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Better transport through technology

SIM AND THE ART OF ITS COMMUNICATIONS

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Introduction

At present there is pressure on conurbations to become ‘Smart’. There are many definitions and views of what constitutes being a Smart City. A common theme is that a Smart City will use digital technology to reduce consumption of resources (which are finite) and this will reduce the cost borne by its citizens and the environment. To achieve this it will need to actively engage with them in as close to real-time as appropriate. Main sectors of the Smart City include energy, water, transport, waste, social and health care.

Smart Cities will rely heavily on the collection of data and the distribution of information. They will require several communication methods to perform these tasks. Mobile Data Networks are one communication platform.

Mobile Data Networks have the advantage over fixed wire alternative as there is little upfront capital investment in Infrastructure required. In the urban city context, coverage is almost ubiquitous. Due to their coverage, the use of mobile networks allow for devices and connectivity to be deployed rapidly and moved with little disruption to service. This portability arguably gives makes it more flexible in the implementation, making schemes more sustainable and green at point of deployment.

The UK tends to favour the use of Fixed Data Networks. This maybe the first choice, but the availability is limited, even in urban areas and this limitation can stifle or kill a scheme before it has got much further than the concept stage, even in urban locations. Mobile data networks are perceived as continual draws on limited revenue budgets which is an expense that is hard to justify to deliver the end results.

This ITS (UK) Blue Guide will address the perceptions of Mobile Data Networks and allow the user to plan projects and execute them with some confidence that revenue budgets are well spent, with the data it delivers being of greater value than the revenue cost through reliably integrating ITS platforms to deliver smarter outcomes.

Points to consider

Why use Mobile Data Networks?

This White Paper will give you a better understanding of working with Mobile Data Networks, the “gotchas” and what to look out for, along with some general tips and advice.

Increasingly there is a need to collect data from out in the field in order to process it and derive some intelligence about your world in real time to give smart or intelligent information. Properly applied, Mobile Data Networks for ITS use offer excellent reliability.

Many people consider mobile networks as both voice and data, and do not realise that there are dedicated machine to machine (M2M) Mobile Data Networks. These networks differ from the normal view of mobile communications, as they offer no conflict of text and voice but provide controlled internet access and Fixed IP through dedicated data networks. This increases the security of the network without the added data and cost that an over the air Virtual Private Network (VPN) creates.

Helpful Advice;

An issue that often is not picked up on is the networks’ tendency to round to the nearest 1KB of data per transaction. This is fine if files are of the order of KB or MB but many ITS transactions are themselves only tens of bytes. Very often the lack of aggregation and the charging for lost SIMs also pushes costs up far higher than an initially calculations would suggest. Therefore it is best to seek out a provider who bills to the byte.

Points to consider

Mobile Networks as Data Carriers for M2M

A SIM is just a SIM so why would you need to buy an M2M SIM? In order to answer this question you have to be clear about the expectations of the voice market. A key point to understand is that voice and data have very different expectations and standards. If you have a mobile phone and it doesn't work, most of the time you will be able to borrow somebody else's phone and make that critical call. The cost of failure is likely to be very low. If there is a problem with the phone or the SIM, the network providers are very quick and professional in resolving it, by for example sending out a replacement SIM on a next day basis. You are worth looking after since the income you represent as a phone user is still relatively high and the network providers have a very streamlined and polished way of handling the pattern of issues that do come up. As a result the customer experience is largely good.

In M2M we have a very different story. Here the revenue is much lower at a tenth or less of what a mobile phone consumer is worth. So there are no resources to look after each individual connection with the same high level of intervention that is expected in voice. In M2M there may be no local 'friendly' user and the environment itself may suffer from extreme vibration and variation in temperature. It is a much more hostile place than a phone is likely to experience. The hardware and firmware will be bespoke so there is not the opportunity to build a profile of likely issues as there is with the relatively limited number of handsets in the market. A call to a customer service desk quickly goes "off script". And once you are there you will almost certainly end up being advised to take the SIM out, give it a clean and put it back in again.

This will probably work but it is because the SIM is usually behind the battery and by taking the battery out you have performed a hard reset. That probably does 'fix' the problem. But it is not a solution; it does not explain why the system failed in the first place. However as far as the support call goes, they have done their job, your equipment or service is working again, and they can go on to the next call. This "giving the SIM a clean fix" has had huge big implications for the industry. We see then two very different expectations- a voice one where 90 to 96% is good and an M2M world that is striving for 99.999 or 5 '9's availability. Keep in mind that 96% means that your system can be out for an hour a day and still be regarded as 'good'. Customers seeking communications services for ITS almost by definition are looking for better.

Helpful Advice;

To ease implementation with internal IT,eek out suppliers with compliance certification that meets or surpasses your corporate Code of Connectivity (CoCo) for example; PCI/DSS (Payment Card Industry / Data Security Standard)

Points to consider

Faulty SIMs

M2M SIMs rarely go faulty as they have solid state construction and have no moving parts. They are used to identify the subscriber onto the network. The primary reason they may not work is often the way that they are set up on the network, with the most common problems being listed below.

- Wrong IP addressing
- Duplicate IP addressing
- Wrong APN
- SIMs being shipped but not activated
- SIMs being enabled for WAP not WEB

Consumer grade SIMs

In 2014 some of the networks reverted to supplying cheaper consumer specification SIMs in M2M applications. These SIMs have a lower grade EEPROM (Flash) on board that means they have a shorter life span, which can be made significantly shorter if the SIM is used as a flash memory in its own right. They also have a smaller cache, again shortening its useful life. The consumer SIM will have a narrower temperature range thus increasing the chances of failure in many M2M environments and shortening its life span.

Consumer SIM:	**M2M SIM:**
Temperature range of -25°C to +85°C	Temperature range of -40°C to +105°C

Network or Cell is down

It is true that mobile networks and cells do “go down”. However this is planned and generally takes place overnight and in very specific locations. When things come back up it is always the poor set up of the equipment that prevents these events passing seamlessly, as often the equipment still regards its last session prior to the disruption as active and is unable to recover from this state without human intervention (manual reboot).

The mobile networks have invested heavily in their networks, improving the cell densities within the towns and cities (greatly reducing the number of “network busy” messages) and covering more and more of the UK land mass. Within most urban environments it is common for a mobile device to see up to 50 cells it can connect to, and even in quite rural locations the ability to see a handful of cells is the norm. Mobile phone manufactures have spent hundreds of millions of pounds on R&D and on software to optimise the way the modern cell phone connects and interacts with Mobile Networks, ensuring that connectivity is flawless.

Contrast this to the modem and routers available for industrial use. Although many have a degree of built in intelligence, they rely heavily on being set up correctly for their particular location and traffic profile by an engineer. However the skill set needed to do this is currently in short supply and most field engineers and computer network specialists leave the default setting “as is”. This in turn degrades the hardware’s performance and ultimately the performance of the delivery of the data.

Points to consider

Mobile “Black holes”: when data disappears

If you have deployed a mobile solution, you will probably have come across these without actually knowing what they are, or what causes them.

When a device has been connected to a mobile network for a period of time, the network sleeps your radio layer if no data has been transmitted (The period varies depending on the usage of the cell you are connected to.) This has no impact on the IP layer which stays “connected”. When you want to send traffic again the radio layer wakes and your session carries on. This is exhibited as the first packet you send takes a bit longer than the packets that follow it and this is the radio layer waking. Occasionally the radio layer does not wake and because you still have an IP layer the software believes it is connected and your packets effectively ‘go into a black hole’.

This could be resolved as simply as sending a “ping” now and again which increases the data volume used and rebooting the device if it fails or as sophisticated as monitoring a Transmission Control Protocol (TCP) session and recovering the session when the TCP connection fails. The strength of the connection is a summation of all the parts in the system and the software controlling it and so requires careful thought from the inception of your scheme onwards.

Helpful Advice;

It can be very easy to avoid mobile “black holes” by making sure that your hardware has the ability to manage its own connection. Many of the latest range of modems/ routers have this functionality. (This requires an understanding of the hardware configuration.)

Multi Network SIMs Managed Roaming

Managed roaming is designed to give you the best connection available in your location used in conjunction with a Global Roaming SIM. Managed roaming allows the device to run a site survey when it is first powered up to see what networks are available to it. Networks that have a poor signal or offer low throughput are black listed and the ones that are left are put in a preferred order (based on signal strength and throughput). When the preferred network has low signal or throughput this is also black-listed and then the next network from the preferred list is selected. Once all networks are black-listed the whole process starts again. This process is perfect for a fixed device.

Another issue that will be experienced with a classic roaming SIM is where the home network applies a set of rules on how the connection is managed, so called steered roaming. For example, consider that you have a Telefonica (O2) SIM and you are network roaming. The device you have the SIM in picks T-Mobile to connect to (maybe using managed roaming). When the authentication request hits O2’s network they reject it because they want you to use O2 where possible, as it costs them less. Your device will usually try this process five times before the O2 network will allow the authentication request through.

The duration of this varies by device but is typically ten seconds per retry, which equates to a delay of up to 60 seconds before a connection is made. By this point most applications will be timed out and will reinitiate the process, therefore giving the perception that no connection can be made. A true Global Roaming SIM does not have steered roaming applied to it and will connect to the first network it tries on the assumption that the device has already applied your criteria for the best possible connection at that time.

Helpful Advice;

Be aware of non UK mainland network SIMs. They do roam on to any UK network, but they are given the lowest priority when cells become congested and overage charges can be very high. Therefore although the ticket price is very competitive, this is offset by the poor performance and high cost of ownership.

Points to consider

USB Dongles vs. Routers

USB Dongles are not designed for permanent installations. Power control is difficult, and there is no connection management as the user is expected to disconnect the dongle and reconnect it if there is an issue. And since the USB port stays live in a power cycle then the standard "turn it off and turn it back on again" process has no effect. The radio module versions are constantly changing, which repeatedly causes incompatibility issues with deployed hardware and so looking after large estates become impossible to manage. USB Dongles do not manage black holes. Radio performance is also poor. They are designed for light domestic/office use and when they are used constantly they have a Mean Time Between Failure (MTBF) of six to eight months.

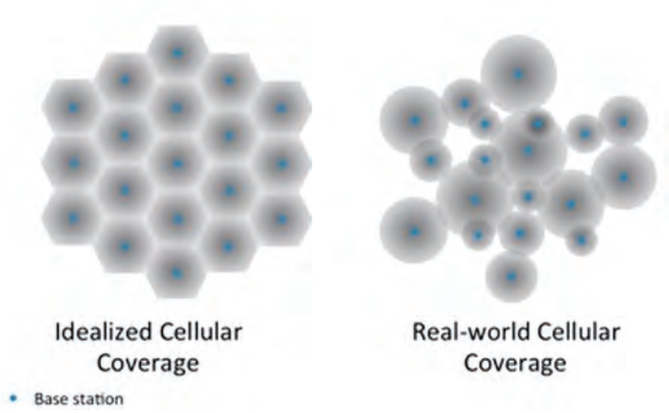
With routers the hardware platform is stable and any changes to the radio modules are controlled and tested before they are released. The MTBF is commonly five years. The manufacturers have connection management to prevent mobile "black holes" (if it is configured correctly). Hours of engineering time out in the field can be saved by bench testing the manufacturer's default setting against what is configurable and observing the net result. As previously outlined, the lack of knowledge about the router's capabilities is often where projects fail to deliver the performance required by the end user.

Helpful Advice;

When tests are run try to keep them as close to the real thing as possible. For example if your device is sensitive to high latency, do not run the server end on a laptop and use Wi-Fi as the connection, since this will increase the real life latency and give poor results. Use the hardware and antenna that you are going to deploy with. Do not test with a Pay As You Go SIM! Talk to a friendly Mobile Virtual Network Operator (MVNO) that can help you with an M2M SIM for testing.

Antenna

Cutting corners with the antenna can cause huge dips in the performance of the hardware or the SIM. You can save hundreds if not thousands of pounds and countless hours of engineers' time by investing in a good antenna. It is often the difference between the site working well and the site being viewed as failing.



Mobile networks cells are constantly changing. A cell will create a donut shaped signal area and anything in that donut will get a signal, but this signal gets weaker the further away from the cell you go. As a user connects to a cell the size of the footprint shrinks. If you are at the edge of a cell and it shrinks you will no longer have a connection to that cell and you will connect to another cell that is also serving your location if there is one, or you will drop to an older technology, like 2G.

The weather also affects cells as do trees and buildings with modern buildings being particularly bad for mobile networks as the mix of glass, steel and foil backed insulation scatters, reflects and absorbs the mobile signal.

Points to consider

Cell Switching

Cell switching occurs all the time when your device is moving as you are passed from cell to cell along your journey. It also can also occur when your device is static, although less frequently. But if you are static and connected to a cell that is suffering from network congestion then the cell will ask your device to switch to another cell that is also serving your location.

A word of caution about using a directional antenna to get a better signal. Whilst this will help if your location is served only by a single cell site, if your location is served by multiple cells using a directional antenna will be counterproductive as your device cannot switch to another cell. Installation of a directional antenna will limit your flexibility in the longer term.

Helpful Advice;

Cable length also plays a crucial role when selecting your antenna. Different cables have different properties. For example, imagine using a cable that loses 1db of signal for every metre of cable and an antenna of 5db gain. So you gain 5db at the antenna, the antenna has 5 metres of cable attached to it, so now you are at 0db gain. The connector at the end of the cable also loses 1db, so your effective gain is now -1db! The best “bang for your buck” when a connection is borderline would be spending on a higher gain antenna.

Cost of Failure

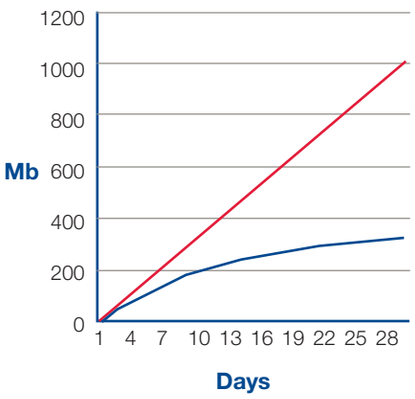
If the SIM stops working in your phone the operator will send you a new one, next day, and while you will be inconvenienced, the cost of failure is minimal. However if a M2M SIM used for ITS stops working, recovering the SIM could entail lane closures, two men and a cherry picker, and £1000’s in cost. As previously stated there is nothing wrong with the physical SIM. It is set up on the network, and the operator has changed the profile of the SIM in error. With that in mind it is prudent to check the whole estate every quarter to prevent this. If the resources are not available to carry out this task it should be a consideration when selecting the supplier of the SIMs.

Points to consider

Machine to Machine Tariffs

The tariff for your SIM does make a difference. Deals such as unlimited voice, unlimited text and unlimited data, all for a fixed monthly cost, are aimed at the smart phone consumer market. However the operators know that the typical use will only use around 400MB per month and they help you to stay near to that figure by applying a fair use policy. The policy includes the agreement for the network to choke throughput speeds, filter content and apply Involuntary Compression. It specifically prohibits over the air updates and streaming. The graph shows the expected usage over a month for a 1GB SIM where the blue line plots the actual throughput for a Mobile Broadband SIM in a traffic installation.

Fair use in practice



- 1GB usage is not linear
- Speed controlled by throttles or by disconnection
- Designed to maintain network availability for all
- Speed attained slows over the month

Peer2Peer is also not allowed by the fair use policy. However most M2M applications use P2P. Your device sends information to the server every hour of every day, which is P2P. All of these filters increase latency by as much as ten times, taking a round trip of 100 milliseconds (ms) and turning it into a second. This level of latency can cause the application some difficulties.

A M2M tariff does not have any of these filters. The typical latency experienced through the M2M platform is less than 80ms from device to end server with the message passing through the networks servers and infrastructure in sub 10ms (Mobius timings). If the user experiences longer delays than 200ms there is a pinch point either at an Access Point Name (APN) or at a server, which can be found with a series of ping traces.

M2M tariffs are more expensive because the operators know that if you buy a 1GB tariff you are going to use 1GB, and not the 400MB that the average mobile phone user consumes.

Data Aggregation

Data aggregation allows the overall cost of an estate of SIMs to be reduced, as it is very rare for all devices in all locations to use the same amount of data. Typically if 100 sites consume just less than 1MB per month on average, some sites use 2MB and others only 0.5MB. Data aggregation effectively gives 100x1MB SIMs therefore a 100MB pool of data. This prevents paying overage on some SIMs when other SIMs within an estate have spare data.

Points to consider

Data Reservoirs

Data reservoirs are large volumes of data, typically multiples of Terabytes, that change the pricing and give more flexibility. An issue with the current model of monthly tariffs is that we under buy to minimise cost but run the risk of overage driven by seasonal demand, unforeseen circumstances or technical error. Or we over buy which means that a large of data bought is unused by the end of the month and 'lost'.

The tariff model also means that each tariff, even if aggregated itself, is separate from any other tariff that we may have negotiated. This means it is possible to have overage charges on one tariff despite having large amounts of data unused in another.

The tariff structure creates inefficiencies in that buying small tariffs may result in a cost of £0.20 to £1.00 per megabit of data while large tariffs, though costing more, drive the cost of a megabit down to around £0.01 per MB.

Private Network Fixed IP vs. Internet Fixed IP

Do you want to be exposed onto the Internet? These BBC articles highlight the perils of using Public Fixed IP and using public IP addressing fixed or otherwise is an invitation to be hacked and it's not if you will be hacked, it's when you will be hacked.

"Shodan" is a search engine for devices where you can look up all kinds of things you might want to access with malicious intent. It makes hacking infrastructure much easier and is not the only one available to everybody.

As well as the fact that your system can be hacked freely, you also need to consider the impact on the revenue budget you have for the scheme. You may have bought 10MB because that is what you need, but if anyone who is connected to the internet has the ability to attack your device you lose all control of data consumption, which could potentially cost hundreds or thousands of pounds in additional data costs. You may have a firewall that blocks the traffic when it reaches the SIM's IP, but the fact is that it will have got there by using up your data.


BBC NEWS TECHNOLOGY

How to hack a nation's infrastructure

By Mark Ward


BBC Sign in News Sport Weather

NEWS TECHNOLOGY

Home World UK England N. Ireland Scotland Wales Business Politics

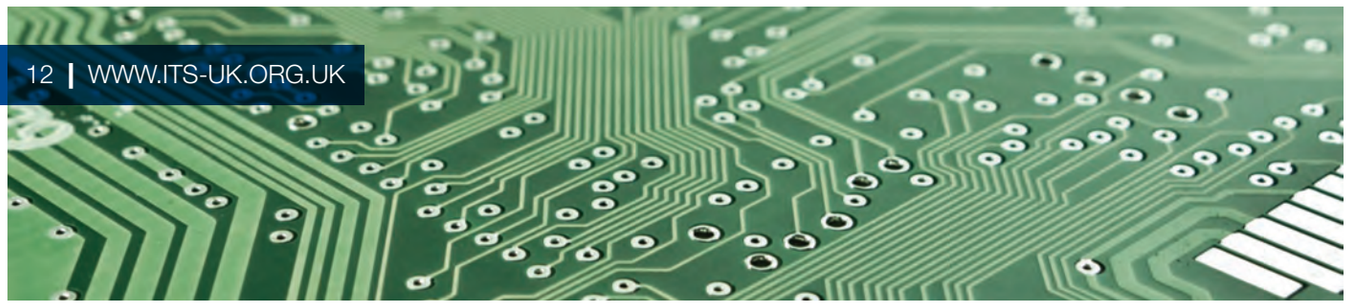
Hacking cars and traffic lights at Def Con

20 August 2014 Last updated at 00:00 BST

One of the biggest hacking conferences in the world, Def Con, took

Helpful Advice;

Using a private Access Point Name (APN) removes all of this risk because from the private APN you can restrict internet access and as all the devices sit on a private network the only way to get to them is through a secure connection from your main office to the operator.



Points to consider

4G and Back Haul implications

4G is here for consumers and will soon follow for M2M. If your hardware is 4G ready then you can take advantage of 4G where it is available. However by using the '3' network then your 4G device will connect using Dual Carrier HSDPA which is twice as fast as traditional 3G. The typical latency in the 4G network however is less than 20ms. With these speeds 4G lends itself to C-ITS application.

All of the carriers talk about super-fast 4G and that you can change your digital life using 4G. In reality we are seeing about five times the speed of traditional 3G. The radio connection is capable of massive speeds but is restricted by the "backhaul" (i.e. the intermediate links between the core (or backbone) network and the small subnetworks at the "edge" of the entire hierarchical network) of the supplier. For example 40 users on a 4G cell site will require 1Gbps of backhaul.

When this gets further back in the network and those 40 users become hundreds or thousands of users or devices the "backhaul" becomes an expensive overhead. Care is needed when choosing suppliers who can support 4G data volumes in their network and can show how they can "backhaul" it to your server or this too will become a potential point of failure, resulting in high latency and lost packets of data.

Helpful Advice;

"Backhaul" and the amount of data through puts are often overlooked when systems are specified. The firewall and server too are often under-specified. This results in a poorly performing system and high ongoing revenue costs, which can terminate the project in the long term. This point also applies to mesh systems as they are often sold as revenue free but do not take into account the possible backhaul costs.

Points to consider

Resilience

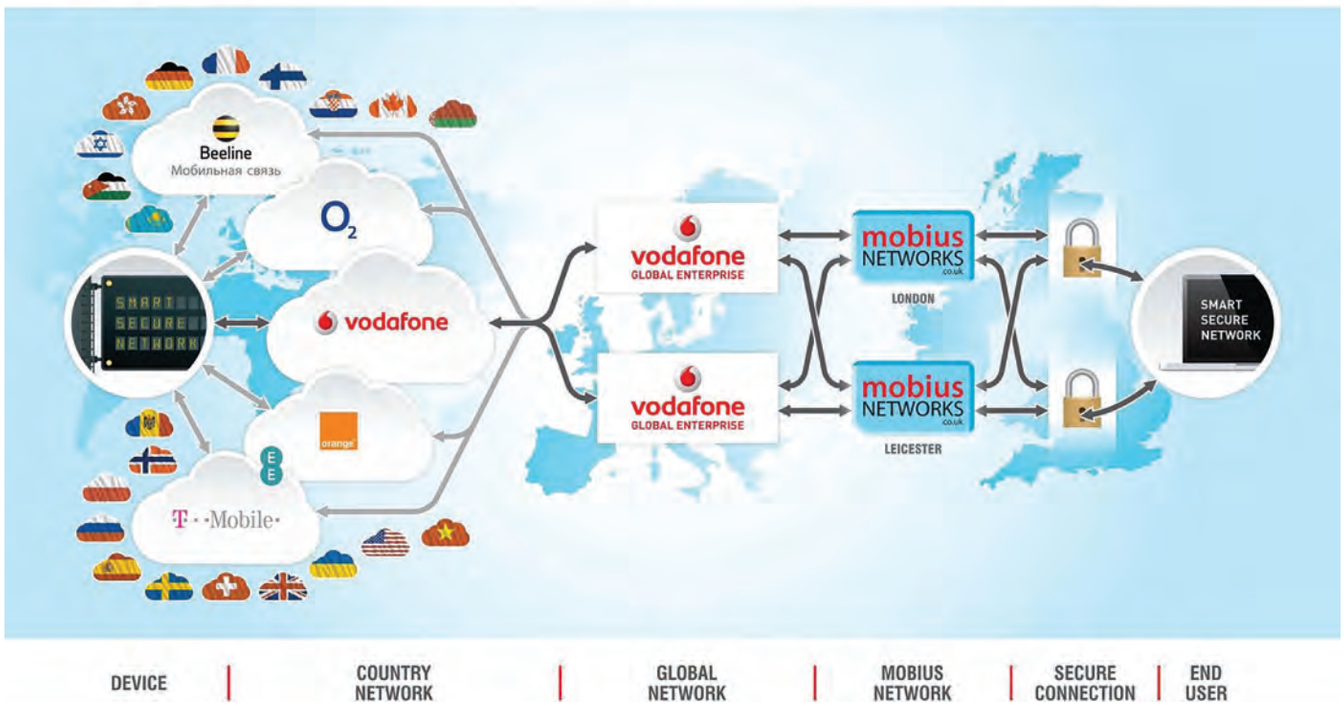
Many mobile networks and resellers only offer a single route for the data to flow through and this is a major flaw in most systems. The single data path can become congested with the physical amount of traffic that the network is carrying. This becomes particularly apparent if there is a single APN carrying all of the data. This typically manifests itself as a long delay (measured in seconds) and occasional data packet loss. The single path is also susceptible to component failure (router, server and firewall). For many applications where data delivery is not time or mission critical this solution is fine.

But components do fail and systems do go down, leaving disruption lasting hours or in some cases a couple of weeks, due to the lead time on replacement components. Within the industry there are a few solutions that will offer 99.995% up time, which is certainly eye catching. However, upon closer inspection this only refers to the core network infrastructure and this is achievable with the help of cloud based back up.

Helpful Advice;

For 99.9995% on-street availability on street, multipath multi network architecture needs to be employed. This requires not only a network roaming SIM but two connections into the mobile network at GGSN level. This dual connection needs replicating throughout the data pathway until the delivery at the customer's firewall, so there is no single point of failure. See diagram below - although this is Mobius' solution it can be achieved with other suppliers, notably the major networks.

Smart Multi-Path Mobile Network From Mobius



Where can I get help?

Help to make the task easier is available from many existing information sources such as:

- The I**TS (UK) Local Authority Interest Group** is a forum for developing good practice for all aspects of ITS in local transport and advising how a business case can be developed. ITS (UK) is a not-for-profit public/private sector association promoting all ITS across all forms of transport. www.its-uk.org.uk

- The **UTMC Development Group (UDG)** is a representative group led by Local Authority purchasers with active participation of suppliers and national and regional government. They ensure the UTMC Technical Specifications are maintained and managed and organise outreach activities such as workshops and seminars. www.utmc.eu

- The **Traffic Systems Group** is open to all those interested in traffic control who work for, or on behalf of, highway authorities. http://theihe.org/tsgforum/

- The **Real Time Information Group** provides a focus for all those involved in bus related ITS. They have a wide membership from local authorities, bus operators and system suppliers, with representatives from Government and industry. http://www.rtig.org.uk/

Web Links:

- http://www.bbc.co.uk/news/technology-22524274
- http://m.bbc.co.uk/news/technology-28850305
- http://www.shodanhq.com/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Published by Mouchel Ltd