Stockholm Metro Project

Innovation making TETRA indispensable

Case Study

The most important thing we build is trust

Overview

Replaced the 17 year old public safety communication system with a multi-band TETRA communication system to be used by the train operators and emergency services.

Challenge

Replacing an existing system can produce numerous challenges including, the smooth transition of the old system to the new system without any down time. The Metro environment also poses a challenge with the restricted space within the tunnels and stations.

The Challenge

In underground locations heavily used by the public, robust wireless communication networks are crucial for the provision of continuous communications during emergencies. The technology of choice for public safety authorities is TETRA, due to its resilience and reliability during disaster scenarios. However, with new standards and regulations changing the public safety network landscape, TETRA has to continuously evolve to keep pace.

The Swedish operator SL is responsible for overseeing Stockholm's metro network. Construction of the network started in 1950 and the latest station opened in 1994. Today, the metro network consists of 100 underground stations, 50 stations above ground, and a total of 105km of track. The metro's public safety network has to support over 1,000,000 journeys on a daily basis. The wireless network's duty of care extends further than the Metro's customers though, with over 3,000 staff needing constant and consistent communications with the operational hub.

To provide a comprehensive coverage solution, SL chose a TETRA network, which for 17 years was supported by a sub-com system, providing coverage in underground sections over three different radio services: train communications linking the operation managers to their drivers and workers in the network, coverage for the Swedish Police and for Stockholm's Fire and Rescue services.

However, over the years the sub-com system began to be impacted by the strain of supporting the Metro network. It was struggling to supply air links to base stations above ground, because of new buildings causing interference issues for 160MHz band signals. The cables linking the system were over 15 years old, there were a limited number of optical fibres available and advances in cellular technology meant that the combination of public safety, broadcast and cellular coverage was required in the upgrade.

SL had to provide ubiquitous coverage not only for the emergency services, but also for public use across the GSM spectrum at different frequencies. Overseeing such a huge project was tough, but even more complicated for SL was to upgrade the network while keeping the old analogue system fully functioning; in order to keep the network up and running.

The key issues:

Totally redundant - Due to the complexity of the underground network, and the amount of traffic flowing in and out, the digital network had to provide extremely high levels of redundancy to ensure communications were effective in the event of an emergency.

Multi-purpose network - The network had to support rail communications, through a completely redundant public safety system, and provide a public network for national mobile network operators.
Replacing old connectors - Cables in tunnels are subjected to a huge amount of vibration, and chocks and connectors are weak points that are often susceptible to degradation. Existing connectors were over 15 years old and needed replacing.
Transitioning old to new - During the switch over there had to be a smooth transition from the old system to the new. The old system had to run in parallel with the new one in order to keep supplying comprehensive coverage to the Metro operator.
Provision for the future – The network had to be prepared to support SL's own forthcoming TETRA system and be capable of adapting to future requirements and expansions.

The Solution

In 2008, to cope with these various challenges, SL commissioned Cobham Wireless to install a highly robust network to replace its existing 17 year-old one. Cobham Wireless supplied a new multi-band system consisting of over 70 repeaters providing radio coverage alongside the 105km long metro track. In addition, a number of repeaters were installed to provide coverage for the commuter trains and the tram lines. The multi-band system supports the existing radio systems while also providing coverage for a TETRA public safety network for the emergency services, a TETRA train communication and information network, and various commercial mobile radio services. With any TETRA deployment the first task is to ensure public safety. To meet the high reliability and availability requirements of the new Stockholm Metro system, and ensure a smooth transition, Cobham Wireless employed a 'distributed antenna system' based on 'fibre-fed repeaters'. Using this method, a single base station can be positioned at each end of a section of tunnel, or group of tunnels, to feed repeaters placed at each underground station, connected through optical fibres.

Fibre optic repeater systems in TETRA networks overcome the challenges of underground locations by leveraging usability and flexibility. The use of these repeaters allows base station coverage to be boosted and extended over great distances to remote locations; removing the issues associated with continuous communications underground. A reliable TETRA radio system must continue performing despite any failures to the system itself. This problem is solved by two independent base stations providing overlapping coverage underground. Each base station is configured to feed several repeaters placed inside a tunnel, and overlapping coverage exists between two adjacent repeaters. If a repeater fails, the other repeater sited next to it will carry on providing coverage. The requirement for critical resilience, ensuring that there are no coverage black spots for the emergency services, is of vital importance. The system installation was strong, yet flexible, allowing the secure handover of RF communications from one unit to the next, should a base station or repeater suddenly be damaged or destroyed during a crisis. This ensures the emergency services receive continuous coverage in an enclosed, and potentially hazardous, environment.

Management and control of the network

To enhance SL's visibility across their entire network, Cobham Wireless installed its software manager Active Element Manager (AEM), to create a balanced system with one technological interface. This provided SL with a supervision system that is able to remotely shut down, or upgrade the network when needed.

Software-defined radio changes the landscape

A smooth transition from an analogue system to a resilient dual-purpose network supporting both public safety and commercial use would not have been possible without the emergence of repeaters using software defined radio (SDR), such as Cobham Wireless' channel selective CSR438 repeater. SDR is a collection of hardware and software technologies that enable reconfigurable system architectures for wireless communications. Traditional hardware-based radio devices limit cross-functionality and can only be modified through physical intervention. SDR enables new wireless features and capabilities to be added to existing radio systems through software upgrades, rather than a hardware upgrade, thus providing a TETRA operator with the flexibility to specify and change sub-band allocations, simplifying the process of updating to new standards in network functionality.

Connected – Seamless – Wireless

The Benefit

Smoothing the transition - In order to keep the old analogue system operational during the transition the signals from the sub com rack were connected to the new racks. During the upgrade the following radio systems were supported: Police, Fire and Rescue, Train radio communication, BussKom (SL's TETRA System), RAKEL (Swedish nationwide TETRA system), FM-Radio, GSM 900 and GSM 1800.

Efficient network - The upgraded network now only uses 4 downlink sites for train radio compared to 70 previously as most of the downlink sites have been replaced with TETRA base stations. Antennas in ticket halls were replaced by leaky feeders to further streamline the network. The network for commuter trains and tram lines uses 10 downlink sites equipped with Cobham Wireless digital CSR438 repeaters and no underground base stations.

Fully redundant network - As a fully redundant system if any part fails the system will continue to run through overlapping coverage between stations. Two independent base stations provide additional capacity and redundancy with a further dedicated site. Two independent fibre paths feed each repeater with redundant station coverage provided by the adjacent stations in case of a repeater failure. This comprehensive wireless system meets stringent safety standards, as the network is underpinned by an automatic single level control, which is integrated in the system, so in the event of any failures the signal will still be carried.

Easy to extend – Providing radio frequency over fibre makes the network flexible to upgrade and offers the ability to add to the network when expansion is needed.

Future-proof solution - The installation also saw the introduction of SDR-based equipment to support FM radio frequencies. A built in SDR coverage solution can be remotely configured using software updates. This provides a TETRA operator with the flexibility to specify and change sub-band allocation providing an easier path to new standards.