Wi-Pie in the sky?

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Communications: Cities across America plan to build municipal Wi-Fi networks to widen access to broadband. Will they work?

"WE WILL not stop until every San Franciscan has access to free wireless-internet service." It was a typically bold statement from Gavin Newsom, the charismatic young mayor of San Francisco, as he announced plans in October 2004 for a Wi-Fi network that would blanket the city with wireless-internet coverage. Mr Newsom thus joined a nationwide movement of cities across America that are planning to provide wireless-broadband access for government workers, residents and businesses.

These municipalities, ranging in scale from communities of a few thousand residents to huge cities including Philadelphia and San Francisco, are concerned that the lack of availability of broadband access, compared with other parts of the developed world, is holding back economic growth and perpetuating a "digital divide" between internet haves and have-nots. A further motivation is that by setting up their own wireless networks, municipalities hope to be able to cut communications costs, improve the efficiency of their staff, and make possible new services such as allowing parking meters to accept debit and credit cards.

Small municipal wireless networks, typically built for local-government use, have been up and running in some parts of America for some time. The far bolder idea of building citywide networks available to all took flight in August 2004, when plans for such a network were announced by John Street, the mayor of Philadelphia. Stringing transmitters across the entire city would

create the world's largest Wi-Fi hotspot, providing access both indoors and out.

This would extend low-cost broadband access to existing users frustrated by the slow speed and high cost of dial-up internet connections. A survey conducted by the city found that 72% of internet-connected households used dial-up connections, compared with 47% nationally. "We wanted broadband at dial-up rates," says Dianah Neff, the city's chief information officer. In addition, the city would provide subsidised or free access to tens of thousands of unconnected residents, sometimes even supplying computers. Only 45% of Philadelphia residents had internet access at home, the city found, which compared poorly with the national figure of 73%. Last October the body established by the city to oversee the project, Wireless Philadelphia, picked EarthLink, a national internet service provider, to build and operate the network, which is expected to cost around $10m.

Philadelphia's ambitious scheme prompted many other cities, including San Francisco, Portland and Minneapolis, to follow. So far, nearly 200 municipalities have announced plans for citywide wireless networks, issued bid requests, or built networks, according to Esme Vos, the founder of Muniwireless.com, a website that tracks the subject. Over the next three years nearly $700m will be spent building such networks in America, she estimates. Some networks will be supported by advertising; many will charge fees of $15-25 per month. Most will offer some form of free access at certain times of day or to poorer users.

Free (or at least cheap) broadband for every citizen—who could argue with that? Plenty of people, it turns out. Critics worry that cities are underestimating the cost and complexity of building and running their own networks. Incumbent telecoms and cable operators are predictably opposed to subsidised schemes that will compete with their own broadband offerings. Then there are the technical objections: no Wi-Fi network as large, dense and complex as Philadelphia's proposed system has ever been built; citywide Wi-Fi networks could interfere with existing Wi-Fi systems; and the networks will be built using proprietary technologies, so that municipalities will become dependent on their equipment-makers.

"Using Wi-Fi at high power levels for citywide coverage could drown out existing networks."

These criticisms have some merit. Last October Mr Newsom back-pedalled on his "free Wi-Fi for all" pledge, in favour of providing "affordable" wireless access throughout San Francisco. And when putting networks out to tender, the preferred model is now for the

construction and operating costs of the network to be carried by the winning bidder, to ensure that cities' own liabilities are limited. But much uncertainty still remains over whether large-scale municipal Wi-Fi networks can be made to work at all. Even if they can, nobody knows how much they will cost. And it is hardly reassuring that rival manufacturers, each promoting different and incompatible technologies, claim not just that their equipment is the best, but that their rivals' will not work at all. When challenged, vendors point to the many smaller networks that are already running. So who is right?

The view from Tempe

To see municipal wireless networking in action, a good place to start is the city of Tempe, Arizona, a suburb on the outskirts of Phoenix with 160,000 residents spread over 40 square miles. The flat, desert terrain is an ideal environment in which to use wireless networking to boost the availability of broadband. Several years ago the city installed wireless-broadband equipment on two buttes at the opposite ends of town. Rather than paying to lease high-speed digital lines from Qwest, each of which would cost hundreds of dollars per month, police stations and other municipal buildings are linked via the city's own wireless network. Telecoms costs have fallen from $1.7m a year a decade ago to $0.5m today. "We're probably not Qwest's favourite customer," says Dave Heck, Tempe's deputy manager of information technology.

As a result, when the city began considering ways to extend broadband access to more residents—including nearly 60,000 students, staff and faculty members at the main Arizona State University campus in the centre of town—wireless made a lot of sense, says Mr Heck. "We don't have a lot of competition for broadband in Tempe," he says. "There's just not a lot there." A local provider, NeoReach, won the contract to build a Wi-Fi "mesh" network to provide broadband throughout Tempe, using equipment made by Strix Systems. NeoReach is paying for the network's construction, and will collect access fees from subscribers; the city's

administration, police, fire and emergency services will also pay to use the network, which will cost $2.3m to build.

Mesh networking allows large areas to be blanketed with wireless coverage quickly and inexpensively. As its name suggests, a mesh network consists of an array of wireless access points, only a few of which are actually connected back to the internet via high-speed links (known as "backhaul" connections). The trick is that all of the access points double as relays, passing packets of data to and from their neighbours. This connects up the mesh, so that users can access the internet at high speed at any of the access points. If the nearest access point does not have a backhaul connection, the packets of data that users send and receive simply make one or more "hops" across the mesh.

As well as being cheap and fast to set up—partly because many of the access points can be attached to utility poles—mesh networks have several other merits. They can provide coverage in areas, such as sprawling suburbs, where fast copper or fibre-optic connections are hard to come by. "When you get out in the residential areas, there's no fibre," says Chuck Haas of MetroFi, whose company has installed mesh Wi-Fi networks in three of the San Francisco Bay Area's largest suburbs. Mesh networks are reliable, since the failure of one or more access points does not bring down the whole network, and they can also route data around obstacles, such as large buildings, which might otherwise block coverage.

By January NeoReach had installed over 400 access points in Tempe, providing Wi-Fi to subscribers in much of the city, and in outdoor areas in downtown Tempe and on the university campus. With the network's completion this month, NeoReach claims to have built the first example of a citywide Wi-Fi network in America. Proof, surely, that Wi-Fi mesh networks are an excellent way to extend broadband coverage across entire cities?

In fact, it is too soon to say. Wi-Fi was designed for use in small hotspots, not in citywide mesh networks. Using mesh networks to connect up a flat, sprawling, relatively sparsely populated suburb is one thing. But many unknowns remain, given the scale and nature of the networks about to be installed in Philadelphia, San Francisco and several other large American cities—all of which will push Wi-Fi technology to its limits. "We're taking this technology and, through some enhancements, we're trying to apply it for an application it wasn't really designed for," says Peter Rysavy, an independent wireless consultant. "Consequently, we just do not know how well it's going to work—but we're going to find out."

Not so fast

Some mesh network devices, notably those made by Tropos Networks, the market leader, use the same Wi-Fi frequencies both for communication between neighbouring access points, and to connect users to the mesh. Wireless experts fear that the use of Wi-Fi at the very high power levels required for municipal-scale networks, particularly in cluttered cities, could drown out existing outdoor Wi-Fi networks, public and private, and slow or disable indoor networks. An estimated 10m American homes contain Wi-Fi networks; many more are installed in offices, schools, coffee shops and parks. "It is absolutely guaranteed that you're going to end up interfering with anybody else that is using any channels within your coverage area," says Mr Rysavy.

To make matters worse, Wi-Fi operates in "unlicensed" frequency bands, which are supposed to be available for anyone to use. By interfering with existing Wi-Fi networks, a municipal network is, in effect, appropriating a shared public asset. "There are going to be 3,000 or 10,000 or whatever access points in the city of San Francisco," says Tim Pozar, a wireless consultant. "Even though this is unlicensed frequency, guess who owns the spectrum? The vendor."

Ron Sege, the boss of Tropos, insists that his firm's technology does not cause undue interference. After all, he notes, there are millions of access points in use already, with more being added all the time. Tropos nodes installed in a city are no different, he says, from a home user buying an access point and plugging it in. The problem, however, is that off-the-shelf access points operate at just 3-20% of the power output of the mesh nodes made by Tropos and its rivals. Reducing the signal strength of the mesh nodes would reduce interference with existing networks, but the density of nodes would then have to go up, increasing costs.

Interference is not the only potential difficulty with municipal Wi-Fi networks. Another problem, notes Mr Rysavy, is that there is no common standard for Wi-Fi meshing, and thus no compatibility between the five leading vendors' equipment. So if a city builds a network and the vendor goes bust—as recently happened to Vivato, a pioneer of long-range Wi-Fi gear—keeping the network running could be difficult. Although a standard for Wi-Fi meshing, called 802.11s, is under development, it is not very far along—and cities want to start building now. "Until there's some standardisation in the mesh protocols, any deployment today is pretty risky," says Mr Rysavy.

That raises another criticism: that wireless technology is developing very quickly, yet most municipal networks will be based on a Wi-Fi standard that is already three years old. Why not wait for the next-

generation standard, 802.11n, which is much faster, or for Wi-Fi's long-range big brother, a much-hyped technology called WiMax? Waiting a year or two might make it possible to build faster networks over greater areas at lower cost.

In fact, 802.11n is designed to perform best indoors, while WiMax has already been factored into most municipal wireless plans— where it will be used to provide backhaul connections to the mesh. EarthLink, for example, will use Canopy, Motorola's WiMax-like technology, for this purpose in Philadelphia and in four other cities. And dedicated Canopy links will also, says Ms Neff, be used to connect several hundred large buildings, which will not therefore rely on the Wi-Fi mesh. "Metro Wi-Fi is going to create the base and the excuse for WiMax," says Tom Hulsebosch of Motorola's Canopy division.

Municipal Wi-Fi must also contend with political interference. A number of reports financed directly or indirectly by incumbent telecoms firms such as Verizon, AT&T and Comcast, have criticised municipal networks as risky wastes of taxpayers' money that will provide unfair competition to private companies. Similarly, there have been complaints that if city governments cannot even fill potholes in roads, how will they be able to manage the far more complex task of running a network? Proponents of municipal networks respond that broadband access is just another utility, and that utilities have been state-run in the past. That is true, but public ownership of electrical utilities was, in fact, as controversial a century ago as municipal Wi-Fi is today.

"If city governments cannot even fill potholes, how will they be able to manage running a network?"

Philadelphia's plans were almost derailed when, after much lobbying, legislation was proposed in Pennsylvania that would have given Verizon, the local incumbent, right of first refusal in any municipal telecoms scheme. A bitter argument ensued, and the bill was signed into law only after Verizon agreed to issue a waiver exempting the city of Philadelphia from the provision. Similar bills preventing municipalities from going into competition with telecoms incumbents have been passed in over a dozen states.

One exception is Texas, where a grass-roots movement succeeded in scuttling a vote on such a bill, which had been sponsored by the local incumbent, SBC (since renamed AT&T). Michael Dell, the founder of the world's biggest PC-maker, based in Round Rock, Texas, helped to undermine the bill when he pointed out to state legislators that more broadband might sell more computers, and thus bring more jobs and tax revenues to the state. To avoid such

political wrangling, many cities are now taking the approach of awarding contracts to firms that build the networks at their own expense, pay taxes or franchise fees, and operate autonomously, in return for special rights to city-owned facilities such as utility poles, towers, building tops and electricity.

All of this means that Philadelphia, San Francisco, Minneapolis, Portland, Chicago and many other cities are participants in a great experiment. Building a large Wi-Fi network is harder than it looks, says Mr Haas, who has first-hand experience, not least because, once deployed in the field, mesh Wi-Fi equipment does not always perform as promised. "The radios we put up in 2002 and 2003 and the first half of 2004—hundreds of them—are either back at the vendors or sitting in the warehouse," he says. Only in the past 18 months has his firm hit upon the right combination of equipment and network design.

One step at a time

Reassuringly, Philadelphia and other big cities are taking a staged approach to the deployment, which will allow the conflicting claims made by equipment manufacturers to be resolved, one way or another. In Philadelphia, EarthLink will start by building a 15-square-mile test network covering different terrain, demographics and building densities. Building such a test network "is very expensive to do, but it's never been done," says Greg Richardson of Civitium, a consultancy that was involved in the bidding in Philadelphia and San Francisco. If EarthLink cannot meet the specifications set by the city and assessed by independent auditors, the network will not be built. "It gives us a chance to see if what we ask for is realistic, or if we need to change some of the parameters," says Ms Neff. And if existing Wi-Fi networks are disrupted, citizens in the test area will know whom to blame.

Mayor Newsom's utopian vision of free wireless for all quickly ran up against the snag that all such giveaways require: there's a price to pay at the end of the day. Even with the decision to charge some users for access, not all cities will find that their plans for citywide Wi-Fi networks turn out as expected. The real measure of municipal wireless networks will not be in places such as Tempe, where they are expected to work, but in bigger cities, where success is far from certain. Whether service providers will be able to meet the required technical standards and still make a profit will soon become clear.