Vehicular Internet Connectivity

- SILVIO conservative (S-conservative). This mode, detailed in Algorithm 2, tries to use a possible multi-hop WLAN connectivity through the VANET (i.e., not only when directly connected to the RSU). In order to mitigate the possible ping-pong effect the mobile router is allowed to perform a handover to the multi-hop WLAN just once per TREBOL area. That is, once the mobile router backs off to the 3G network, it will not try again to obtain connectivity via the WLAN interface until it changes area. Moreover, the VANET WLAN is only used if the number of hops between the mobile router and the RSU is smaller than a configurable threshold ($t_{\text{hops-wlan}}$). In Fig. 5 the method of operation is detailed. When a vehicle finds a new available path through the multi-hop VANET, it performs a flow handover to WLAN (Fig. 5(a)). However, if the WLAN connectivity cannot be maintained (e.g., due to an obstacle between two hops, as shown in Fig. 5(b)), the mobile router switches back to the 3G interface, and keeps using it even if a new valid path is discovered (Fig. 5(c)).

- SILVIO persistent (S-persistent). This mode of operation is slightly more aggressive than the ones already presented before. It tries to make use of the VANET longer by allowing the mobile router to hand off between 3G and WLAN more than once per area, but only while the vehicle is getting closer to the RSU, and if the number of hops between the router and the RSU is smaller than $t_{1 \text{-hops-wlan}}$. The maximum number of handover attempts from 3G to WLAN is limited by a configurable threshold ($t_{\text{ho-attempts}}$). However there is a exception: if the VANET route is shorter than $t_{2 \text{-hops-wlan}}$ hops, then the number of 3G to WLAN handover attempts is not limited. Algorithm 3 describes the handover behaviour of this mode. As shown in Fig. 6 when the mobile router finds a new path to the RSU, it hands off again the selected flow to the WLAN. When moving away, if the mobile router decides that the WLAN link does not satisfy its quality constraints, it moves the flows back to the 3G network, without looking to other possible paths in the VANET.

- SILVIO sticky (S-sticky). This is the greediest operation mode, in which the mobile router tries to keep using the VANET even when moving away from the RSU. From a pure handover management point of view it is exactly the same as the S-persistent mode (therefore Algorithm 3 is also valid to describe the operation of this mode). The only difference (depicted in Fig. 7) between S-persistent and S-sticky modes is that in the

![Fig. 4 S-Direct mode of operation](image-url)