Recommendations on using VPN over SATCOM access

David PRADAS (VIVERIS)
Romain Guilloteau (VIVERIS TECHNOLOGIES)
Guillaume Pelat (VIVERIS TECHNOLOGIES)
Nicolas Kuhn (CNES)
VPN are everywhere

• Working from home, interconnecting entreprise networks
  ➢ increase security needs
  ➢ VPN helps !

• Using HTTPS may not be enough
  ➢ added layer of security
  ➢ crossing a non-secured network will be safe

• Lots of VPN solutions and configurations
  • Wireguard (IPSec)
  • OpenVPN (OpenSSL, SSL, TLS) on top of UDP or TCP
TCP-splitting middleboxes are everywhere too! (and in particular in SATCOM systems)

- SATCOM systems typically deploy TCP Proxy (PEP) [RFC3135]
TCP-splitting middleboxes are everywhere too! (and in particular in SATCOM systems)

• Connection initialization:
  • setting up the connection requires three round trips, impacting the moment from which the actual data can be transmitted
    ➢ Improved by custom TCP initial windows in TCP - PEP
  • Window size required:
    • to fully exploit the available capacity, it is necessary to increase the sending buffers are the client and the server
    ➢ Improved by custom TCP buffers in TCP - PEP

• Reliability:
  • packet loss detection and correction is slow (end-to-end retransmission performance is also affected on GEO access)
    ➢ Loss recovery in splitted in three segments
  • Convergence of congestion control:
    • the exponential increase in data rate is considerably slowed down for a GEO satellite.
    ➢ Improved by custom TCP AIMD in TCP - PEP
TCP-splitting middleboxes are everywhere too! (and in particular in SATCOM systems)
Rationale of the study

• I have VPN and PEP ... do they cooperate?
• What VPN should I use?
• If I can choose my congestion control ... what should it be?
Configurations

• SATCOM
  • GEO : RTT of 500 ms, bottleneck bandwidth of 10 Mbps
  • LEO : variable RTT, bottleneck bandwidth of 10 Mbps
  • Random losses on the SATCOM link

• PEP
  • Before (Option B) or after (Option A) the VPN tunnel
  • CUBIC, CUBIC without Hystart and BBRv2
  • Various initial congestion windows

• Same congestion control applied to all the nodes

• VPN
  • Wireguard
  • OpenVPN UDP
  • OpenVPN TCP

• Application : 30MB file transfer
### Results – no loss scenario

<table>
<thead>
<tr>
<th>VPN</th>
<th>PEP</th>
<th>No loss LEO</th>
<th>OpenVPN TCP</th>
<th>Wireguard</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUBIC w/o Hystart</td>
<td>None</td>
<td>26,8</td>
<td>29,9</td>
<td>28,0</td>
</tr>
<tr>
<td>CUBIC w Hystart</td>
<td>None</td>
<td>27,1</td>
<td>32,0</td>
<td>28,0</td>
</tr>
<tr>
<td>BBRv2</td>
<td>None</td>
<td>27,9</td>
<td>31,6</td>
<td>28,7</td>
</tr>
<tr>
<td>CUBIC w/o Hystart</td>
<td>None</td>
<td>29,4</td>
<td>34,2</td>
<td>30,4</td>
</tr>
<tr>
<td>CUBIC w Hystart</td>
<td>None</td>
<td>29,9</td>
<td>38,6</td>
<td>30,5</td>
</tr>
<tr>
<td>BBRv2</td>
<td>None</td>
<td>32,8</td>
<td>39,8</td>
<td>32,2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VPN</th>
<th>PEP</th>
<th>No Loss GEO</th>
<th>OpenVPN TCP</th>
<th>Wireguard</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUBIC w/o Hystart</td>
<td>None</td>
<td>29,4</td>
<td>34,4</td>
<td>30,9</td>
</tr>
<tr>
<td>CUBIC w Hystart</td>
<td>None</td>
<td>29,9</td>
<td>36,1</td>
<td>30,5</td>
</tr>
<tr>
<td>BBRv2</td>
<td>None</td>
<td>32,8</td>
<td>39,8</td>
<td>32,2</td>
</tr>
</tbody>
</table>

- **OpenVPN TCP in PEP position A**: worst performance (i.e. “TCP in TCP” issue)
- **Wireguard with a PEP in position B**: best performance
- **OpenVPN UDP with/without PEP and Wireguard without PEP**: fair performance
Results – loss scenario

- Losses on the satellite link: BBRv2 as a transport layer protocol helps
  - When the end-to-end congestion control can not be adapted, when the end-to-end transport is CUBIC
    - OpenVPN TCP exhibits the best performance by reducing the transfer time
Summary

• No loss
  • Use wireguard with a PEP in B position (before the Wireguard instance)
  • CUBIC and BBRv2 exhibit (more or less) the same performance

• With losses
  • BBRv2 helps a lot
  • When BBRv2 is not possible, damages can be reduced with the usage of OpenVPN TCP

• Limits of the conclusion :
  • When losses are on the LAN, PEP can help a lot (split the recovery process)
  • In the study, losses are applied on the long-delay satellite link : PEP can not really help the loss recovery process

• More details on ArXiv paper
  • “Recommendations on using VPN over SATCOM”; David PRADAS, Romain Guilloteau, Guillaume Pelat, Nicolas Kuhn