Rapid Transit, Weston-super-Mare to Bristol

Using a novel electromagnetic drive for a public transport system.

1. Why?

Road transport capacity is reaching saturation, especially in and around our towns and cities. And despite improvements in engine efficiency, overall fuel economy is falling as ever more time is spent in traffic hold-ups. Furthermore, thermodynamics also sets an upper limit on the efficiency of heat engines, whilst our concern regarding carbon dioxide emissions and the production of many other pollutants within engine exhaust is, and is likely to remain, an ever-increasing preoccupation.

Meanwhile electric traction, using modern electronic and mechanical engineering, has recently begun to offer major potential improvements in public transport. The linear induction motor, combined with magnetic levitation, allows us to realise a tracked vehicle system with various highly desirable qualities, permitting propulsion, support without wheels, and stable guidance all to be implemented simultaneously to achieve very quiet, and highly energy-efficient transport of large numbers of people on a track with a small footprint (by comparison with a road). Most of the mass of the electric motor is in the track wherein electromagnets supply a rippling magnetic field which Professor Eric Laithwaite vividly and very aptly described as a “magnetic river”. The track width is perhaps 3m or so and can be raised above ground, at ground level, or below ground, as local conditions dictate. It can be very unobtrusive and accommodating of local conditions. Several such magnetically levitated (MAGLEV) public transport systems already exist worldwide.

The use of regenerative braking (particularly important on a suburban stopping route) allows electric energy to be conserved during braking rather than simply dissipated as heat. The linear motor principle coupled with magnetic levitation permits the forces of acceleration or deceleration to be exerted on the passenger vehicles in a widely distributed fashion without the stress concentration associated with conventional railway rolling stock. Amongst many other benefits, this permits very light-weight construction using modern fibre-reinforced materials which reduces greatly the mass which needs to be accelerated. Furthermore, since a (variable) passenger load is now a substantial part of the mass to be accelerated, the energy expended when lightly loaded is substantially reduced. Maintenance costs are also greatly diminished in such a system which has neither mechanical point contact with the track nor any need for conventional wheel bearings.

The use of “high temperature” superconductors, cooled with liquid nitrogen rather than liquid helium, results in major improvements in ease of operation and in achieving the engineering requirements placed upon the relevant magnetic circuits. Modern semiconductor power devices permit the reliable control and switching of the high currents within the track itself.

We should also note that, although most MAGLEV systems in operation at present across the world emphasise maximum speed, very high rates of acceleration are also possible. This must be tempered by practicality – we are not all astronauts or fighter pilots – but even the modest 0.1g adopted below (which is generally regarded as very practical) permits impressively high throughput and short journey times on appropriate commuter routes. I suggest that the route between Weston-super-Mare and Bristol is just such a route.

As a result of recent pressures within the housing market, W-s-M has assumed a major role as a dormitory town for an expanding Bristol. This has had various unfortunate consequences of which a major element is congestion on all the road routes between the two centres. Commuting flows are thousands per day. Improvements in the passenger-carrying capacity of the conventional rail connection are highly constrained and I suggest that the time has come to acknowledge that conventional road and rail connections derived from (sound but archaic) nineteenth century engineering principles now need to be supplemented, in the twenty-first century, by solutions offered by twenty-first century engineering. Moreover, all the necessary engineering expertise already exists within Britain.

2. A MAGLEV route for passenger traffic between W-s-M and Bristol.

The proposal I envisage here interconnects most of the principal population centres within North Somerset and is based on a single track with double-track passing points at stations along the line. Very high peak operating densities are possible with modern control systems employing computer control of the current steering and switching regimes which operate the driving electromagnets along the track. The actual transit times (limited by a 0.1g ceiling set here for the acceleration) are small (see below) but the waiting plus embarking and disembarking times must be added to this. Certainly, several thousand passenger movements per hour would be achievable with suitable vehicle systems. Moreover, if sufficient land were available, and funding permitted it, a dual track system throughout might be contemplated, thereby increasing throughput and operating flexibility and also dispensing with the need for “points” to permit vehicles to be switched from track to track near stations.

I offer here a suggested route, but detailed planning would be needed to examine this. I suggest that, apart from a route which runs between the two centres via Clevedon and Nailsea, a second spur route, arising around The Vale area SW of Bristol, would permit the realisation of an unobtrusive but very high capacity public passenger transport route to Bristol Airport from the centre of Bristol (with onward public transport links to destinations elsewhere). Improved access to the Airport via public transport is a major preoccupation at present. Relatively steep gradients, as encountered on the airport route, are no problem for a Maglev system.

This proposal (with rather frequent stops) envisages a system, constrained by the need for relatively frequent halts, where the moving vehicles are always either accelerating or decelerating.

The journey schematic offered below is, of course, highly provisional. In practice, one would not apply uniform acceleration but would probably blunt both the onset and the offset of the accelerating or decelerating forces. In compensation, one might apply slightly more than 0.1g in the middle of the accelerating and decelerating phases or perhaps restrain acceleration on a long leg to restrict the maximum speed attained. At high speed, air resistance is the principle opposing force, rising as the cube of the speed.

We should recognise that substantial time should be added to the journey for passing, embarking and disembarking. Of particular benefit, however, in any automatic-vehicle control system such as this, is the fact that timing of the service can respond flexibly to high demand.

Two journey profiles are presented here: Weston-super-Mare to Bristol Temple Meads and Bristol Temple Meads to Bristol International Airport. These are depicted below as Figure 1 and Figure 2 respectively.

These profiles break the journey into legs, each of which is defined by a station stop. These stops also provide (on a largely single-track regime) the potential passing places. Also included is a speed versus distance profile (Figure 3) for the longest leg (10km) with and without slight blunting of the transition from acceleration to deceleration. The maximum speed achieved on this longest leg is slightly more than 200mph.

Text Figures:

Figure 1 The journey from Weston-super-Mare to Bristol Temple Meads

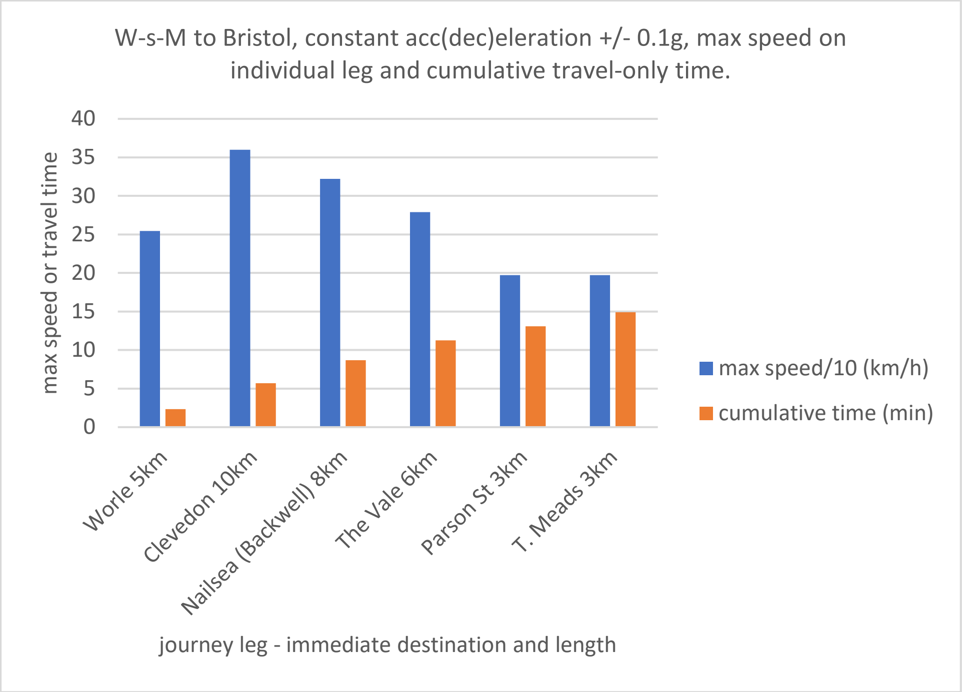


Figure 2 The journey from Bristol Temple Meads to Bristol International Airport

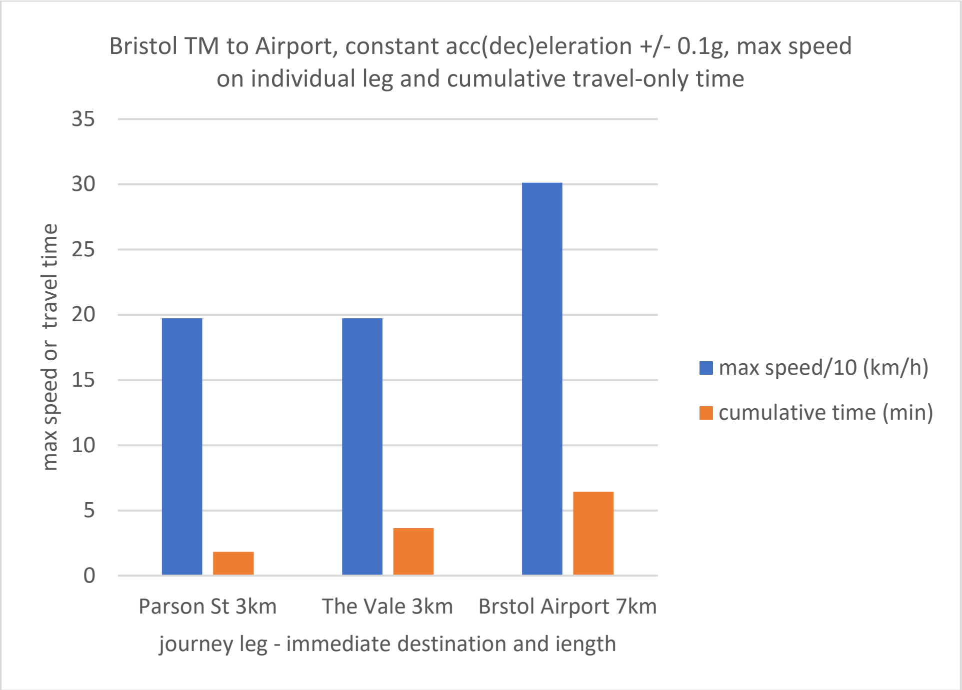
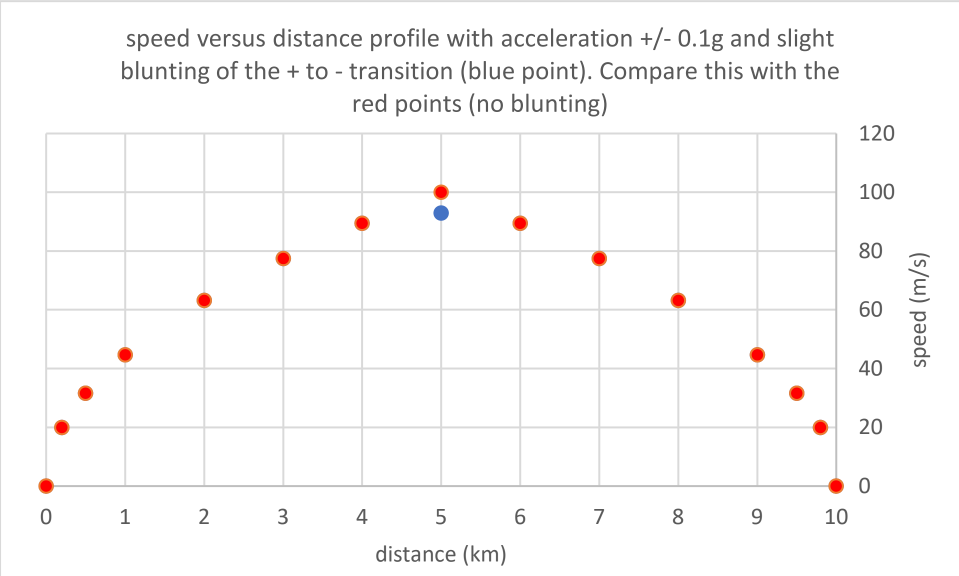


Figure 3 A speed profile along the 10km leg from Worle to Clevedon



3. Implementation

This proposal implies a very large construction project. It would first require a substantial feasibility study and a decision about whether to build in stages. An obvious first stage would be a link from Bristol City (or perhaps from the The Vale) to the Airport. The precise route taken would also require careful planning, but a particular virtue of such a system is its very small footprint and its flexibility: thus it is able to meld rather unobtrusively into the landscape, whilst being able also to negotiate intensively built-up areas either on comparatively lightweight support pylons or in tunnels. Rather steep gradients would pose no particular problem. Costing such a project at this early stage would be an unrealistic effort.

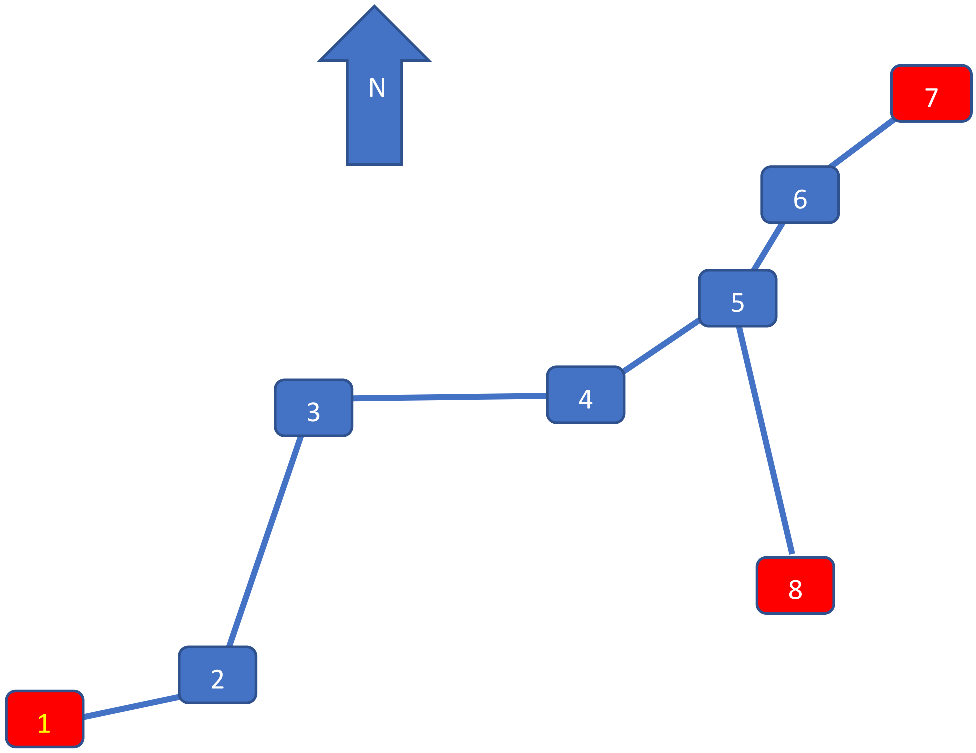
Robin Jeacocke April 2018

A proposed light rail passenger link from W-s-M to Bristol and to Bristol Airport

Using linear induction motor propulsion plus MAGLEV

Stations (T) is a terminus:

1. Weston-super-Mare (T)
2. Worle
3. Clevedon
4. Nailsea (Backwell)
5. The Vale
6. Parson Street
7. Bristol Temple Meads (T)
8. Bristol International Airport (T)



Terminus stations are in red