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Agenda Item 3: Aeronautical Fixed Service

ALTERNATE ROUTING PROPOSAL FOR AIR TRAFFIC CONTROL VOICE SERVICE BETWEEN AIRPORTS FIJI LIMITED, AIRWAYS CORPORATION OF NEW ZEALAND AND THE UNITED STATES OF AMERICA FEDERAL AVIATION ADMINISTRATION

(Presented by the United States of America)

Summary

Similar hardware multiplexing platforms allow for the possibility of cost effective alternate routing for air traffic control voice service between the USA, Fiji, and New Zealand. This paper details the steps required to implement this alt-route capability.

1.0 Introduction

1.1 In 2002, the United States of America (USA) Federal Aviation Administration (FAA) and Airports Fiji Limited (AFL) upgraded their bilateral Aeronautical Fixed Services (AFS). The FAA and AFL replaced their existing unsupportable multiplexing equipment with Network Equipment Technologies (N.E.T). Promina 800 and N.E.T. Promina 100 equipment, respectively. The FAA and AFL also established a 64 kilobits per second (kbps) trunk circuit between Oakland Air Route Traffic Control Center (ARTCC) and Nadi Area Control Center (ACC). The services implemented over the USA/Fiji trunk circuit are listed in Appendix A.

1.2 Similarly, in 2003, the USA FAA and Airways Corporation of New Zealand Limited are in the process of completing the establishment of bilateral AFS communications using Promina equipment. The FAA upgraded their Promina 800 equipment at the Oakland ARTCC to accommodate voice and data services to New Zealand. Airways Corporation of New Zealand implemented Promina 100 equipment at the Auckland ACC. A 64 kbps trunk circuit was also established between Oakland ARTCC and Auckland ACC. The services implementing over the USA/New Zealand trunk circuit are listed in Appendix B.

1.3 The purpose of this paper is to discuss one of the benefits of implementing the same multiplexing platform for the USA/Fiji and the USA/New Zealand services – alternate routing. Even though alternate routing can be accomplished for an entire trunk circuit or any combination of channels on the trunk, this paper focuses on the proposal to establish alternate routing capabilities for only the Air Traffic Control (ATC) voice service.

2.0 Reliable Air Traffic Control Voice Service

2.1 Reliable ATC voice communications is critical for safety, airspace efficiency, and the timely coordination of aircraft information. USA/Fiji and USA/New Zealand ATC voice communications have been established. The new USA/Fiji ATC compressed voice service transitioned to operational service in October 2002. The USA/New Zealand ATC compressed voice service became operational in March 2003. Both of these voice services are compressed to 8 kbps. The Promina equipment uses an industry standard, the Conjugate Structure Algebraic Code Excited Linear Prediction, CS-ACELP (G.729), for voice compression.

2.2 There is currently no backup for these voice services. The implementation of an alternate routing capability between the USA, Fiji, and New Zealand would improve the current configuration by increasing service reliability. Alternate routing would provide another layer of diversity for critical Air Traffic Control voice services in the event of an outage on the primary leased communication link.

3.0 Alternate Routing

3.1 Alternate routing is accomplished automatically by the Promina node. The node alt-routes services when it declares that the trunk circuit carrying these services is down. An obvious case of this is if the telecommunications line is cut. The node also declares a trunk down if the telecommunications line is degraded to the point where the local node loses the ability to communicate with the downstream node. (For other degrees of service degradation, manual alt-route is available.) To avoid a pin-wheeling effect, where the node gets into a cycle of a trunk coming up and going down, the node must lose communications for four seconds before it is declared down, and must have regained connectivity for five seconds before it is declared usable for the transport of services.

3.2 In alternate routing, the origination side of each circuit needs to find another path to complete the circuit. The node looks at the network management route tables to determine the links between the nodes. It then decides how to get to the destination nodes via the shortest path/least number of hops. Then, it notes if there is available bandwidth to reroute the circuit. For example, if alternate routing was implemented for the ATC voice service and if the USA/Fiji trunk circuit failed, the USA Promina node would determine that the only other link is through New Zealand. It would verify that an 8 kbps path for the ATC voice service was available between the USA and New Zealand and between New Zealand and Fiji. If bandwidth were available on both of these legs, then the circuit would be rerouted along this path. If the required bandwidth is not available, then the node looks at the preemption levels of the services on the alternate route (if implemented) to determine if a less important call can be failed allowing a more important call to become active.

3.3 Priority is the order that circuits are restored or originally established when a node initially powers up. When node connections are active with calls, preemption values can be used to ensure the most important calls always remain active. When there is conflict or contention for bandwidth, preemption determines the order in which calls can “preempt” a less important call (as determined by air traffic agreement). The Promina equipment will always place a call in available bandwidth before preempting an existing call. Priority and preemption factors are more important in a large network. There are sixteen levels of priority and sixteen levels of preemption. If alternate routing were implemented between the USA, Fiji, and New Zealand, the states would need to come to agreement on the priority and preemption levels for all services on each trunk circuit, to ensure only the most important calls survive telecommunications failures.

3.4 Manual alt-routing can be accomplished via human intervention. Technicians at the FAA Network Operations Center (NOC) at the Salt Lake City (SLC) National Network Control Center (NNCC) have a Network Management System (NMS), which provides them the capability to monitor performance and availability of the network. The operator will be notified of a degraded circuit via a system alarm on the NMS or a call from technicians in Fiji or New Zealand. Fiji and New Zealand technicians also have the capability to monitor trunk circuits by connecting a terminal to their Promina 100 system operator console port.

3.5 To manually alt-route a circuit, the USA, Fiji, or New Zealand technician blocks calls on the trunk circuit. Block is a software command that restricts any calls from building on a blocked trunk circuit. The technician then manually moves existing traffic off the degraded trunk circuit. This is accomplished by disabling data ports to tear down the existing calls and then reactivating them, or by taking the whole trunk circuit down. Calls will rebuild over the alternate route. The original trunk circuit would then be called into the telecommunications service provider(s) for repair.

3.6 When the failed trunk circuit comes back online, the alternate routing is not immediately cancelled. Instead, the Promina node performs an optimization check at a predetermined time. The predetermined time, usually during a slow air traffic period, is manually set by an operator. The Promina node would automatically reroute to the original trunk circuit upon completion of the optimization check. A technician can also manually reroute the circuit onto the repaired circuit by performing a “reconnect call” command.

4.0 Requirements for Implementing Alternate Routing Between the USA, Fiji, and New Zealand

4.1 Alternate routing of the ATC voice service between the USA, Fiji, and New Zealand would require the following upgrades:

- Implementation of a 64 kbps trunk circuit between Fiji and New Zealand. Potential services for implementation over the Fiji/New Zealand trunk circuit are listed in Appendix C.
- Termination of Fiji/New Zealand circuit into the Promina equipment at each location
- Reconfiguration of both the USA/Fiji and USA/New Zealand circuits so an additional 8 kbps is reserved for alternate routing of critical ATC voice service
- Connection of a standard 2-wire cross-connect phone cable from the voice switch to the punch down block at both the Fiji and New Zealand facilities. The punch down block is already connected to the Promina 100 node.
- TRK-3 Front and Rear Interface Cards, one set each for the Fiji and New Zealand operational Promina nodes
- TRK-3 Front and Rear Interface Cards, one set each for Fiji and New Zealand as recommended spares

4.2 The Rear Interface Card is dependent on the agreed interface type between New Zealand and Fiji. There are four possible versions of the Rear Interface Card: E1, T1, RS-530, and V.35. Since the V.35 interface is already being used for the USA/Fiji and USA/New Zealand trunk circuits, it would be ideal to use the V.35 interface for the Fiji/New Zealand trunk too. This configuration would require a TRK-3 Front Card and V.35 Rear Interface Card for the Fiji and New Zealand operational Promina nodes. It is recommended that a set of spares also be procured for each location. Without spares, if a non-spared card failure were to occur, it would take approximately one week from the time NET receives a purchase order, to replace the failed part.

4.3 Currently, there are no spare trunk cards for the USA/Fiji and USA/New Zealand circuits. However, there is an operational Promina 100 and a spare Promina 100 at Fiji and New Zealand. The trunk card is built into the Promina 100 motherboard chassis. If a problem were to occur with these trunk cards today, a technician would need to swap the operational Promina node chassis with the spare chassis (essentially unplug one chassis and plug in the other one). In the case of a Fiji/New Zealand trunk failure, if a spare was available, the TRK-3 card could be removed from the standby node and used for the replacement of the failed node's card.

4.4 There are no software upgrades required to implement alternate routing between the USA, Fiji, and New Zealand. The FAA SLC NNCC would need to reconfigure the existing ports on each Promina node (5-10 minutes of configuration time).

4.5 Figure 1 illustrates the proposed alternate routing scenario for a USA/Fiji trunk failure.

5.0 Recommendation

5.1 In conclusion, since similar hardware platforms exist and additional bandwidth is available on both the USA/Fiji and USA/New Zealand trunk circuits, enabling alternate routing for USA/Fiji/New Zealand Air Traffic Control voice services could provide cost effective protection against trunk/channel failures.

5.2 Airports Fiji Limited and Airways Corporation of New Zealand, Limited are invited to consider the implementation of alternate routing for Air Traffic Control voice services between the USA, Fiji, and New Zealand as described in this paper.

5.3 Other states are invited to review this alternate routing proposal for potential applicability to their international Air Traffic Control voice communication services.

Appendix A: USA/Fiji AFS Services

The following list details the implemented and potential future AFS services between the two states:

- Implemented Services
  - 8 kbps -- management overhead
    This channel is required for the Promina equipment to determine the network topology and establish calls. It allows the equipment to check the condition of other compatible equipment and the links to this equipment.
  - 3 kbps -- framing overhead
    This channel is used for framing and maintaining the 64 kbps trunk line code.
  - 1.2 kbps -- emergency management access channel
    This channel allows the FAA to work with AFL technicians in troubleshooting the Promina equipment and/or any tail circuits. Fiji would have the option of leaving this channel up or activating it when desired.
  - 2.4 kbps -- X.25 Aeronautical Fixed Telecommunications Network (AFTN) data channel (existing)
  - 8 kbps -- air traffic, compressed voice channel (existing – modified)
  - 8 kbps -- weather compressed voice channel (between Fiji and Honolulu, Hawaii)
  - 4.8 kbps -- weather data channel (between Fiji and Silver Spring, Maryland)

- Potential Future Services
  - 9.6 kbps -- Aeronautical Telecommunications Network (ATN) data channel
  - 8 kbps -- air traffic compressed voice channel (contingency voice channel)
    - **8 kbps -- air traffic, compressed voice for alternate routing**
  - 3 kbps -- unallocated bandwidth

Appendix B: USA/New Zealand AFS Services

The following list details the proposed and potential future AFS services between the two states:

Implemented Services

A. 8 kbps -- management overhead
This channel is required for the Promina equipment to determine the network topology and establish calls. It allows the equipment to check the condition of other compatible equipment and the links to this equipment.
B. 3 kbps -- framing overhead
This channel is used for framing and maintaining the 64 kbps trunk line code.
C. 1.2 kbps -- FAA emergency management access channel
This channel allows the FAA to work with Airways Corporation of New Zealand Limited technicians in troubleshooting the Promina equipment and/or any tail circuits. New Zealand would have the option of leaving this channel up or activating it when desired.
D. 8 kbps -- air traffic, compressed voice channel
E. 9.6 kbps -- X.25 AFTN data channel

Potential Future Services

F. 9.6 kbps -- ATN data channel
G. 8 kbps -- air traffic, compressed voice channel (contingency voice channel)
H. 8 kbps -- air traffic, compressed voice for alternate routing
I. 8.6 kbps -- unallocated bandwidth

Appendix C: Proposed Fiji/New Zealand AFS Services

The following list details the proposed future AFS services between the two states:

Proposed Future Services

A. 8 kbps -- management overhead
   This channel is required for the Promina equipment to determine the network topology and call setup. It allows the equipment to check the condition of other compatible equipment and the links to this equipment.
B. 3 kbps -- framing overhead
   This channel is used for framing and maintaining the 64 kbps trunk line code.
C. 8 kbps – air traffic, compressed voice
D. **8 kbps -- air traffic, compressed voice for alternate routing**
E. 37 kbps -- unallocated bandwidth
   - AFTN?
   - ATN?
   - Additional voice?
   - Other?

Figure 1: Proposed Alternate Routing Scenario for a USA/Fiji Trunk Failure