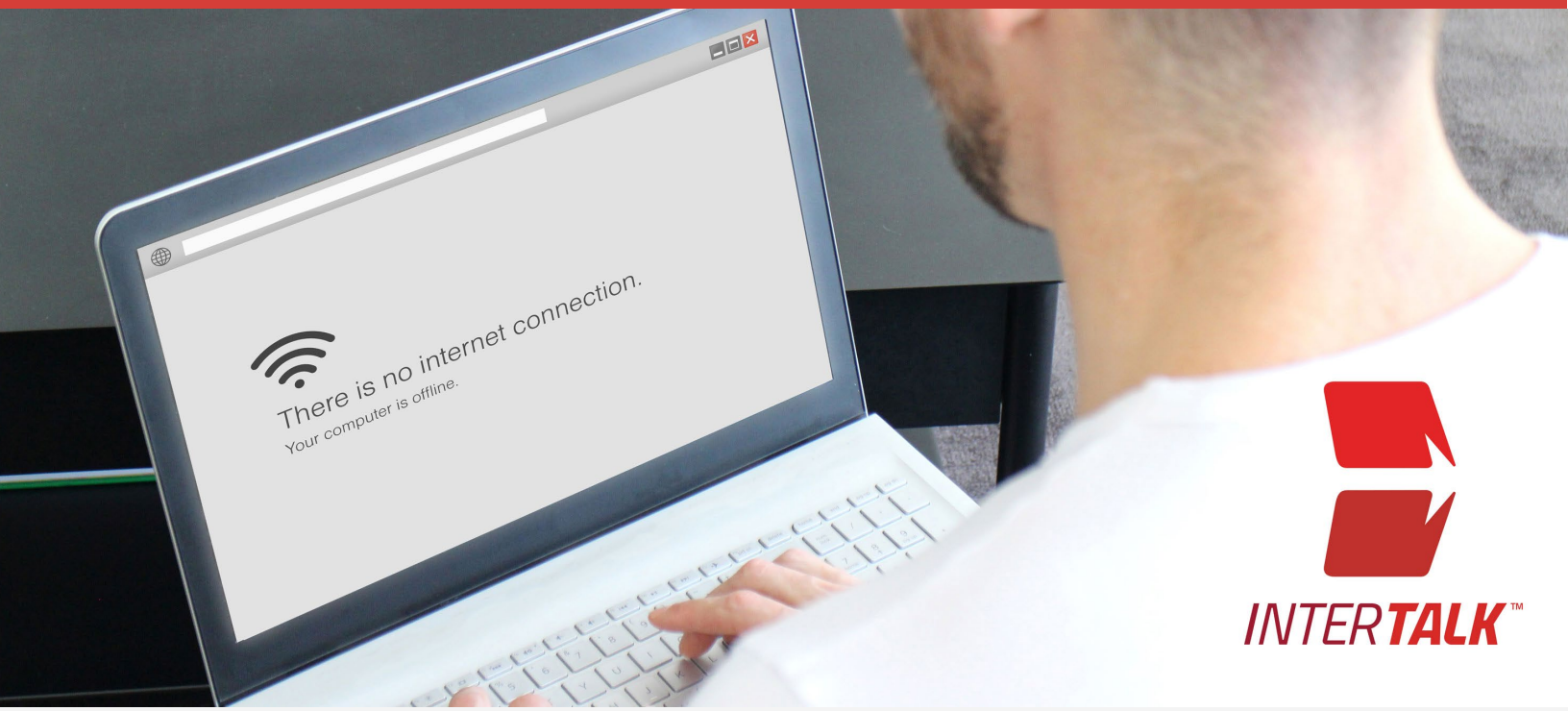

High-Reliability Public Safety Dispatch Networking

What Happens When the Internet Goes Down?

InterTalk Enlite™ can be deployed with gateway equipment on-site, co-located with your radio equipment and independently connectable. Users that are in the same network partition as the radios can continue to communicate with their radios even if the rest of the internet is unavailable. From their browser, each radio site is a direct connection and may be made even if other parts of the internet are not available.

What happens when an InterTalk radio site goes down?

Simply have more than one radio site with duplicated radios tuned to the same frequencies and have more than one public safety grade network path to get to them. Dual SIM with Public Safety QoS flags (e.g. Telus RANS and AT&T FirstNet), Starlink Satellite and microwave WAN to an ISP provides significant redundancy on a per-site basis.

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Setting the Stage

In many public safety jurisdictions around the world, reliable Internet connectivity is not a certainty. For instance, on an island, the microwave, satellite or submarine cable connecting the island to the mainland may get severed due to a passing storm, a solar eclipse or a band of roving sharks. In a rural community, the main Internet link can get severed accidentally due to construction work or wolves. If these communities embrace the promise of Hosted dispatch, how do they maintain operations when their citizens need them most?

In this article, we'll identify a few of the options available for creating robust communications infrastructure in service of all communities and demonstrate how Hosted architectures can improve citizen outcomes everywhere.

The Old School Option

One of the advantages of radio communications is that all that is necessary for two parties to communicate is a receiver, a transmitter and a radio line-of-sight between the two. This basic property has resulted in the almost universal propagation of radio dispatch systems as a series of overlapping "bubbles" across any jurisdiction where communications are necessary. Any radio user can communicate with anyone else in the same bubble, and the size of each bubble is entirely dependent upon the power of the transmitters, the sensitivity of the receivers and the unique geography of the earth between them.

Taking the High Ground

As more agencies and corporations embraced the power of radio networks, fixed towers with powerful electrical componentry began to be important and economical ways to satisfy the needs of large coverage without having to create expensive chains of fixed stations. Simultaneously, each agency and corporation realized the importance of prime geography (specifically, hilltops) as being key to gaining the coverage that was needed, and so a small gold-rush unfolded as each competed for space on the same real estate (and sometimes, on the same towers).

Over time, key hilltops became saturated with a plethora of radio equipment, and so regulation and frequency manipulation became key to keeping things safe and orderly

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for everyone involved. Consequently, each hilltop tower became more expensive to operate and site and while the greater power allowed for greater coverage, the fixed position created a number of known coverage dead spots which needed to be either ignored or addressed with smaller transmitters sited specifically to get into the radio shadows cast by the larger towers.

A Light In The Darkness

With key towers in our communications infrastructure identified and prioritised, we ended up creating significant shadows in our field coverage. Places where we knew field units lacked coverage and were cut off from the resources available in the wider area. Dead zones.

Depending on the nature of each dead zone, we could sometimes move it around by changing the timings and signal characters of the tower that covered them, but the better approach was to gain coverage by putting up a relay tower that the main tower could talk to and could be used to gain coverage in the zone that was hidden by the line of sight from the hilltop.

Eating Blackberries

With the growing use of car and pocket phones, once again, radio towers have become important. But because the field units for pocket radio phones were regular people moving about their urban environment, the need for large transmitters on the hilltop quickly gave way to the need to get multiple repeaters into the increasingly important radio shadows of a city. Instead of the CN Tower in Toronto, it became important to provide radio coverage in the underground subway stations and between the tall buildings of Bay Street using smaller transmitters. Each smaller radio bubble owned by the industry telecommunications operators became standardised and modular so that each transmitter could sit at the centre of an interconnected network of bubbles. In many ways, these densely packed bubbles began to look like the cells of an organism, and so the cellular radio network for telephony became the standard for growing telecommunications service without stringing cables on poles.

Further, the rise of the home internet and the work PC meant an increasing amount of citizen activity was conducted through e-mail on the go. With the radio infrastructure

already in place for transmitting telephone audio to cars and walkers, it became a simple matter to add modem capability to the existing radio signals and thereby transmit packets of data in addition to analog audio.

The New School Option

We are now at a point where an important packet of information can be sent over multiple mediums between parties. Many areas are covered by physical ethernet, radio LTE 4G/5G, Wi-Fi terminated ethernet, high satellites and low satellites operated profitably by a plethora of communications companies. It is increasingly possible not only to have a coverage option available, but to be assured of some signal being available in almost every environment at a reasonable cost.

Further, the events of 9/11 in the US have shown that public safety data needs to be prioritised and most telecommunications providers now have an option to flag that the packets of data traversing their networks are of public safety importance and can be prioritised over others or privileged to access dedicated frequency and infrastructure.

A MODERN SOLUTION IS TO LEVERAGE MULTIPLE RADIO AND FIBRE COMMUNICATIONS CHANNELS FOR EACH PIECE OF DATA UNIFIED OVER THE NOW-UBIQUITOUS PACKET SWITCHED TCP/IP INFRASTRUCTURE.

Solution

Disaster Networking

Every story has two sides and every communication has at least two parties connected together over a medium. During a disaster, this means that there are three potential problems:

1. The Dispatcher is unavailable.
2. The Resource is unavailable.
3. The link between the Dispatcher and the Resource is unavailable.

The formula for calculating the availability of a system composed of modules in series is:

$$R=R1\times R2\times R3\times \ldots \times Rn=\prod Rj$$

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The formula for the availability of a system composed of modules in parallel is:

$$R(t) = 1 - \Pi[1 - Rj(t)]$$

From this, we can see that a system in series is weaker than its weakest member while a system in parallel is significantly stronger than its strongest member. Many weak modules in parallel are substantially stronger than a few strong modules in series.

So, for extreme availability, we use lots of weaker modules rather than focus on perfecting a few strong ones. Further, investing in improving the quality of a single node is quickly outdone by investing in an additional node of average quality.

We can utilize a combination of wired, LTE, 5G and satellite connectivity to ensure our system stays connected and a plethora of smaller towers to ensure that there's always a useful resource available at the end of the link.

Architecture

During every public safety disaster in recent times, our public telecommunications infrastructure has only partially broken. While some pieces have been knocked out in some locations, not all of them have been everywhere. Further, operating dedicated private radio networks is increasingly becoming cost prohibitive.

> **TO ACHIEVE HIGH RELIABILITY, WE SIMPLY DUPLICATE EQUIPMENT, PEOPLE AND ROUTES.**

Dispatchers can be co-located with radio towers so that if the external links disappear, the radios are available "next-door" or they can be located closer to the information systems that they need to communicate with their field units or diffused throughout their jurisdictions so that if something happens not every Dispatcher is affected in the same way. Dispatchers, radios and other devices can be in their homes and connected over public-safety enabled LTE or Fibre, or they can be in smaller dispatch substations or in large central operations centres.

For instance, InterTalk's home in Nova Scotia, Canada, is frequently subject to hurricanes and blizzards. To ensure extremely high availability, each Dispatcher would be provisioned with a rugged laptop, a NENA compliant headset and a handswitch. The

laptop would be connected to a battery backed multi-WAN router, which provided an upstream to a dual-SIM wifi router with connections to Bell and Telus networks using the public safety unlimited data plans offered by each and physical connections to Bell Fibre, Telus High Speed and Starlink/Immarsat satellite. Similar multi-path networking could be used to provide extreme availability to the radios in the lab with similar power backups. In this way, all possible connections would need to be lost, and the generators unsupplied before connectivity by the Dispatcher was lost.

To ensure even greater availability, Dispatchers would be located in various other places, including our partner offices in the south of California, USA or Montreal, QC, Canada, as well as several sites around Nova Scotia.

The Dispatch Enterprise

If we look at the information landscape for an emergency event, we quickly realise that voice-over-radio from a hilltop tower isn't the only piece of technology being used by Dispatchers to save lives during disasters with better information. There are cameras, Computer Aided Dispatch (CAD), maps, internet websites, social media, training videos and text messages that are used to make sure that field units have the right information at the right time and in the right format.

This is delivered over a high-reliability enterprise network with services residing in multiple data centres and integrated with the wider information landscape provided by other agencies and the general public. The same availability problems apply to these services as they do to hilltop radios. The same solutions apply - redundancy and dispersion.

To connect to a diverse set of public safety enterprise information systems located in many different data centres, Dispatchers use the appropriate InterTalk Enlite™ Mission and WebFrame tools to filter down from the thousands of potential information sources (from cameras, from smartphones, from sensors, from the internet, from other responders, etc...) to only the useful information for handling the specific call that they're addressing. And then, they use the InterTalk Enlite™ missions interface to patch and push callers and responders together in a mediated and coordinated way.

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Conclusion

An extremely high availability public safety infrastructure can be created from a diffused set of redundant resources in the same way as has been done in the past - by having lots of independent resources that can be integrated together by a set of intelligent human Dispatchers.

“The Internet going away” is resolved by having no single “Internet” to be reliant upon. Each site offers resources, and each Dispatcher has the ability to connect to any resources that they can see from their console. All sites are connected to the wider world using several mediums.

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