Currently, improvements in civil aviation performance are difficult to achieve, often relying on improvements in materials or engines which only provide small benefits. Instead of continuing down this road, it may be better to come up with new and different ideas which may offer larger improvements. In-flight refuelling could be one option, but some designers have decided to go even further by transferring passengers at stratospheric altitudes between a feeder and a cruiser. The cruiser/feeder concept provides the possibility of optimising each type of aircraft for their specific mission, thus trading conformity for efficiency while still using available aviation technology.

Before we start talking about future passenger aircraft, let’s step away from lift-to-drag ratio (L/D) or specific fuel consumption temporarily. The growth of civil aircraft transport performance seems to have reached a plateau for years. Each percentage of improvement requires great efforts; it is time to rethink the current “system of systems” method.

**In-flight passenger transfer**

Suppose you live in Rotterdam and have business in Shenzhen, you need to take a flight from Schiphol airport, with a transfer at Shanghai or Chengdu airport. Though it is the most convenient travel way to connect the two cities, the whole journey takes at least twenty hours, including at least five hours on the ground, travelling or waiting. If you want to buy a cheaper ticket, then there will be at least another two hours for transferring in Paris or Frankfurt.

With the cruiser and feeder transport system you can take intercontinental flights from small airports like the Rotterdam-The Hague airport. First, you get onboard an aircraft slightly smaller than an Airbus A320, called the ‘feeder’. The feeder takes off, intercepts a cruiser at a rendezvous point, then docks with the cruiser whose capacity can be as large as 3,000 passengers. (T.Trueman, 2007)

The feeder will not be joined with the cruiser for a long time, as it sabotages the clean aerodynamic configuration of the cruiser when docking with it. Instead, it puts the ‘can’ – a kind of pressurised cabin into the cruiser, and then moves along the pylon of the cruiser to the next position to pick up another can which is to arrive in Rotterdam and leaves, while the cruiser continues on its way.

When your cabin is securely connected with the cabin of the cruiser, flight attendants will open the hatch and let you walk into the cruiser with your personal belongings. For the next several hours, you can enjoy your flight within the spacious cabin aboard the aircraft, which is large enough to have ample relaxation and entertainment areas. Thirty minutes prior to arrival, the passenger once again boards a ‘can’ under the guidance of flight attendants. When a feeder docks with your cruiser, your ‘can’ will be isolated from the cruiser’s cabin again and picked up by the feeder, which will carry you directly to your destination.

Such a system emphasizes door-to-door travel, and is not only more convenient for passengers, but also greatly reduces the stress of ground travel facilities around hub airports.

**Cruiser**

Similar to navy ships, our sky cruisers are optimized for long-range high-speed cruise. There are four key effects that
make them more efficient than conventional aircraft, even with the same level of aviation technology.

Firstly, when aircraft become larger, the size effect subsidizes the I/D ratio. This is because for larger aircraft, the boundary layer becomes thicker and thicker when air flows along the surface of the aircraft. Compared with the increased dimension of the boundary layer, the constant skin roughness becomes relatively smaller, thus leading to less friction drag, which usually makes up about 60% of subsonic total drag. This is the main reason for manufacturers to build bigger airliners. For our enormous large sky cruiser, the I/D ratio becomes much higher, leading to less fuel burnt for a set mission.

Another extraordinary feature of the cruiser is that it lands only when major maintenance work needs to be done. In other words, it remains flying along a global route for weeks, even months. To keep it airborne, fuel feeders will refuel it repetitively. To take advantage of this, the cruiser can be designed with a fuel capacity for only 3,000nm range (Nangia, 2006), only half that of today’s large airliners. A smaller fuel capacity means less structural weight, which leads to less thrust needed, resulting in less fuel burnt. This ‘snowball-effect’ makes the cruiser even more efficient.

Staying airborne for a very long time also greatly reduces the maintenance needs of the aircraft. Without pressurizing and depressurizing repetitively, the main cabin in the cruiser suffers less fatigue problems. Similarly for other loaded structures—the cruiser stays at the stratosphere, hardly encountering any shear wind loads or turbulence, meaning gust loads for instance are much less likely to be encountered. It even has benefits for the engines: even though they are working continuously for weeks on end, they are mostly operating at their optimized condition and are thus less likely to encounter conditions which might stress the engine.

Last but not least, the cruiser does not need to take off or land with passengers and cargo. So even despite its tremendously large size, the weight during takeoff or landing is not scaled up comparably, making the landing gear weight a smaller portion of the operational empty weight than for a current aircraft. Although you still need a comparably wide runway to operate such an aircraft, the runway does not need to be placed close to a city or any hub airport.

FEEDER
As mentioned previously, there could be two kinds of feeder aircraft. One will be a passenger & cargo feeder, which should be a short take off and landing (STOL) aircraft, quiet enough to operate at a small airport close to a major city, fast enough to intercept the cruiser whose flight stalls at high subsonic speed, and manoeuverable enough to dock on the cruiser’s pylons. While this may seem difficult, it does not need to cover a long range. Therefore with a smaller fuel load, the feeder (probably with an unconventional configuration) can easily be designed to meet the required criteria. The other kind is a fuel feeder, known as a tanker. As you cannot have a 3,000 passenger cruiser struggling to catch a basket or flying behind a tanker (either efficiency or passenger comfort become unacceptable), an alternative must be found. Therefore instead of having the receiving aircraft manoeuver to meet the tanker, future tankers should instead go after the cruiser, just the opposite from current military tankers. Such an aircraft can be operated from remote airfields to prevent the noise problem.

TOO FUTURISTIC?
Despite the great potential of such a system, there are numerous problems with implementing such a system. Among them, safety is the top issue. There are many details which must all be carefully analysed. For instance, how can you make sure that close formation and docking manoeuvres are safe? Should the cruiser encounter a devastating failure, how can people escape? Another threat is the budget; once the system is built up, it should be far more efficient and cheaper to operate than the current one, but building it will require a significant amount of time and investment.

Although this system may seem far away, the first steps have already been thought of. These include in-flight refuelling for airliners. We can begin with modified conventional airliners with which are fed by military tankers. Research has shown that for long range travel, the fuel (and thus financial) savings can be as much as 30-40% (Nangia, 2006). Then, both passenger aircraft and tanker can be optimized and re-designed for a new way of refuelling where the tanker chases the airliner. Once all these technologies are demonstrated to be safe and sound, then the time may come to build our huge sky cruiser.

References
