# The transportation internet

# or

# What's next after driverless cars?

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## Evolution

The moment when software replaces all human drivers is not the end of the "driverless car" story. It is just the beginning. In the evolution of life, there came a point where single-celled organisms began to work together to become multi-celled organisms. Within the multi-celled organisms, the single cells began to differentiate into tissues, each tissue being specialized for a part of the task of living for the whole, each cell ceding its own independent life to the life of the whole. These new multi-celled creatures have properties which are unimaginable to one who has only known bacteria. As regards transportation, we are such people now. We know cars, trucks, buses which differ from each other only or primarily on the basis of size.  They all work independently to transport people and/or things from point A to point B. The vehicle travels the full distance from A to B along with its cargo.  These vehicles can all navigate essentially any roadway, need to stop to pickup or drop off a payload, or to be refueled. Their payloads need to be matched along many dimensions to the characteristics of the vehicle. None of these properties are necessary for transportation, though all are necessary for independent operation of vehicles. All of these properties fall away when the next evolutionary step is taken.  In short,  getting rid of the car's driver eventually entails getting rid of the car itself. The car becomes subsumed into a network of interworking transportation units collectively providing a transportation flow. The step to multi-cellularity is not possible until human drivers are automated away, but is inevitable once they are.

## An Ideal Transportation System

Certain truths if not self evident are at least empirically verified: bigger vehicles are more efficient than smaller vehicles and fully loaded vehicles are more efficient than partially loaded ones, as measured on a per unit of payload transported basis. A vehicle should be as big as the dimensions of the roadway on which it travels allows. It is evident that to maximize throughput vehicles should ideally be always moving as fast as a given roadway safely allows. This in turn means that stopping to pick up or drop off payload should be minimized, and the bigger and more fully loaded the vehicle the less often it should stop and the shorter the time it should spend stopped. In our present singled-celled transportation world, all these criteria cannot be simultaneously optimized. For instance, a big vehicle will generally take longer to load and unload than a smaller vehicle, and will thus be stopped longer. A vehicle as big as it can be and still fit on a multi-lane interstate highway could not fit into the smaller roads leading to many destinations, so building such a vehicle makes no sense. It would have to stop on the highway to be loaded from smaller vehicles and then stop on the highway again to be unloaded to smaller vehicles. Once we move to multi-celled transportation these conflicts between optimization criteria disappear.

## How do we do it? Part I: Docking

The first technical feature which makes a multi-cellular transportation organism out of a collection of single vehicles is docking. An automated vehicle can dock, at any speed with another automated vehicle. That is, it can drive right up to another vehicle, touch it, and lock into it, while moving at speed. Once a first automated vehicle has docked with a second one, the first can transfer payload to or from the second one. This is what glues single cells together into a multi-celled being. Automated vehicles can do this safely and reliably, though human drivers cannot. To reliably dock while moving requires more than just skill at piloting a vehicle. It requires complete and instantaneous sharing of knowledge of what the other vehicle is seeing, doing, and intending. A merging of minds which human intelligence is incapable of but artificial intelligence can do readily. Docking, like playing chess or integrating differential equations, is something that machines can already do much better than humans can. By the time that all vehicles on the road are automated vehicles, the automated vehicles will be exponentially better equipped to take on docking than they are now.

### How do we do it? Part II: Nesting

The second useful technical feature is nesting of automated vehicles. An automated vehicle operating inside of another one. Imagine two big automated vehicles docking while driving down the highway. The first one contains a smaller automated vehicle, let's call it a pod, and think of the pod as a sort of automated chair, in which a person is comfortably and securely seated. The pod drives from the first big highway vehicle into the second one, treating the combination of big vehicles as a short stretch of pod roadway. Once the pod is in the second vehicle, the first and second vehicles can undock. The motion of the container vehicles and the contained vehicle are electronically co-ordinated so that the transfer occurs quickly and safely.

It will serve to distinguish a special kind of docking, let's call it bootstrap docking, where a pod, operating as an independent automated vehicle, boards a traveling container vehicle. The pod is traveling along a roadway co-ordinates its motion with that of the traveling container vehicle on the same roadway and gets lifted into the container vehicle. Once the pod is contained, it can then be transferred along a sequence of other container vehicles, via a sequence of dockings of container vehicles. When it is time to for the pod to alight at its destination, the bootstrap is reversed whereby the final container vehicle in the sequence disgorges the pod and lowers it to the roadway, where it can continue on its own to the destination.

## Why this is ideal

Now we in a position to simultaneously optimize on all our criteria for transportation efficiency. At one end of the vehicle size spectrum we have the basic pod, which is ideally small enough to fit through the doorway of a house, and carries one person. At the other end we have massive highway vehicles perhaps even several lanes wide and as high as the overpasses on the stretch of roadway on which it operates allows. In between there are vehicles optimized in size for various classes of surface streets. Except for the pods, all vehicles are generally traveling at the maximum legal speed for their class of roadway. The smallest vehicles, the pods, do all the stopping, so stopped time per unit transportation capacity is minimized. Larger vehicles stop only when demand falls below the level at which they are needed to be presently operational. They don't stop for fuel since fuel comes to them in a pod. All vehicles are always operating at or near full capacity. If a highway vehicle, for instance, is not at full capacity it will take on more pods from feeder vehicles, or transfer its own pods into another highway vehicle so that it is empty and can be withdrawn from circulation until it is needed again. Most pods most of the time will be traveling in the largest and most efficient class of vehicle available, and the efficiency of the entire system is maximized.