INFRASTRUCTURE ATM TECHNOLOGY

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IP: THE WAY OUT

ATC turns to dynamic routing for enterprise-wide voice communications

VOICE COMMUNICATION CONTROL SYSTEMS (VCCS) serve as a nexus for various air traffic control resources, among them very high frequency (VHF), ultra high frequency (UHF), and high frequency (HF) radios, as well as weather information displays and traffic-flow management systems. Typically, these elements are integrated on a 'local' level—at an individual airport or flight control centre, for example.

The drawback to this approach is that it creates a silo of communications capabilities, integrated only within the single location. The system operates independently of other VCCS systems within a country or region, and often uses different equipment providing varying capabilities. This poses significant drawbacks in an increasingly interconnected digital world.

How to solve this challenge going forward? Air traffic control organisations are looking to the application of Internet protocol (IP)-based systems to provide effective voice control and data communications capabilities across the total enterprise. This includes the US Federal Aviation Administration as well as the European agencies, which are seeking to modernise their VCCS with platforms that deliver new technology and capabilities across the voice enterprise.

TECHNOLOGY EVOLUTION: ANALOGUE, DIGITAL (TDM), AND DYNAMIC ROUTING (IP). The path to IP is the result of continued technology evolution. Like every other industry, the field of air traffic control communications has advanced over the years in the physical hardware used and the signal format quality as well as in environmental factors.

Hardware has evolved from very large, noisy, heat-producing equipment with mechanical relays and vacuum tubes to much smaller, uniform-sized chassis and surface mount components. These produce very little noise and a fraction of the heat of legacy equipment, while also using much less power and providing greatly enhanced reliability.

The transition from analogue to digital signal processing eliminated the problems of extraneous noise and interference from external electrical fields, while increasing the quality of voice or data. Equally important, digital signals also offered the ability to transmit information over longer distances without the degradation inherent in analogue circuits.

For years, time division multiplexing (TDM) was the standard method of transmission for digital signals. TDM is a direct signal connection that links two points over cable or radio. It requires that both points share the exact timing, data transmission protocols, and data speeds—and often requires the same type of equipment at both ends. Because TDM provides a direct connection between two end-points or devices, there is minimal signal processing, which enables TDM to have lower latency than other modern transmission technologies.

This direct connection is both a benefit and a drawback to TDM. While it speeds signal transmission, the bandwidth of the transmission path can be used only for the communications between the two devices involved. No dynamic recovery is possible apart from providing a parallel, dedicated path.

Dynamic data routing was to be the next step in the evolution of communications. While there are many protocols that use dynamic

WHY IP IS A RELIABLE SOLUTION FOR VCCS. VCCS networking today means much more than voice communications. ATFM, weather, voice, radar, RCAG and other applications are shared or must be available wherever needed. To accomplish this with TDM would require an extensive, expensive network of dedicated communications links.

Another drawback of TDM quickly becomes apparent while networking modern applications—bandwidth. TDM is fixed bandwidth that is difficult to change without new equipment, and there is major time consuming steps involved with each bandwidth change, sometimes taking weeks to implement.

Using IP to network VCCS and other sites can solve many of these problems. In the IP world, each piece of equipment has an electronic address. All data sent over an IP network is labelled with the address of the equipment that it is destined to reach, as well as the equipment from which it originated.

Only one primary connection—and one alternate for critical sites—is required to provide access to all sites connected to the network. Network routing equipment sends the data packets along a network based on the addresses, and routers use logical circuit information to pick the most efficient available route to the destination equipment. IP also provides error-correction schemes to ensure data integrity.

In addition, bandwidth is shared among applications, supporting burst mode requirements, and can be adjusted quickly without a major infrastructure change. The routed IP network is self-healing and adapts immediately to path failures, increasing reliability. The operating costs decrease due to less equipment, circuits, and infrastructure; and the opportunity for enterprise-wide network management with protocols like SNMP is available to ANSPs.

Critics of IP cite the additional time required to process data into packets and perform routing decisions as a drawback vs. TDM. However, even with the processing and decision-making that is performed in a dynamically routed network the time is still measured in milliseconds—very fast and unnoticeable to the hu-

switches. By 2011, 92 per cent of global PBX shipments were IP systems. IP systems are replacing legacy TDM systems in many mission-critical applications, from military command and control operations to commercial call centres.

The purchase of a VCCS is a significant capital investment that typically has an extended lifespan, but even more important, it is the cornerstone of air traffic control that integrates everything in the system. Using the speed and response times related to TDM as benchmarks for modern enterprise-level systems limits the discussion of options to an older generation of digital transmission technology that is no longer "future proof".

IP is a refined technology that is regularly used to carry voice and data around the world and to reliably connect varying system architectures and different equipment. The advanced capabilities and the highly interdependent technologies IP supports can change the way global air traffic control systems operate, reduce operating costs, and improve the passenger experience.

IP is, in fact, a reliable and effective means of communication that allows us to do many things that TDM did not:

- Connect dissimilar devices—transmission path timing and format are no longer critical
- Connect many devices together in a network web—providing many back-up paths, rather than each device being connected one-to-one, as with TDM
- Share bandwidth—data can take one of the many routes to its destination, so unlike TDM, a failure in a single path or cable does not stop communications, and costs are reduced by utilising common communications links
- Connect equipment of differing speeds—many speeds of IP or Ethernet can be merged together on a single network without issue— TDM must have exactly the same speed and timing at both ends of a connection.
- Reduce manually intensive configuration—IP is software-controlled and self-adjusting, while most TDM applications require new configurations to be initiated manually.
- Less cabling and equipment is required with IP, many self-healing connections are possible not only with large networks but also small networks such as VCCS position equipment. Rings, hub-and-spoke, and web, are all possible with a minimal amount of equipment and cable when compared with TDM installations.