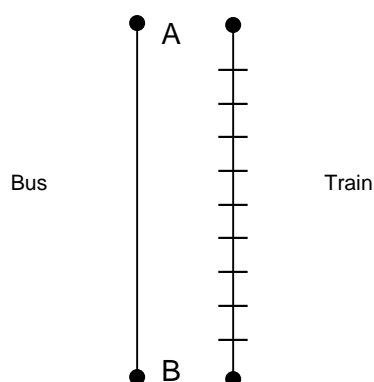


## Substitutable and complementary flows

1. This appendix simply illustrates possible substitutable and complementary bus and rail flows.
2. Figure 1 shows simple substitutable flows in which bus and rail operate between two identical origin and destination points—A and B. However, the extent of substitutability will still depend on the characteristics of those flows; in particular, the differences in the generalized cost of using bus and rail, taking into account journey time, frequency of the services, accessibility to the bus stop and rail station and fares.

FIGURE 1

### Substitutable flow

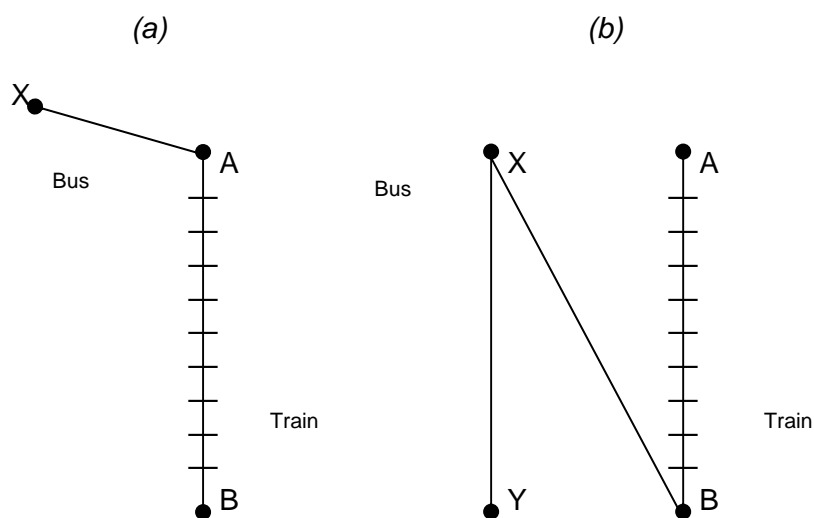


Source: CC.

3. Figure 2 shows a range of possible complementary flows. First, in Figure 2(a) where the bus operates as a feeder to the railway station, passengers travel from X to A by bus and change at A on to the train to travel onwards to B. Hence, passengers' use of the rail flow from A to B is related to their use of the bus from X to A.

FIGURE 2

**Complementary flows**

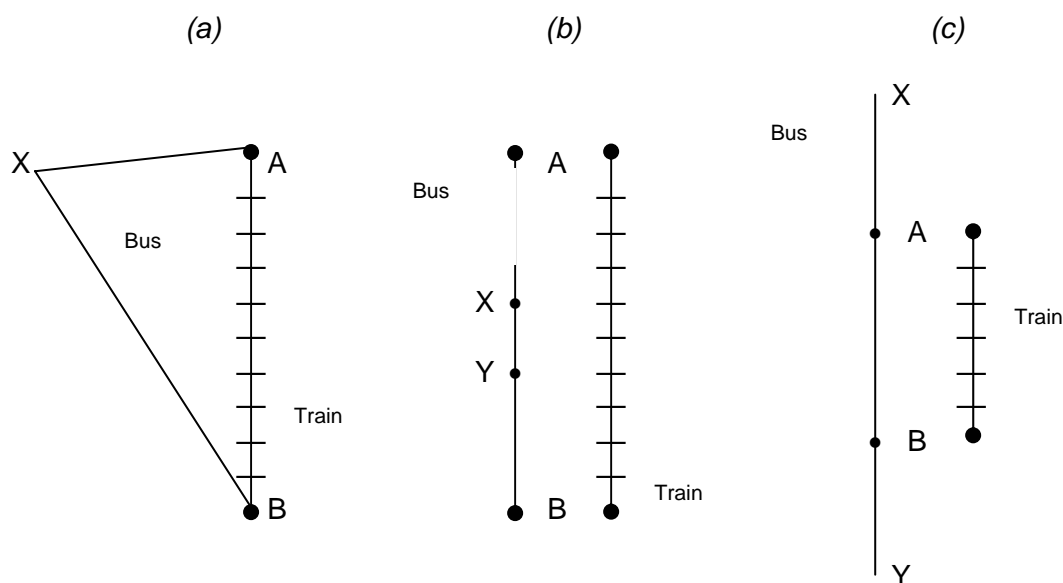


Source: CC.

4. Complementarity could also be regarded as occurring, not from the perspective of individual passengers, but in terms of the network, if bus and rail are serving separate flows. As shown in figure 2(b), bus services may operate from X to B, and train services from A to B: at X and A passengers do not have the choice between bus and train. Alternatively, the bus route may serve totally different origins or destinations to the train: for example the flow from X to Y in figure 2(b).
5. Some bus and rail services may have elements of substitutability and complementarity. In figure 3(a), for example, the feeder service from X to A, allowing passengers to transfer on to the trains to travel from A to B, may compete with a direct bus service from X to B. Passengers' choice would depend on the generalized cost of travelling on the direct bus service or using the feeder route and travelling on by train, but also including the disadvantages of having to change from bus to train at A (sometimes referred to as an interchange penalty).

FIGURE 3

**Partly substitutable and partly complementary flows**



Source: CC.

6. As shown in Figure 3(b), the bus service may to only some extent overlap with a train service. The bus service from A to B for example also serves X and Y: passengers have a choice between bus and train from A to B but not if travelling to or from the intermediate points X and Y.
7. Similarly, as shown in Figure 3(c), the bus may serve destinations beyond the points served by the train. Passengers travelling to X or Y have to use the bus to travel to or from X or Y, hence the part of the route using X or Y can not be regarded as substitutable. They would have the option of changing at A or B to travel by train between the two points, but their decision to do so will depend on the generalized cost of the alternative options for the journey, again including the disadvantage of having to interchange. Similarly (not illustrated here), the train service between A and B may serve intermediate points, or points beyond A or B, and flows between them where there are no substitutable bus services. Whether services are substitutable or complementary may indeed reflect how they are operated; we are aware of instances where bus services that could be substitutable with new light rail or tram developments—such as a route between X and B in Figure 3(a), or between A and B in Figure 3(c)—have been withdrawn when the new light rail or tram services have started operating.