. However, such guarantees require a resource reservation and/or policy routing scheme and are beyond the scope of the current IP Type of Service facility.

Although the TOS field is provided in all current Internet packets and routing based on TOS is provided in routing protocols such as OSPF [See 5,6,7], there is no realistic chance that all of the Internet will implement this additional TOS any time in the foreseeable future. Nevertheless, users concerned about traffic analysis need to be able to request that the physical security of the links over which their packets will be pass be maximized in preference to other link characteristics. The proposed TOS provides this capability.

1.2 Confidentiality

Use of physical links with greater physical security provides a layer of protection for the confidentiality of the data in the packets as well as traffic analysis protection. If the content of the packets are otherwise protected by end-to-end encryption, using secure links makes it harder for an external adversary to obtain the encrypted data to attack. If the content of the packets is unencrypted plain text, secure links may provide the only protection of data confidentiality.

There are cases where end-to-end encryption can not be used. Examples include paths which incorporate links within nations which restrict encryption, such as France or Australia, and paths which incorporate an amateur radio link, where encryption is prohibited. In these cases, link security is generally the only type of confidentiality available. The proposed TOS will provide a way of requesting the best that the network can do for the security of such unencrypted data.

This TOS is required for improved confidentiality, especially in cases where encryption can not be used, despite the fact that it does not provide the guarantees that many users would like. See discussion at the end of the Traffic Analysis section above.

1.3 Link Physical Security Characteristics

   Physical links, which are composed of lines and routers, differ
   widely in their susceptibility to surreptitious observation of the
   information flowing over them. For examples of line security see the
   following list:

      1) Land line media is usually harder to intercept than radio
         broadcast media.

      2) Between different radio broadcast media, spread spectrum or
         other low probability of intercept systems, are harder to
         intercept than normal broadcast systems. At the other extreme,
         systems with a large footprint on the earth, such as some
         satellite down links, may be particularly accessible.

      3) Between land lines, point to point systems are generally harder
         to intercept than multi-point systems such as Ethernet or FDDI.

      4) Fiber optic land lines are generally harder to intercept than
         metallic paths because fiber is harder to tap.

      5) A secure land line, such as one in pressurized conduit with
         pressure alarms or one installed so as to be observable by
         guards, is harder to intercept than an unsecured land line.

      6) An encrypted link would be preferable to an unencrypted link
         because, even if it was accessed, it would be much more
         difficult to obtain any useful information.

   Routers also have different levels of security against interception
   depending on the physical security of the router site and the like.

   The above comparisons show that there are significant real
   differences between the security of the physical links in use in the
   Internet. Choosing links where it is hard for an outside observer to
   observe the traffic improves confidentiality and protection against
   traffic analysis.

2. Protocol Specification

   The value 15 decimal (F hex) in the four-bit Type of Service IP
   header field requests routing the packet to minimize the chance of
   surreptitious observation of its contents by agents external to the
   network. (This value is chosen to be at the maximum hamming distance
   from the existing other TOS values.)

3. Protocol Implementation

   This TOS can be implemented in routing systems that offer TOS based
   routing (as can be done with OSPF, see RFCs 1245 through 1247) by
   assigning costs to links. Establishing the "cost" for different
   links for this TOS is a local policy function.

   In principle services are incomparable when criterion such as those
   given in the Nature of Requirement section above conflict. For
   example, a choice between an encrypted broadcast system and an
   unencrypted fiber optic land line. In practice, link encryption
   would probably dominate all other forms of protection and physical
   security as mentioned in criterion 5 above would dominate other land
   line distinctions.

   An example of "costs" at a hypothetical router could be as follows:

              Cost   Type
               1   Strong encryption with secure key distribution
               2   Physically secure point-to-point line
               6   Typical point-to-point line
               8   Typical local multi-point media
              12   Metropolitan area multi-point media
              24   Local radio broadcast
              32   Satellite link

   Link costs should be chosen so as to be in the same ratio as the
   probability of interception. Thus the above example costs imply a
   local policy assumption that interception is 32 times more likely on
   a satellite link and associated router than on a strongly encrypted
   line and its associated router. It is not necessary to estimate the
   absolute probability of interception on any particular link. It is
   sufficient to estimate the ratio between interception probabilities
   on different links.

   It should be noted that using costs such as the example given above
   could result in using many more links than if the default type of
   service were requested. For example, the use of over 50 highly
   secure links could be better than using two insecure links, such as
   an unencrypted satellite hop and radio link. However, if the costs
   have been properly set in proportion to the probability of
   interception, this larger number of links will be more secure than
   the shorter default routing. This consideration should make it clear
   why it is necessary to estimate router security as well as link
   security. An excessive cost ratio based solely on the security of a
   communications line could cause packets to go through many routers
   which were less secure than the lines in question. This necessity to
   take router characteristics into account is also present for all

other defined TOS values.

It should also be noted that routing algorithms typically compute the sum of the costs of the links. For this particular type of service, the product of the link probabilities of secure transmission would be more appropriate. However, the same problem is present for the high reliability TOS and the use of a sum is an adequate approximation for most uses as noted in RFC 1349.

References

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[6] Moy, J., Editor, "Experience with the OSPF Protocol", RFC 1246, Proteon, Inc., July 1991.

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Security Considerations

   The entirety of this memo concerns an Internet Protocol Type of
   Service to request maximum physical link security against
   surreptitious interception.

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