



Cities look to reduce use of cars

In this special report, **Robert Wright** looks at the infrastructure issues that face both emerging and developed economies

The stream of traffic that pours noisily down Sheikh Zayed road on a weekday evening is a powerful reminder of the challenge facing public transport.

In Dubai, as in many emerging economies, road remains the means of transport of choice for much of the population.

Despite the forbidding traffic jams that are a feature of many of the world's fastest-growing cities, most residents have a strong preference for travelling in the comfortable, air-conditioned motor cars that are among their proudest possessions.

But a look to one side of the road should give hope to the delegates gathering in Dubai this week for the congress of UITP, the international public transport association. Just off the road, by the garish Ibn Battuta shopping mall at the city's southern end, passengers bustle between buses and a station on Dubai's smart new metro system.

They are undertaking, by metro and bus, journeys that, until little more than 18 months ago, they would have had little option but to make by car or taxi.

The city's metro, like many urban transport systems in developing economies, has outperformed its pre-opening traffic forecasts. It is gradually becoming the backbone of the city's public transport system, shuttling passengers between interchanges that let them undertake the complex journeys inhabitants of any modern city want to make.

It is the kind of scene likely to be increasingly replicated across the Middle East, as the region's economies, buoyed by high oil



On the right track: the Dubai metro speeds by the Sheikh Zayed road. The metro has outperformed its pre-opening traffic forecasts, despite the regional popularity of the car AFP

prices and strong demand, rapidly develop their cities and seek to make them more pleasant.

"Dubai took less than four years to build its first metro line," says Mohamed Mezghani, head of UITP's Middle East office, contrasting this with the far slower pace in most of western Europe. "Building 50km in less than four years - it's a very big achievement."

But Dubai, as well as Abu Dhabi, Qatar, Saudi Arabia and other new areas considering building substantial public transport systems for the first time, need to be conscious of their biggest competitor, Mr

Mezghani says: "We must offer services that are competitive with the comfort they have in their cars, with the travel times they can have with their cars."

The surge of public transport interest in the Gulf reflects a worldwide trend, according to Alain Flausch, president of UITP and chief executive of Brussels' public transport company.

Many governments in western Europe, Asia and the Americas are either developing new public transport systems or trying to wring extra capacity from existing networks.

Most are responding to pressure from the wave of urbanisa-

tion that is bringing populations from rural areas into densely packed cities.

Buses, trains and metros are often the only realistic means of transporting the huge numbers of people seeking to move about the most heavily populated metropolises.

"When you look around at people talking about the future, they all say about their cities, 'Our city will not survive if we do not develop public transport'," Mr Flausch says.

"Being practical, the amount of space we have in any city is limited. If we want our cities to remain pleasant places to live, there's a limit to piling up cars."

It is not only the most eye-catching developments - the gleaming new metro and light-rail systems - that are reviving interest in public transport.

In many developing-world cities - such as Johannesburg in South Africa and Bogotá in Colombia - the humble bus is likely to remain the mainstay of public transport for the foreseeable future.

Buses' efficiency in such cities has been transformed by their use of special, dedicated lanes and stops that look more like metro stations than traditional roadside halts.

Laurent Dauby, director of knowledge and membership

services for UITP, argues that bus rapid transit systems offer such clear benefits that they may edge trams out of some emerging economies' transport mix.

"I think that in the big emerging cities of Asia and Latin America, we will have metro or bus," Mr Dauby says.

"I'm afraid that maybe tram will not have its place in the mobility portfolio. This is because, when buses are designed as a system, with their own right of way, you can achieve a lot that you achieve with a tram."

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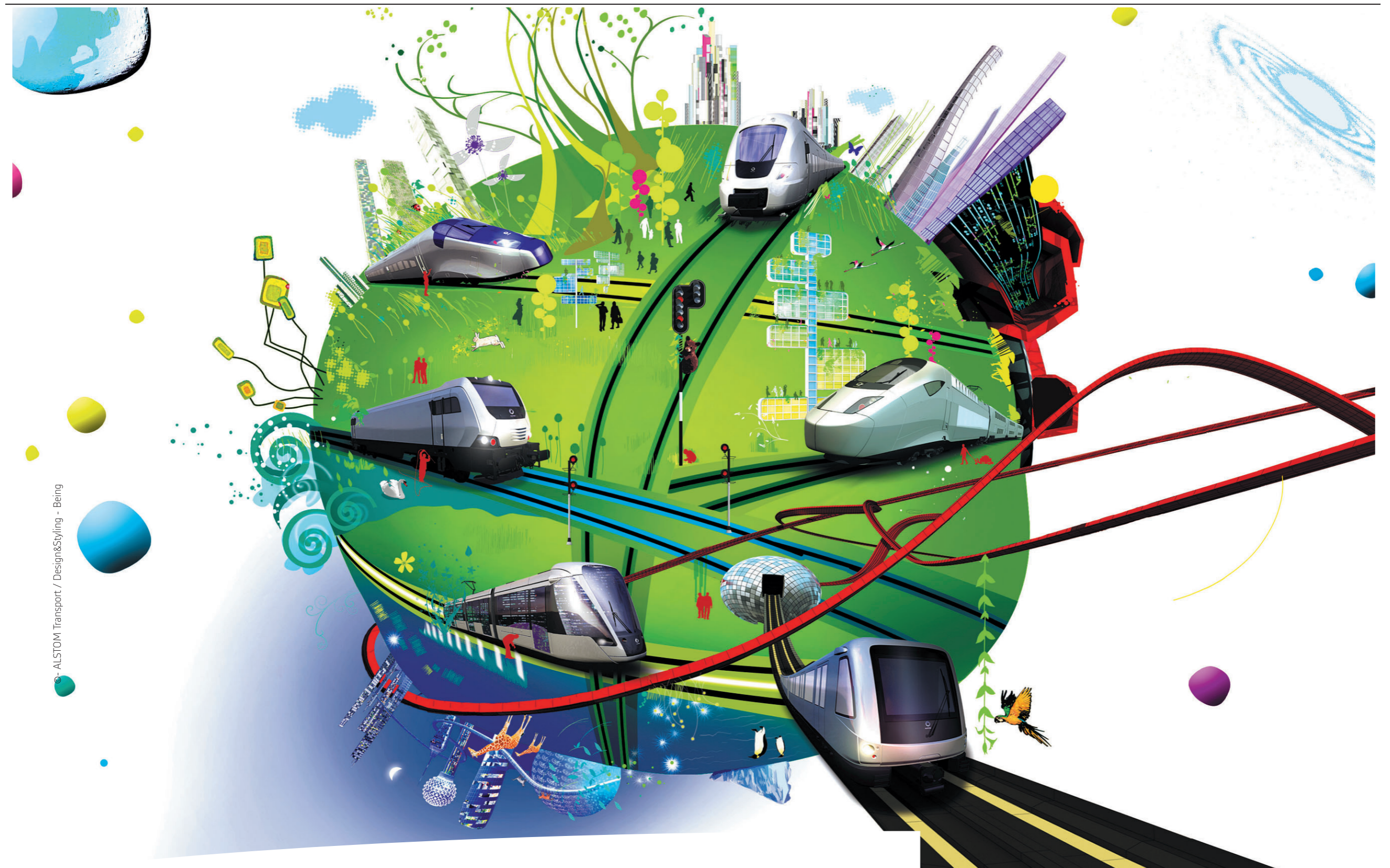
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Desert city aims to help put others in the shade

Environmental issues

A development on the edge of the sands is providing a green example regionally and globally

It is obvious from the moment a visitor arrives at Masdar City, on the edge of Abu Dhabi, that this is more than just another development sprouting from the desert. The transport from the car park to the main square is an electric, four-seater pod guided by wires beneath the road. A staircase at the terminus leads to a narrow street and shaded squares.

The atmosphere is reminiscent of Tangiers or one of the Arab world's other more ancient cities rather than a modern development. But Masdar, being designed by London-based Foster and Partners, is meant to be more than a pleasant retreat.

Its promoters hope that, with its mix of high technology and time-honoured methods of coping with the Gulf heat, it will set an example by consuming less energy than other newly built cities in the region.

The question is how far any lessons learnt can be applied to the sprawling metropolises blooming elsewhere.

Pedro Haberbosch, one of the Foster and Partners architects

Mohamed Mezghani, head of UITP, Middle East; Masdar is 'a laboratory of new technologies'

leading the project, says the main aim is simply to make Masdar as green and sustainable as possible.

He describes the city as "a showcase of what components need to be considered in sustainable urban design".

The Masdar approach contrasts sharply with that taken until recently in Dubai, the United Arab Emirates' largest city. On the Palm Jumeirah – the vast artificial archipelago that is one of the city's most notable recent developments – developers were allowed to meet demands to supply public transport by building a monorail with only two stations, one at the palm's outer edge and the other at its roots.

The monorail glides past rows of apartment blocks on the palm's trunk. This could make an excellent public transport market, according to Mohamed Mezghani, head of the Middle East office of UITP, the international public transport association.

"It's like we missed an opportunity there to offer a public transport service to those people living on the trunk," Mr Mezghani says.

The most striking aspect of Masdar's transport infrastructure is what is lacking.

While linked buildings

elsewhere in the Gulf are joined by air-conditioned bridges, Masdar has been designed, Mr Haberbosch says, so that inhabitants have to come down to the ground.

That is intended to create a bustle at street level that will encourage residents to walk. Conventional cars are also banned. In due course, electric taxis, a metro station and light rail should arrive, and the developers are keen to encourage cycling.

"In the UAE... the whole connective tissue of the city is primarily car-based," Mr Haberbosch says. "The notion [in Masdar] is to design a very compact city, a high-density, low-rise urban environment, that's self-shading: a streetscape that first and foremost is very attractive for pedestrians."

There remain fundamental problems. The pod system that transports visitors from Masdar's car park to the postgraduate Masdar Institute of Science and Technology is unsuitable for the citywide application originally intended. Later phases of the development will rely on other transport modes.

There are also question marks over how quickly the planned light-rail system and Abu Dhabi metro, a station of which should form a focal point for Masdar, will reach the development.

"It's a laboratory of new technologies and it's a small-scale project compared with a city such as Dubai or Abu Dhabi," Mr Mezghani says. "It could be a model, maybe; it's too early to say whether Masdar will be a good practice case or not."

But there are undoubtedly aspects of Masdar's design that other places want to emulate. Worldwide, many cities originally built around cars are now scrambling to create areas of denser housing, shopping and recreation inspired by ideas similar to Masdar's closely packed buildings.

Public transport requires high population densities, while tightly packed developments also naturally crowd around public transport stops.

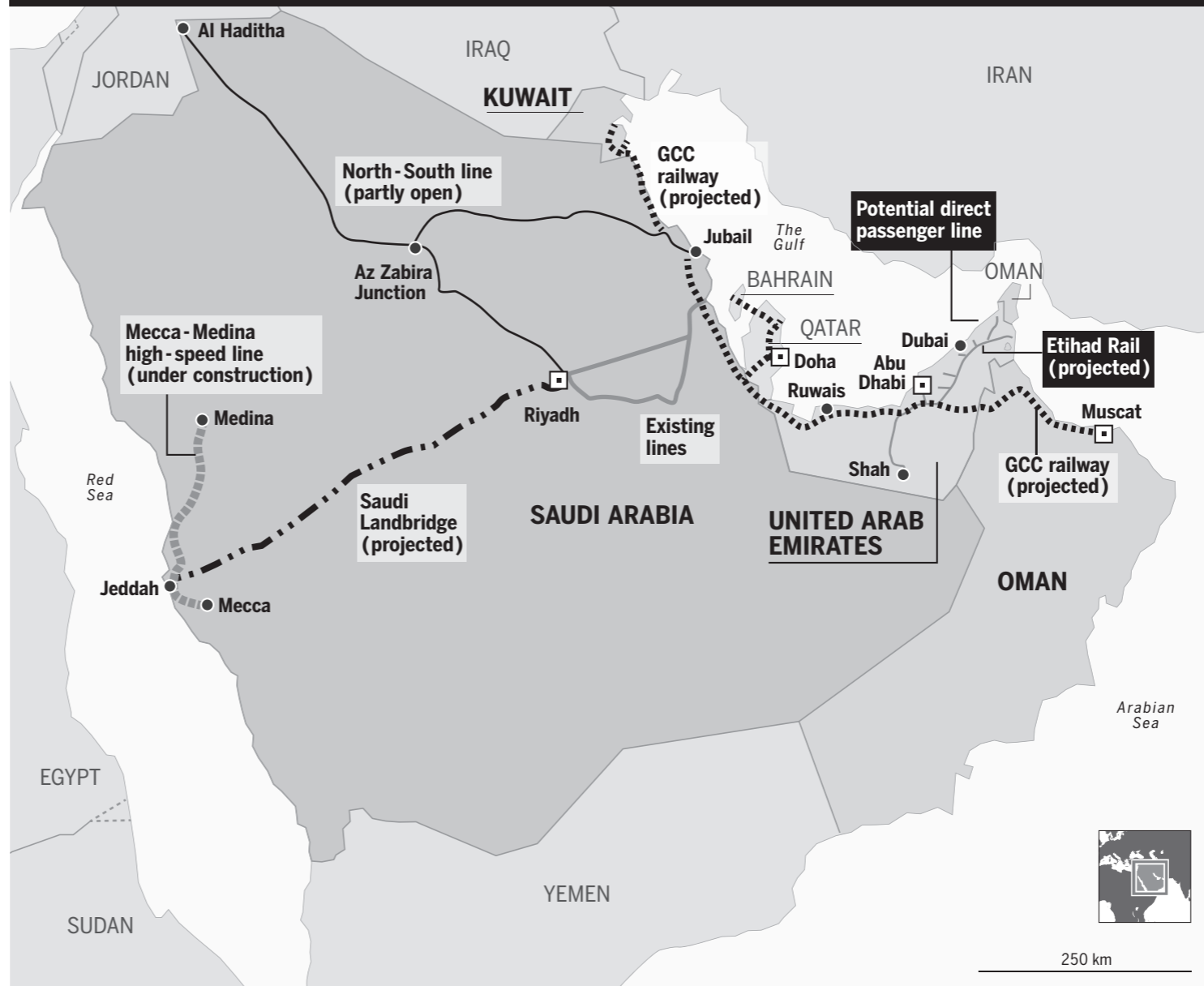
Adnan al Hammadi, chief executive of the rail agency at Dubai's roads and transport authority (RTA), says developers are already prioritising building developments close to Dubai's relatively new metro line.

"Many developers have seen the benefit of coming close to a transportation system and how that can add value to their property," Mr al Hammadi says. "We are being approached by many developers."

While only a traditional, large-scale metro was ever likely to have addressed Dubai's transport needs, Ramadan Abdulla Mohamed, director of the RTA's rail operations department, believes Masdar-style ideas might spread to smaller cities.

"Looking at Dubai... having a metro service was the best solution for us," he says. "If you have a smaller area or something else different, you can choose another solution"

Gulf states: planned rail links



Sea of sand is set to be transformed by network

Long-distance lines

The UAE and GCC states are rushing to emulate China's dash to build rail links

The scrub-speckled desert that covers much of the United Arab Emirates is reminiscent of parts of the American midwest – arid, flat and carpeted by the wiry plants that can survive in such conditions. The resemblance will grow still closer after 2013, when the same kind of heavy, diesel-powered freight trains that roll across many a US wilderness will become part of some UAE deserts.

The plans – not only for a new railway system to span the UAE but also for a wider network linking all six Gulf Cooperation Council (GCC) member states – are making the Middle East the latest region to emulate China's rush to build long-distance railway lines. Both Etihad Rail, formerly Union Railway, building the UAE's system, and GCC Rail make ambitious claims for the amount of traffic they should be able to transfer from cars and trucks to rail.

However, while high-speed rail tracks are rapidly snaking their way between China's main cities, and other developing economies are working on similar plans, passenger rail looks set to take lower priority in the Gulf. The passenger trains that do operate are also likely to run at lower speeds.

Saudi Arabia, where demand patterns are different because of the annual arrival of millions for the Hajj pilgrimage, is working on a line to carry 320kph trains between the holy cities of Mecca and Medina. But the initial passenger services between Abu Dhabi and Dubai, and across other parts of the region, look set to run at a maximum 200kph.

The debate over how to fit passengers into the Gulf's rail plans raises broader issues about the extent to which regions with spread-out, low-density cities will ever be able to transfer large numbers of longer-distance passenger journeys from road and air to rail.

In February, the US state of Florida abandoned plans to build a high-speed rail network partly because passenger number projections seemed over-optimistic.

Mohamed Mezghani, head of the Middle East office of UITP, the public transport organisation, says he is sure there is potential to offer rail commuter services at least between Abu Dhabi and Dubai.

There is also potential for long-distance rail services to encourage use of the region's developing metro and light rail networks. Passengers who arrive in a city centre by rail are far more likely to continue to their final destination by metro, where it exists, than those arriving by car or air.

"There would be no problem finding space to build this connection," Mr Mezghani says of the Abu Dhabi-Dubai line. "I'm surprised it's not yet done."

Richard Bowker, Etihad Rail's chief executive, says the decision to focus primarily on freight reflects the UAE's economic priorities.

"There's a growing need for logistics capability in the country, because the pace of growth has been phenomenal," he says. "Keeping pace with that requires infrastructure and logistics capability, which the road network is really struggling to cope with."

There can be no doubting the determination of Gulf countries to build railways fast. Eran Gartner, president of the systems division of Bombardier Transportation, the world's big-

"There's a need for logistics capability in the country because the pace of growth has been phenomenal"

gest trainmaker, says the position of Gulf countries is similar to that of China, the only place in the world where projects routinely finish ahead of schedule.

"The kingdom and the various emirates, once they have selected their partner, are eager to see the fruits of their ideas quickly," he says.

Etihad Rail announced on March 23 that, although it had only just issued tenders for the first phase of a 264km line to carry sulphur between Shah, in inland Abu Dhabi, and the port of Ruwais, it intended to move

the first cargo in 2013. The entire 1,200km network planned for the UAE, handling both freight and passenger services, should be complete by 2018.

This extraordinarily tight timeline, Mr Bowker says, has helped focus Etihad Rail on a mixed freight and passenger network designed mainly around freight needs.

The company examined the potential for a direct passenger-oriented, and potentially high-speed, route along the coast between Dubai and Abu Dhabi. Early analysis suggested there was "quite a strong" case for building such a line in addition to the mixed-traffic route, which will detour some distance inland.

However, a direct, coastal passenger route would require substantial, complex co-ordination between transport authorities in Dubai and Abu Dhabi.

"There's only so much you can do at once," Mr Bowker says. There remain questions over how attractive the passenger services on the mixed-traffic lines will be. Mr Bowker declines to be drawn on the journey time for the initial Abu Dhabi to Dubai passenger services. Without a high-speed capability, journeys on other parts of the GCC network look set to be intimidatingly lengthy.

However, Mr Bowker points to Dubai's often crowded new metro as evidence that Gulf residents can shift to other forms of transport. "I think that's a very useful test and evidence that, if we plan this right, we will be able to persuade people to use it," he says.

Planners look to reduce car use

Continued from Page 1

But many public transport markets – particularly in the developed world and the richer emerging economies – still demand the improvements in comfort, efficiency and environmental performance that are only possible with the latest advanced technology.

Among the most widely applied of these is communications-based train control (CBTC), the now standard signalling system for modern metros. This allows some systems to dispense with drivers altogether.

Such technology is spreading beyond the narrow world of metros to both suburban railways, including London's Thameslink and Crossrail routes, and tramsways.

Dubai's Al Sufouh tramway will be equipped with CBTC, one of the first to feature such a system, to ensure the vehicles stop precisely next to the doors of its air-conditioned stops.

Patrice Houdu, a senior executive in the rail control division of France's Alstom Transport, says the system allows operators to wring extra capacity out of overstretched networks safely. "In many cities, there's an increasing need for operators to increase the traffic and minimise the distance between vehicles," he says.

Yet, a little up Dubai's metro line from Ibn Battuta, there is a reminder of a key problem that will weigh on the minds of many at the UITP congress.

Near Dubai Marina metro station, work on the Al Sufouh tramway has only just restarted after stopping when funding dried up during Dubai's financial crisis in late 2009. Similar shortages of public-sector funds – less acute but probably longer-lasting – threaten many urban transport schemes worldwide.

The shortage is sparking interest in private sector-led funding mechanisms. It may also offer a foothold to cheaper, Asia-based suppliers of metro and other rail vehicles, including the Chinese manufacturers currently working hard to break into the UK market.

But capacity to invest in public transport looks bound to be weaker in many important markets in coming years. The most indebted Eurozone countries – Greece, Spain, Portugal and Ireland – had all invested heavily in light-rail systems. They have little prospect of making significant investments again soon.

That will only increase the importance for rail and bus suppliers of less traditional markets, such as the Gulf states.

An increasing proportion of the available work is also likely to involve the difficult task of modernising ageing light rail, metro and suburban rail systems.

But there remain unmistakable signs of hope. Even glitzy Dubai has shown signs of turning its back on the car and taking to the metro and bus.

Public transport may finally be looking like the cool, sophisticated choice that the car seemed to be for much of the 20th century.

To retain that allure, according to Richard Bowker, chief executive of Etihad Rail, the company building the United Arab Emirates' first mainline rail system, it needs to maintain the high standards that the best networks are achieving.

"The Dubai Metro has already shown that if you plan it right, execute it very well, and the service quality is superb, people will get out of their cars and use it," he says.

Neighbours keep close eye on success of Dubai scheme

Metro system

Project faced with problems including social conservatism

A passenger heading to Dubai Marina from the metro station of the same name had better be in the mood for walking.

After an initial upward ride on an escalator, the route heads briefly parallel to the Sheikh Zayed road, which runs for the length of the elongated, sprawling city.

Then an air-conditioned bridge stretches 200 metres over Sheikh Zayed, some other roads and the construction site for the new Al Sufouh tram line.

Finally, a second set of escalators deposits the passenger at a stop for buses heading to the marina itself.

The scene illustrates the challenge the United Arab Emirates' largest city faces in trying to introduce public transport in a place that, like many in the fast-developing Middle East,

has grown up around wide roads and large distances that suit cars.

Planners knew from the start they would face a struggle persuading the city's population to abandon comfortable motor vehicles when the physical barrier of the roads, the lack of pavements in many places and the sheer heat that lasts for much of the year were working in the car's favour.

That the Gulf region's first metro, opened in September 2009, is already sometimes uncomfortably full has encouraged a spurt of interest in the potential for other cities in the region to launch similar systems.

The question is what elements of the planning have made Dubai's metro a success and what lessons it can teach other cities in the region that are considering similar schemes.

They include Abu Dhabi, the United Arab Emirates' capital, and Doha, capital of Qatar.

Paul Abbosh, regional development manager for the Gulf at Atkins, the engineering consultancy, says such cities watched Dubai's experience before deciding whether to build metros themselves.

"You're now looking at a lot of activity in terms of metros across the Gulf," Mr Abbosh says. "So they must have

concluded it was a positive experience."

Among the challenges the metro has had to overcome – and which may be still more severe elsewhere in the region – is the Arab world's instinctive social conservatism.

Cars are popular not only because of their convenience but because they afford privacy for women and children.

Local Arabs – who make up some 20 per cent of Dubai's population – can also be reluctant to mix with the Indians, Pakistanis and Filipinos who make up Dubai's working class, according to Mohamed Mezghani, head of the Middle East office of UITP, the international public transport association.

"Public transport is seen as a mode used by those who have no choice," he says.

Each train is equipped with a higher priced "gold

The metro has transformed the commuting scene



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Asians push for a bigger slice of wheel action

Foreign competition

Suppliers from Japan and China are making inroads into Europe

International passengers arriving at London's St Pancras station on Eurostar trains can already see one sign of Asian suppliers' push into the European passenger train market, the biggest in the world. The Class 395 high-speed domestic trains that use the platforms next to Eurostar's were supplied by Japan's Hitachi.

There could be more evidence shortly. As they enter St Pancras, Eurostar passengers could soon pass over Hitachi-built Super Express trains operating services from London's King's Cross station next door, after the UK government reaffirmed Hitachi as preferred bidder to supply the trains. Within a few years the same passengers may see Chinese-built trains running to north-west England from London Euston.

The questions about this proliferation of Asian-built trains are how widely it will spread, whether it is fair to allow such manufacturers into open European markets when their home markets are less open, and whether standards will suffer.

"We don't complain about Hitachi," says Michael Clausecker, director-general of Unife, the European railway industry body. "Hitachi, like every company in the world, uses the opportunities the market supplies to it."

Japanese policy towards outside manufacturers in rail and some other industries has long been discriminatory, however. "It takes them decades to open up and change their attitude to foreign companies," says Mr Clausecker.

The issues vary according to which Asian suppliers are under discussion.

Unife accepts the right of Chinese suppliers, which have yet to supply any trains to European Union markets, and companies from Korea, whose Hyundai Rotem has supplied the Athens metro and Irish rail-



On target: Hitachi's 140mph Class 395 Javelin train can travel from Ashford, Kent, to London St Pancras in 37 minutes Bloomberg

But he questions whether Chinese suppliers, while providing trains with lower capital costs, are able to offer the same low running costs as the latest, highly reliable, fuel-efficient European models.

David Shipley, chief executive of Chinese-Sourced Railway Equipment, a British company that markets Chinese trains in Europe, says such claims contradict other complaints European suppliers sometimes make.

Some, most notably Alstom of France, Europe's second-biggest trainmaker, have insinuated that China's export drive is drawing on technology European suppliers transferred to China under train-building joint venture agreements. Such technology is not meant to be exported outside China.

"They want to accuse the Chinese of stealing their own designs and technology and building them into their own trains – then they say the Chinese technology isn't as advanced," Mr Shipley says. "It cannot be both."

But the scene at St Pancras also illustrates the limits of the likely Asian advance. The current trains used by Eurostar, controlled by France's state-owned SNCF, were all built in France, mostly by Alstom, the country's national engineering champion.

When, last October, Eurostar announced plans to become the first SNCF affiliate to go to Germany's Siemens rather than Alstom to buy high-speed trains, the decision sparked bitter controversy in France, which builds nearly all its trains at home. The French government has held up changes to Channel tunnel safety rules necessary to allow the German-built trains to run.

Mr Clausecker insists the Eurostar controversy illustrates how much more open and competitive Europe's train markets are becoming. However, the Asian advance looks set to be confined to countries on the edge of the EU's core railway system, such as the UK, Sweden, Turkey and Ireland.

ways, to compete in European tenders. But there are questions about whether Chinese trains are yet able to match the reliability and low operating costs of European designs.

With Japanese suppliers, meanwhile, the argument is over the treatment of European suppliers. Japan's government has consistently excluded European companies from domestic tenders under rules that allow it to bar suppliers that fail to meet the country's strict earthquake safety standards.

Alistair Dormer, managing director of Hitachi Rail Europe,

insists the issue is that no European supplier has invested the same time and effort in understanding Japan's technical standards as Hitachi has in understanding the UK, the continent's most open market.

Germany's Knorr-Bremse, the brake supplier, which has devoted significant effort to understanding Japan, has succeeded in supplying brakes for the country's Shinkansen high-speed trains, Mr Dormer adds.

Mr Clausecker says Knorr-Bremse is supplying technology that no Japanese supplier can and that the real issue is

Japanese train operators' refusal to allow European suppliers even to participate in bidding competitions.

Unife would like European governments to use their right under trade treaties with Japan to exclude Japanese companies from tenders on the ground that it has not opened its own market reciprocally.

"We've never even seen an invitation to tender from one of the Japanese railways," Mr Clausecker says. But he accepts that Hitachi has brought in useful technology. The Class 395's arrangements for handling

erratic power supplies from iced-over third rails have withstood recent harsh winters better than rival equipment.

But Mr Clausecker adds: "There are certainly a large number of other technical questions where you find brilliant European solutions, and the Japanese could use these."

As for Chinese suppliers, Mr Clausecker accepts the country's technology has advanced significantly in recent years, and he points out that, since these normally source certain key components from Japan, quality is likely to be high.

'It takes the Japanese decades to open up and change their attitude to foreign companies'

Computers taking over the driving seat signal change

Track management

Automatic train operation is seen as the way forward for suburban lines

Northbound trains approaching London Bridge station in the UK capital are rolling over history. The brick arches that support the track were constructed during building of the London and Greenwich Railway. That line, opened in 1836, was the first built to serve traffic within a city and to cater predominantly for passengers.

The same area is now set to pioneer another new technology.

From 2018, drivers of trains leaving the last of the arches on the Thameslink cross-London route will see their electronic control panel change. The panel will first start telling them precisely how fast to drive. Then the computers will take over the driving until the train leaves the Thameslink route's busy core section, north of King's Cross.

The route is among a handful of places worldwide seeking to introduce automatic train operation (ATO) – the system of computer-controlled driving increasingly used in metros worldwide – on heavy-rail, mainline suburban rail services.

The technology should allow much-improved use of scarce track capacity in such heavily used areas.

Without ATO, even on railways equipped with the best mainline signalling, the differences between individual drivers' driving styles mean that trains make less-than-optimum use of the route's capacity.

While computers will do most of the driving under the new system, drivers will be retained to supervise the computer and control the doors.

Michael Clausecker, the director-general of Unife, the European rail industry

association, says the technology can help infrastructure owners avoid the expense and trouble of laying down extra track.

"Space is a crucial resource within cities," Mr Clausecker says. "So, everything you can do to increase the density on the existing network is useful."

The challenge for developers of such schemes – including Network Rail, the UK rail infrastructure company upgrading the Thameslink route – is to adapt technology designed for lighter, less heavily loaded metro trains to heavy, suburban rail vehicles carrying twice as many people.

"They're very different challenges," says Chris Binns, Network Rail's senior programme engineering manager for Thameslink, comparing the its route with that of a typical metro line.

"It takes longer to get people on and off the train and it takes longer to clear the platform because the train is twice the length."

The technology is indispensable, according to Mr Binns, if the Thameslink route is to limit station stops to 45 seconds, the maximum stay that will allow trains to run at two-and-a-half minute intervals.

Drivers will need to concentrate on checking that passengers are moving swiftly on and off the train and closing the doors promptly.

Services running on ATO will also use the new technology's ability to monitor trains' position and speed more accurately to accelerate faster and run closer together. "The ATO will be driving like an aggressive driver," Mr Binns says.

Yet the route towards a successful delivery of a

'Everything that you can do to increase the density on the existing network is useful'

new, high-capacity Thameslink service is unlikely to be straightforward. The first metro ATO systems, including the original one, London Underground's Victoria Line, were designed for railways operating in tunnels on new track.

The layout of the lines was designed around the limited capacity of the signalling system to handle unusual patterns of braking and acceleration, according

to Andrew Love, principal engineer at Atkins, the UK-based engineering consultancy.

The core section of the Thameslink route, meanwhile, could be purpose-built to challenge the signalling system's capabilities. The present route was knitted together in the 1980s from a hotch-potch of operating and abandoned rail lines, including some of London's oldest underground tunnels, dating back to 1868.

The ATO system is required, according to Mr Binns, partly because Network Rail realised that drivers were unlikely to run trains fast enough down the route's steepest slope to allow the necessary 24 trains an hour.

Thameslink and other potential ATO-operated mainline railways will also have to grapple with changes in trains' behaviour in different weather conditions that computer systems might find hard to understand.

"The slipperiness of the rails will vary," Mr Love says. "That's the sort of thing that a human driver can judge and, without even thinking about it, will adjust to. ATO systems need to have that level of complexity built into them."

Mr Binns accepts that there are risks attached to being one of a pioneering group of cities working on similar projects.

Others currently working on similar plans include Copenhagen, which wants to turn over two busy suburban rail lines through the city to ATO. "Whoever is first will have lessons to learn," Mr Binns says.

The ATO system will, however, be based on two well-understood technologies: the European Train Control System, now standard for new mainline railways, and the widely used Communications-based Train Control system for metros.

That should ensure the risks are kept under control, Mr Binns insists.



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Trip computer: inside the cab of a suburban ATO train

Rail & Transport



Taking stock: the new trains are capable of driving themselves nearly independently and have air conditioning as well as computers that tell depots when parts need replacing

Departing A Stock gives way to higher-performing arrival

Modernisation

More energy-efficient metro cars will soon grace London's Metropolitan Line

The new train standing by a dingy platform at London Underground's Baker Street station looks as if it is a visitor from the future when compared with the Metropolitan Line's battered 50-year-old carriages.

Brightly lit, air-conditioned and boasting sophisticated passenger information systems, the S Stock offers a level of comfort and performance that would have been beyond passengers' most lurid imaginings in 1960, when the outgoing A Stock trains first came into service.

But the S Stock trains, and other similar new metro cars worldwide, represent a challenge for transport operators and their suppliers alike.

The latest traction technology and lightweight materials offer the potential for vehicles to become significantly lighter and for energy consumption to fall substantially.

However, passengers' growing expectation of levels of comfort and information, on a par with air-conditioned, GPS-equipped cars, are simultane-

ously eating away at the efficiency gains made.

"You have an energy budget you cannot exceed," says David Waboso, London Underground's director for upgrades, explaining how the trackside power supply imposes the ultimate limit on consumption. "Ideally, you want to bring it down."

Power constraints are part of the reason London Underground has still not found a way of putting air-conditioning on trains in its constrained, deep-level tube tunnels.

Air-conditioning is possible on the S Stock trains because they run on the shallower, subsurface lines.

"What can I do to bring myself within that energy budget?" Mr Waboso says. "You need to attack it like that."

Yet, whatever the challenges, there is no doubting recent years' improvements in metro trains' capabilities.

The S Stock, like many other modern metro trains, is a single, continuous tube, with flexible gangways at the joints between carriages. Because passengers are more visible to each other, there is less risk of crime.

The train's computers track components for signs of problems and can alert maintenance staff about which are likely to break down, allowing them to ensure the relevant part is available and ready to be fitted.

Significant efforts have also gone into reducing the train's weight – and hence the energy needed to move it – says Paul Brown, project manager for the upgrade of the subsurface lines for Bombardier Transportation, the train's builder.

The body shell was built from aluminium extrusions – light material but still strong enough to meet the strict rules on trains' ability to withstand crashes that add further to the complications of producing a lightweight modern train.

"What can I do to bring myself within that energy budget?" You need to attack it like that'

"Weight saving and weight targets were a key design characteristic," Mr Brown says.

However, Mr Waboso says, it is only because of a sophisticated power-management computer system and brakes that feed energy back into the power rail that the train is not more power-hungry than its predecessor.

He estimates that the braking system – known as regenerative braking – reduces the S Stock's energy use by 20 per cent.

"In broad numbers, this train

consumes more energy, because its power draw is greater," Mr Waboso says. "The way you compensate for that is regenerative braking."

A further improvement of the S Stock – its ability to accelerate and brake faster than existing trains, cutting journey times – will come into its own only later this decade, when LU installs more sophisticated signalling systems that will run the trains with minimal driver intervention.

Bernard von Wullerstorff, head of railway systems for Unife, the European railway industry association, expects more metros to adopt such technology over the next 15 years, with an increasing number moving to entirely driverless operation.

"It started 25 years ago with the odd system or branch," Mr von Wullerstorff says. "Now, it's something that I think will happen everywhere. Driverless systems on metros can be much better performing than a human being."

However, Mr von Wullerstorff adds, not every metro worldwide may make the same calculations as London about the balance of weight and energy consumption.

Some metros in South America, or other less wealthy parts of the world, may choose to use the energy savings to cut energy bills.

"They might ask for the same energy efficiency, but they might not ask for the same passenger information systems or the latest doors," he says.

Meanwhile, even for metros that choose to give passengers the latest in comfort, there remains further scope for improvement, Mr von Wullerstorff says.

Mr Waboso predicts the next big step will be the elimination of some bogies – the frames that hold trains' wheels.

Each carriage might rest on only one set of wheels, as happens with some suburban train designs. Bogies are a big contributor to a train's overall weight and, hence, its energy consumption.

LU has said it is considering such a design for replacement trains on its Bakerloo Line, which will have the network's oldest fleet once the S Stock trains are fully introduced.

Passengers on the Metropolitan Line, however, are unlikely to complain about the S Stock.

The outgoing A Stock took over on the outer parts of the line from steam haulage.

That its successor should be a train capable of driving itself nearly independently of a driver, with air conditioning and computers that tell depots when components need replaced, may seem like remarkable enough progress to passengers for the time being.

Tram makers hit curve as markets adjust

Manufacturers

Industry faces test as clients move away from standardisation

The segregated track that carries smart Citadis trams alongside the Aegean in Voula on the outskirts of Athens could scarcely form a more marked contrast with the tram line that snakes down the narrow, cobbled streets of the St Gilles district in Brussels.

The Athens tram was purpose-built ahead of the 2004 Olympics according to the needs of the latest tram designs, which have low floors to make boarding easier but struggle to cope with sharp bends.

The tracks through St Gilles are a legacy of the 19th century, when tram lines were often built through areas that would be regarded as entirely unsuitable for them now.

Yet, after years when tram makers' most lucrative business was supplying southern European cities with versions of their standard trams for new, urban light-rail lines, the industry suddenly faces a far less appealing prospect.

For the foreseeable future, many of the types of rugged, idiosyncratic vehicles needed in places such as St Gilles, rather than the standard designs suitable for Athens.

The question is whether the tram industry, which has spent years developing standard platforms for vehicles to cut costs and complexity, can fit the new, more awkward orders into its strict templates while maintaining profitability.

"We have to cope with a global market that has very diverse requirements," says Pierre Gosset, platform director for the Citadis, Alstom Transport's standard light rail vehicle.

"That requires the industry to have some very reliable products and some agility to deal with those different performance and technical requirements."

The reason for the shift lies in the drying up of the stream of public funding that enabled many municipalities in Europe to invest in light-rail systems in the past decade.

The large tram makers were able to supply cities such as Valenciennes and Nimes in France, Barcelona and Malaga in Spain, Dublin in Ireland and Porto in Portugal with trams designed to the latest technical standards and based around standard designs – or platforms – that barely needed to be changed from system to system.

According to Germar Wacker, president for light rail at Canada's Bombardier Transportation, the budget crisis in many eurozone countries – allied with the most financially troubled countries' disproportionate enthusiasm for ordering light-rail systems – means that contracts for new systems will be in short supply in the immediate future.

"There's a higher proportion of the market volume in Europe coming from the more established systems, for example the German-speaking markets," he says.

The shift means that tram makers that want to win the new orders on offer will have to be prepared to supply relatively small numbers of vehicles

tailored to meet the eccentricities of systems that have grown up over 130 years. Because most systems were built in isolation, nearly every parameter – from the tightness of curves and the placing of the pantograph to the track gauge and maximum vehicle weight – may vary from order to order.

Yet the change in emphasis is forcing tram operators to change – and their suppliers too.

Bernard von Wullerstorff, head of railway systems for Unife, the European railway industry association, says suppliers recognise it makes no sense to try to rebuild a historic city such as Zagreb, the Croatian capital. It uses trams with a non-standard track gauge of a metre, so that vehicles can negotiate the many tight bends and narrow streets.

But there are circumstances where operators, rather than the manufacturers, recognise the need for adjustments.

"Sometimes, it does make sense to change the radius of a curve on an existing system, rather than adapting 50 to 100 trams," Mr von Wullerstorff says.

Alain Flausch, chief executive of STIB, the Brussels public transport company, who is also president of UITP, the international public transport organisation, illustrates how operator attitudes are changing.

"We told them we wanted something that would meet our needs," Mr Flausch says of his

'We have to cope with a global market that has very diverse requirements'

initial conversation with suppliers over the replacement of much of his company's tram fleet. "They said, 'If you want it that way, it will cost more'."

The chief engineer insisted the specification must not change. But he left and was replaced by others who realised the nature of the trade-offs involved.

"The new ones say: 'If we want to pay only €2.5m [\$3.5m] for a big tram, we're willing to standardise'," Mr Flausch says.

STIB is now the largest single operator of Bombardier's Flexity family of trams, with 250 vehicles.

"I don't hear a lot of complaints about it from the operating side," Mr Flausch says.

The process under way is far more complicated than a move away from the standardisation of one-size-fits-all new tram systems back to the near-chaos of technical non-standardisation, according to Mr von Wullerstorff.

Different systems will continue to have unique requirements. Many of the new tram systems likely to be ordered may be in regions such as the Gulf, where vehicles will have to cope with temperatures of more than 40°C.

Some of the replacement orders are likely to come from parts of the former Soviet Union where tracks are in poor condition and temperatures can fall as low as minus 40°C.

However, there remains considerable scope to standardise at least some parts of light rail systems.

"There are some opportunities for further standardisation," Mr von Wullerstorff says. "But it cannot be forced."

London and UK establish a lead in technology

Buses

Green hybrid and hydrogen vehicles show the way, says Gill Plimmer

They look old but include the latest technology – they are the shiny red Routemaster buses that will return to London's streets in time for the Olympic Games next year.

The buses – open backed, double-decker and with new fuel-efficient technology – are a sign of just how strongly people can feel about public transport. Abolished in 2005, their return – by popular demand – was a pre-election pledge of Boris Johnson, London's mayor.

More than that, however, they show the extent to

which London is a leader in bus technology worldwide.

"We lead the manufacturers by trialling the new technology," says Mike Weston, operations director for buses at Transport for London, the capital's transport authority. "If we can't lead by example, who can?"

Bus travel has taken off in the past decade, with the number of passengers in London, for example, increasing by 57 per cent since 1999-2000.

But along with the surge in passenger numbers has come a competitive race to introduce more environmentally friendly, fuel-efficient vehicles.

Much of this has been driven by government. The UK Climate Change Act has set a target of an 80 per cent reduction in greenhouse gas emissions by 2050, and with transport accounting for 21 per cent

of total domestic emissions, public-transport operators are a focus of attention.

The government has established a Green Bus fund, which will pay the difference between a traditional diesel bus and a new more environmentally friendly one.

As a result, nearly all the big British bus operators have been buying hybrid vehicles – powered using a combination of an ordinary diesel engine and an electric motor.

Hybrid buses emit less carbon dioxide, nitrogen oxide and carbon monoxide than diesel vehicles. They are already running on the streets of London, Sheffield, Manchester and Reading and are expected to dominate public transport within years.

Although most buses on London streets are currently diesel, any vehicle

bought from now on will be hybrid. This includes the new Routemaster, which will have an open platform for hopping on and off, three doors and two staircases, while the platform can be closed at quieter times. They will be much quieter than the old Routemaster buses.

But although the Routemaster will catch tourists' eyes, it is the new zero-polluting hydrogen buses that will be watched by manufacturers and transport authorities throughout the world.

Powered by the latest hydrogen fuel cell technology, there will be eight of these buses on the streets by the end of this year, emitting nothing

but water vapour.

There are five already travelling a route between Covent Garden and Tower Bridge in the capital – the only hydrogen bus fleet in the UK and the largest in Europe. But they could be rolled out further should the technology prove successful and the price of the buses begins to fall.

They are currently significantly more expensive than hybrid vehicles, although the gap could narrow should the price of fuel continue to rise.

With oil breaching \$120 a barrel, bus operators

Hybrids have much lower emissions than diesel buses

are looking at other means of keeping the price of fuel down.

Stagecoach and First-Group, two of the big British bus operators, have introduced a high-tech economic driving system that uses a traffic lights-style dashboard to provide drivers with real-time feedback on their driving style, including speed, braking, acceleration, lane-handling and turning.

The so-called GreenRoad system helps to reduce fuel consumption by about 4 per cent, cuts carbon emissions, and improves passenger comfort, as well as cutting the risk of accidents.

Giles Fearnley, managing director of UK bus at First-Group, which announced the installation of the system along with the £160m purchase of 955 hybrid buses earlier this month, says: "With fuel consump-

tion worth £4m to £5m a year, there are hard cost savings to be made and, with oil prices soaring, it's important to minimise fuel use. But it's also a great marketing boost for the companies."

As with the spike in oil costs in 2008, bus operators are hoping the current petrol-price surge will drive people to public transport.

With this in mind, Stagecoach has rolled out its luxury Goldline coach, which includes BMW-style interiors (hand-stitched leather seats and more leg room, for example) designed to attract car users, after research showed that people often take their own car because they believe it is more comfortable.

Brian Souter, Stagecoach group chief executive, says: "We are challenging people to rethink their expectation of bus travel."

