Transactions on the Built Environment vol 64, © 2003 WIT Press, www.witpress.com, ISSN 1743-3509

Ultra light rail as intermediate transport for the urban environment

C. Jefferson[1], T. Griffin[2] & J. Skinner[3]
[1]*Faculty of Computing, Engineering and Mathematical Sciences, University of the West of England, UK*
[2]*AEA Technology Rail, Uk*
[3]*Bristol Electric Railbus, UK*

Abstract

Ultra Light Rail (ULR) is a form of transport that combines the environmental and user advantages of light rail with the cost effectiveness of bus operations. It is characterised by the use of small vehicles which can penetrate pedestrian areas safely and unobtrusively, and which are autonomously powered, so avoiding the cost and visual intrusion of overhead supplies and also the cost of track isolation and the need to relocate services beneath the road. Implementation costs are typically around £1M per km. Headways of down to 30 seconds allow a capacity of up to 6000 passengers per hour per direction. ULR is therefore a viable option on routes where patronage is insufficient to justify conventional light rail schemes. A further advantage over buses is the ability to run on conventional railway where it already exists.

Two case studies are presented, Bristol, UK and Kalamata, Greece, where ULR schemes are planned.

1 Ultra light rail, what is it?

Ultra Light Rail (ULR) is a name that has been given to a new concept based on existing well-tried tramway technology and principles [1]. The principal features are:

Transactions on the Built Environment vol 64, © 2003 WIT Press, www.witpress.com, ISSN 1743-3509

- Use of conventional light tramway or railway, with consequent improvement in energy efficiency (ULR trams require around one third of the energy used by a similar-sized diesel bus)
- Small capacity vehicles (35-45 passenger modules) providing a frequent service on less intensively used routes, which do not justify the cost of conventional LRT.
- Tighter minimum curve radii (12m instead of 25m) allowing greater flexibility in choice of route and therefore a higher probability of feasibility and of achieving lower costs.
- One person operated trams.
- Easy access for all, since ULR trams will meet modern accessibility requirements in full.
- Lighter vehicles allow lighter track and structures and shallower track bases in the street.
- No need to remove under street services since light vehicles can use temporary track whenever access is required.
- No continuous electrification, this avoids ugly and inconvenient overhead wires with all their hazards and cost. It also avoids electrical interference and earth leakage problems. Light vehicles running on steel rails use less energy which opens up a number of attractive options for low energy, low emission traction systems.

ULR provides solutions to the following problems that many transport providers have faced over recent years:

- A low cost public transport system that is as attractive to the user as conventional light rail.
- An attractive, readily accessible system that can operate safely in pedestrian areas
- A fixed route public transport system that encourages investment in sustainable (traffic free) development by enhancing property values
- An effective transport system for historic and sensitive sites due to its minimal environmental impact.

2 Traction options

Ultra Light Rail vehicles use on board energy storage (at present batteries or flywheels) to drive their electric traction motors. For limited range applications vehicles are charged from an electrical supply at stops. To give added flexibility and range and avoid the costs and potential time delays of charging at stops, a small on board generator can be provided. This can be powered by clean diesel or gas (natural or propane). The generator need only be a quarter the size of a conventional vehicle engine because it is used in association with

Transactions on the Built Environment vol 64, © 2003 WIT Press, www.witpress.com, ISSN 1743-3509

energy storage. In the longer term it is anticipated that ULR trams will be powered using fuel cells, eliminating emissions entirely [2].

3 Relative costs

Numerous studies, supported by quotations from suppliers demonstrate that complete ULR systems, including trams, can be implemented and built for between £1million and £2million per route km, according to the application. This is about one tenth of the cost of full scale LRT systems and roughly equivalent to that of a high quality bus priority scheme.

The operating economics should be similar to those applying to a microbus operating commercially along a fairly low intensively used route.

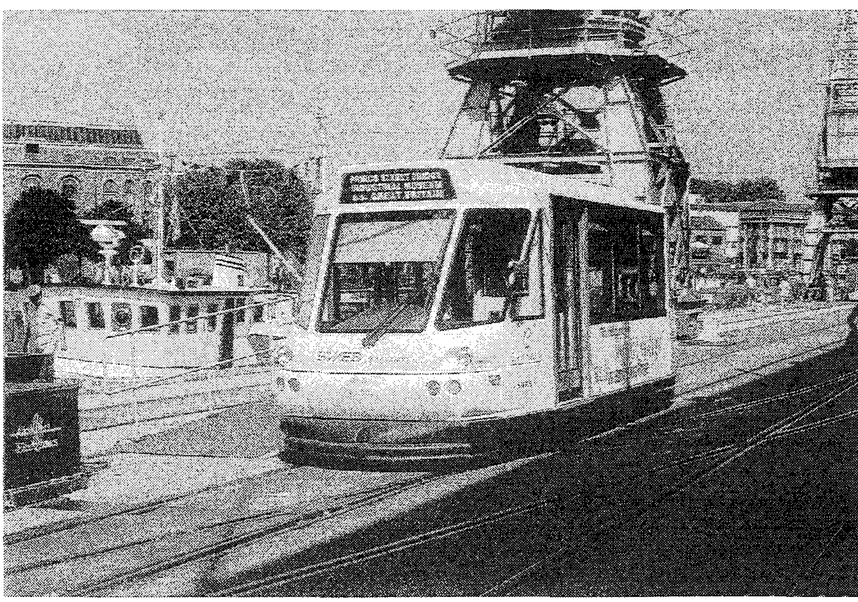

Figure 1 Ultra light rail at work in Bristol

4 Why trams not buses

Trams have many advantages over buses. But there are two characteristics in particular which make trams likely to be the vehicle of choice for future urban transport – popularity with the public and high energy efficiency. It is only the exceptionally high cost of conventional trams which has prevented them from replacing buses in urban areas. Conventional tram systems are so expensive

Transactions on the Built Environment vol 64, © 2003 WIT Press, www.witpress.com, ISSN 1743-3509

that they can only operate commercially in large towns with high population density, where they can carry in excess of 3000 passengers in each direction every hour. But now, with the introduction of Ultra Light Rail, this is all set to change.

Ultra Light Rail is a public transport system that provides trams instead of buses, at a similar cost. It is an idea that started with a West Midlands (UK) entrepreneur called John Parry who was looking for a solution to housing problems in Africa. He remembered that in 19^{th} century England trams had provided cheap transport to carry industrial workers between the factories and their homes. However, in the UK, the tram was largely swept away by the powerful financial interests promoting the internal combustion engine, rubber tyres, oil products, the diesel bus and the motor car. Parry experimented with the design and manufacture of a low-cost, light tram, running on electrical energy, stored in a flywheel.

Bristol Electric Railbus Ltd., set up the first-ever demonstration ULR service in 1998, running along the Harbourside in Bristol (UK), using a proof-of-concept Parry tram. It ran for 30 months and carried over 50,000 paying passengers, proving highly popular with the people of Bristol. The demonstration ran until October 2000, when Bristol City Council agreed to include an extended ULR route in its current Local Transport Plan.

5 Long term development

A unique opportunity exists for integrated development of land in the Ashton Vale and Cumberland Basin areas of Bristol along a disused rail corridor. It is proposed that such development should meet all sustainability criteria and thus be a model for sustainable urban development elsewhere.

It is planned to develop and extend this rail corridor into a fully operational 4.5 km passenger transit link which would connect the proposed development with:-

- Ashton Gate, with eventual convenient rail connections to Portishead, Bristol Temple Meads (the main railway station) and beyond
- The Arena Leisure Complex
- The Riverside Garden Centre
- The Create Centre and Bristol Record Office, both major employment centres
- South Harbourside (Industrial Museum, Maritime Heritage Centre and SS Great Britain), a major visitor attraction.
- North Harbourside and Arnolfini arts complex

Transactions on the Built Environment vol 64, © 2003 WIT Press, www.witpress.com, ISSN 1743-3509

- The City Centre, with connections to the main public transport network.

The potential exists for extension of the route to the Long Ashton Park and Ride site, though limited parking provision could be provided along the existing route. A schematic of the route is shown in figure 2.

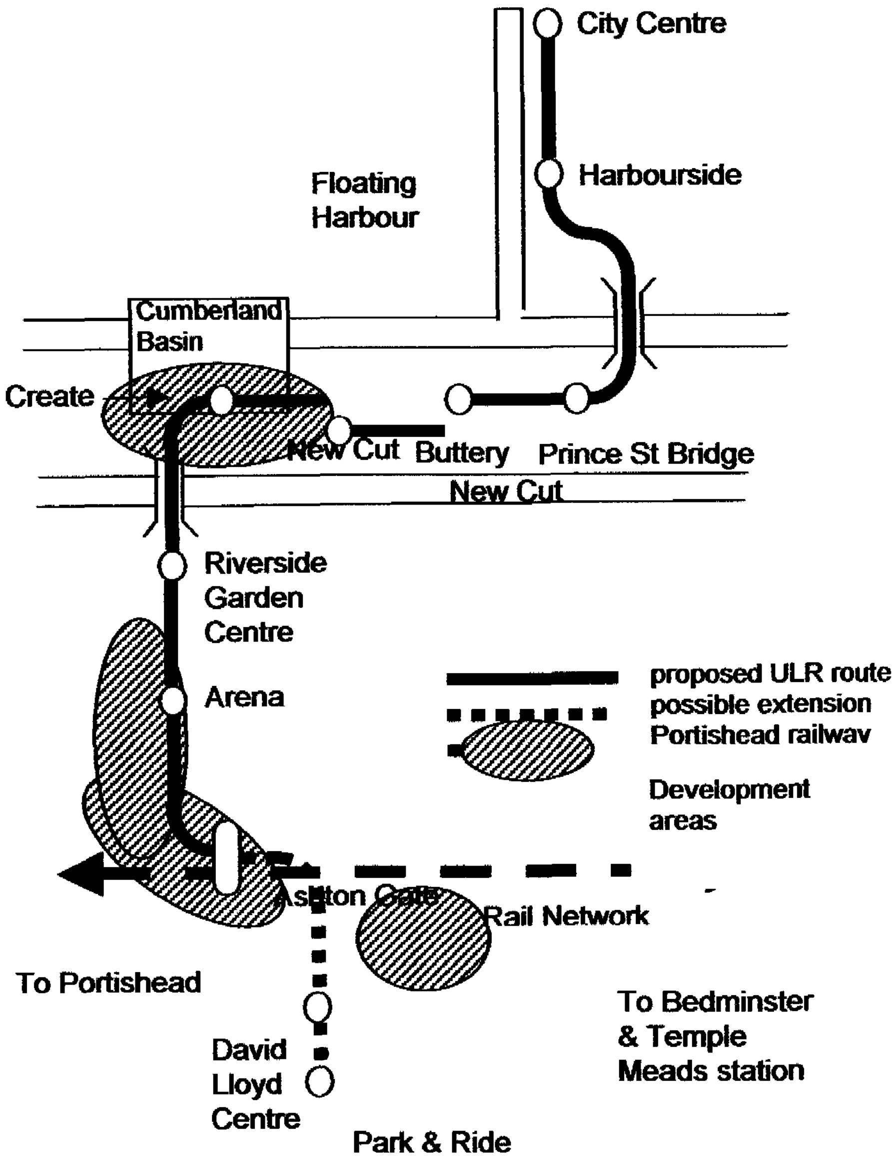

Figure 2. Opportunities for ULR based development in Ashton Vale

Transactions on the Built Environment vol 64, © 2003 WIT Press, www.witpress.com, ISSN 1743-3509

The technology proposed for this transport link, Ultra Light Rail, would meet the strictest environmental and safety standards, being either emission-free or very low emission (at least meeting EURO V), and highly energy efficient. This transport link will not only provide transport facilities to the Park and Ride, thus encouraging further transfer from private car to public transport, but will also provide for the mobility and accessibility needs of the community in and around each development. It provides the opportunity, as a contribution to sustainability, to incorporate a significant proportion of low cost and car free housing, drawing on experience in such development in Sutton (UK), Edinburgh (UK), Germany and the Netherlands.

6 Future transport links

Development external to this scheme will provide the opportunity for further enhanced transport links:

- Reopening of the Portishead line. This could enable links to Portishead, Pill, Bedminster and Bristol Temple Meads (i.e. connecting with the main line rail network)

- Linkage with the proposed Citylink rapid transit route at the Centre giving access to Broadmead, Temple Meads and Bristol's North Fringe.

The development could not only provide for the local community but could considerably widen access to Central Bristol (and eventually the North Fringe) from the South and access to SW Bristol from elsewhere, without increasing road traffic.

7 Proposal for Kalamata, Greece

The town of Kalamata, Greece, is scheduled to become the first 'showcase' for this novel form of transport. A group of British companies, working together as the Sustainable Transport Consortium (Sustraco), has been approved to supply the world's first urban Ultra Light Rail (ULR) public transport system to the town. On 30th April, the Municipal Council of Kalamata voted to proceed with their plans for the purchase and installation the ULR system.

Kalamata is a seaside town and port in the southern Peloponnese, with a population of 55,000. The plans are based on an offer for the supply of the system by Sustraco, following a design and route prepared for the Municipality by the Greek transport consultants Dromos of Athens. The ULR system for Kalamata is based upon ultra low emission hybrid diesel/electric trams using state-of-the-art sodium nickel chloride batteries to provide efficient energy storage.

Transactions on the Built Environment vol 64, © 2003 WIT Press, www.witpress.com, ISSN 1743-3509

The Sustraco offer comprises supply of the rail and switches needed for a 10-kilometres of metre-gauge light rail track and eight trams, to be built by Clayton Equipment Ltd of Hatton, UK, each with 45-passenger capacity, together with certain technical services. The service is designed to provide a tram every 7.5 to 10 minutes in each direction.

It is expected that with the associated civil works, to be carried out by a local contractor, the total project cost will amount to less than one tenth of the cost of a conventional light rapid transit system, (of the type that now exists in Manchester, Birmingham, Sheffield and Croydon).

The Sustainable Transport Company was formed by Bristol Electric Railbus Ltd, which pioneered Ultra Light Rail with its 30 month demonstration service in Bristol. The consortium is led by De Leuw Knight Piesold, specialist railway consulting engineers, with staff in Athens. AEA Technology Rail will provide specialist consultancy services.

The Kalamata decision marks an important milestone in the introduction of Ultra Light Rail as an alternative option for public transport. The principal advantages of ULR, apart from its low capital and operating cost, are its popularity with the public, its ultra low emissions, its exceptionally high energy efficiency and its compatibility with pedestrianised areas, which are becoming an increasingly important feature of town centres in all parts of the world. The vehicles will have zero emission operational capability if required (e.g. in congested town centre conditions). Figure 3 shows an impression of the proposed vehicle.

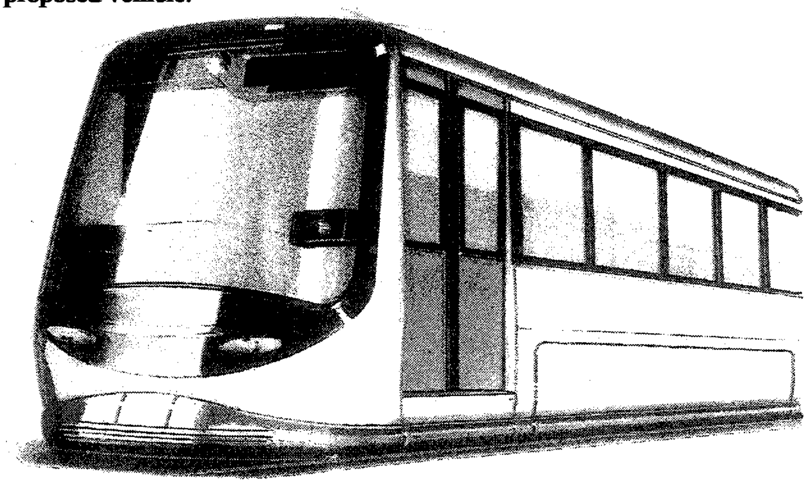

Figure 3. An impression of the proposed ULR vehicle for Kalamata

Transactions on the Built Environment vol 64, © 2003 WIT Press, www.witpress.com, ISSN 1743-3509

Funding for the Kalamata project is expected to come principally from the European Union through the European Investment Bank with the balance being made up by the Government of Greece. The supply contract is for Euros 6.2 million and the whole system will be installed for less than £5 million or £500,000 per kilometre. This is a revolutionary event in public transport – guided busways are normally reckoned to cost around £3 million per kilometre and even normal bus lane systems about £1 million per kilometre.

The Kalamata tramway will run for 5km from the Market adjacent to the bus station in the north of the town south through the town centre to the port and then east along the seafront. The exact detail of the route has yet to be decided and will involve consultation, but the objective has been to separate trams from traffic as much as possible so that they both make new pedestrian areas more attractive and serve the town more effectively. Although there are large pedestrian squares in the town centre at present, most streets are congested with car traffic and with parking on both sides. There is very little off-street parking.

The planned route runs south from the market on reserved track to the bottom of Othonos Street where it becomes a street tramway. The idea is that it will run down the main Aristomenous street which will be pedestrianised and then through Vas. Georgiou the principal square in the heart of the town. Here it will directly serve shops, restaurants and cafes, civic buildings, the theatre and pass close by the railway station. The route then splits; the route to the port continuing via Faron, which is a wide shopping street: the return route will be through Filellinon on a largely reserved track route. These two single lines will be two short blocks apart.

The two lines will combine on the seafront at the foot of Faron at a stop where it will be possible to turn trams back during the off-season. The seafront line will continue on the seaward side of Navarinoy as a tramway, to a terminus near the Patista Hotel. The seafront is a busy area and there may be an advantage in reducing traffic along it. At present many cafes have seating split by the road. The depot will be located at the northern end of the route and reached by a short reserved track extension. It will be near to an existing Council maintenance depot.

The route will bring people from the bus and rail stations into the town and to the seafront. It will provide a very convenient and frequent 'hop on and off' link in the main shopping and commercial streets and along the seafront. It corresponds with the principal traffic movement within the town. Its existence will allow the introduction of park and ride, further pedestrianisation and investment in the town. This will improve the environment of the town centre, reduce accidents and increase prosperity. Kalamata will be a much more lively and pleasant place to visit and do business in. Local people and visitors will have the convenience of high quality, frequent, accessible, relatively fast and reliable transport facilities. This will

Transactions on the Built Environment vol 64, © 2003 WIT Press, www.witpress.com, ISSN 1743-3509

encourage greater public transport use in the town generally and improve the viability of the local bus network.

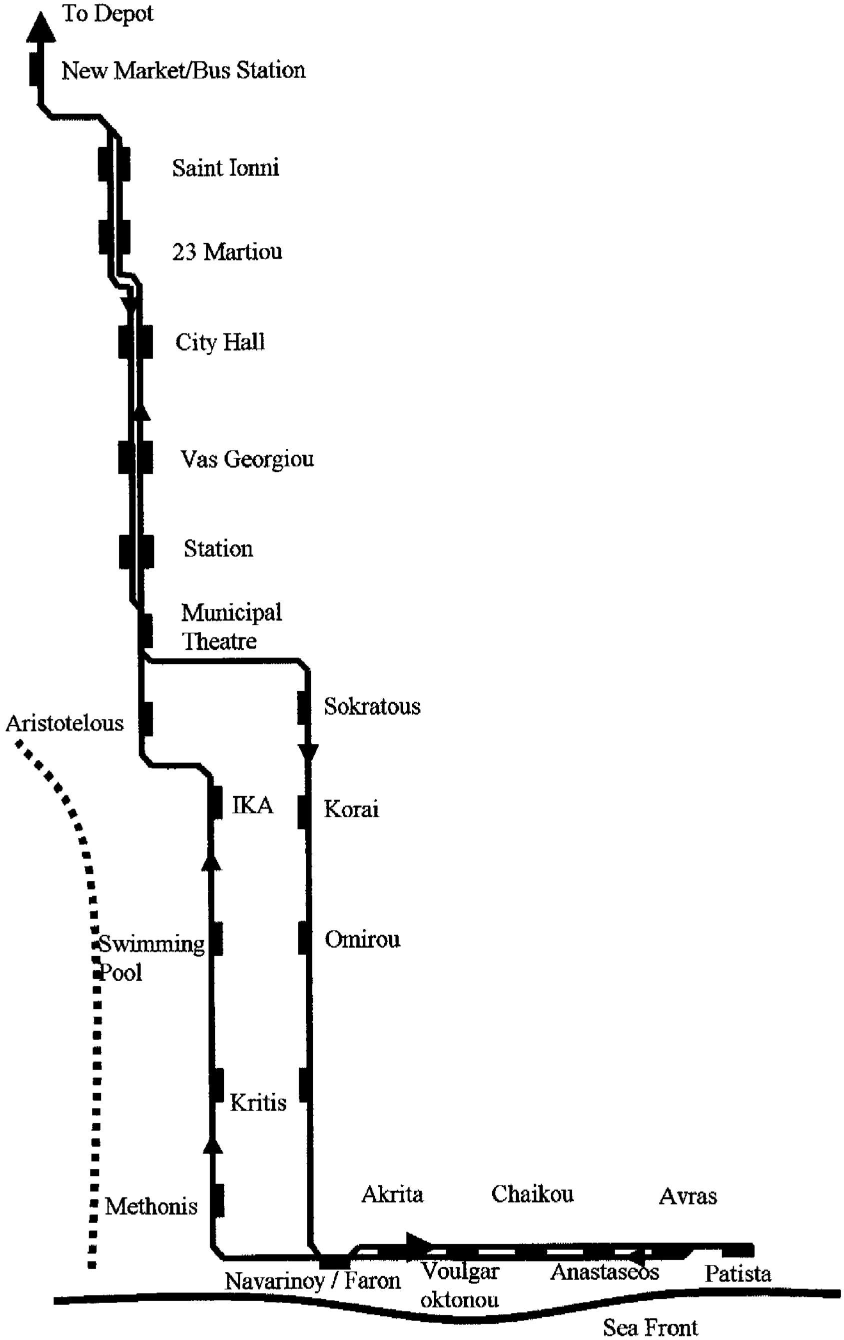

Figure 4 Plan of proposed ULR route in Kalamata

Transactions on the Built Environment vol 64, © 2003 WIT Press, www.witpress.com, ISSN 1743-3509

8 Comparison with bus operation

Apart from its ability to penetrate pedestrian areas safely, the most significant advantage over the bus is its far greater energy efficiency. Clayton reckons that the ULR tram will consume about 10 kWh energy per circuit, compared with 35 kWh for a similar sized bus. This difference comes principally from the reduction in rolling resistance achieved by running the tram with steel wheels on steel rails. The Kalamata tram will be at least 3.5 times less polluting than an equivalent bus, being powered by a highly efficient low-emission 35kW diesel generator, running at a steady speed and power for optimum efficiency.

9 Future vehicle development

This technology represents only an interim stage in the progress towards the definitive zero-emission ULR tram. This will be a light tram, powered by a low capacity fuel-cell, storing energy in ultra-capacitors and using hydrogen fuel produced by renewable energy through electrolysis of water [2]. This is where the true significance of the energy efficiency of the ULR tram will come into its own. Hydrogen provides an excellent means of storing energy generated by photovoltaics and wind – but it is expensive. The low capacity fuel cell and reduced energy requirement of the ULR tram will make it commercially viable where the equivalent bus would be far too expensive both to procure and operate. The fuel-cell powered tram will be able to provide towns and cities all over the world with a popular form of public transport with zero emissions, using locally-generated, renewable energy.

Conclusion

The Kalamata tram represents a major milestone in the development of low-cost, low-emission ULR which can be adapted for zero emissions when the technology becomes available. When governments, transport authorities and operators become genuinely interested in energy saving and, thus, CO_2 emission reduction, then the introduction of ultra light rail can provide a popular, effective, low-cost way to achieve it. Further advantages of rail based transport are that it not only provides safe access to pedestrian areas which buses cannot, but it also gives the public confidence in the permanence of the service.

References

1. Griffin, T. Ultra Light Rail Developments. Proc. I Mech E Vol 215 part F, F02600, 21st November 2000.
2. Jefferson C M and Barnard R H, *Hybrid Vehicle Propulsion*, Advances in Transport, Vol 10, Ch. 4, WIT Press, Southampton, ISBN 1-85312-887-2