

USING AIRBORNE DIGITAL REPEATERS IN  
EMERGENCY COMMUNICATIONS

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The state of Florida is, as pointed out so dramatically on August 23-24, 1992, vulnerable to the destruction of a hurricane. Communications links so vital to recovery are often among the weakest, most vulnerable targets. Linking the southern half of the state with the state capitol in Tallahassee is more than difficult, because of the distances involved (Figure 1).

On the southwest coast of Florida in Naples, 110 miles due west of Ft. **Lauderdale**, the Collier County Emergency Operations Center provides link from **EOCs** up the west coast to Dade, Broward and Monroe Counties, including the National Hurricane Center in Coral Gables, Florida. A dual port network node is located at Ochopee providing 220 and 440 links to the east coast. Another is planned for a federal government site near the Dade County line, providing redundant sites along US **41 between** Naples and Miami.

To the north, the FMY node stack is located at the Lee County EOC in Ft. Myers, consisting of 2 meters, 220 and **440** nodes some 40 miles north of Naples. Thirty miles to the north is **Punta** Gorda with a 2 **meter/440** node serving Charlotte County, and linking to Sarasota. From there, the ROSE network takes over to Tampa, and Pasco County. There, the northbound network virtually stops, except for a tenuous connection along the I-4 corridor (Figure 2).

Packet radio connections have been made between the **WB2WPA** BBS in Naples, and the state EOC in Tallahassee, but the connections have relied on enhanced paths to provide a slow link which is not capable of providing reliable extended periods of communication. If a storm was to destroy the terrestrial **VHF/HF** network, the entire state would **have** to rely on HF **packet** communications to link the southern half of the state with Tallahassee.

At **the** 1989 Florida Governor% Hurricane Conference in Tampa, I proposed a method of flying nodes in "**orbits**" along the length of the 120 mile wide peninsula at relatively high altitudes, providing a 2 hop link between the southern end of the 'state and the State EOC.

Under the plan, Civil Air Patrol aircraft would fly circles between 6,000 and 10,000 feet near **Wauchula** in Highlands County, some 50 miles ESE of Tampa Bay, and near Cedar Key or Gainesville in the north central portion of the state. Conceivably, these two aircraft could link the state from Jacksonville and Tallahassee to Miami and Naples. A third aircraft over the panhandle near Apalachicola would tie in the rest of the state.

Basic tests were run using a single aircraft to basically determine the maximum usable range of air to ground link. A Cessna **172** was equipped with a small lantern battery, a Yaesu 5 watt handheld, and a **PacCom** TNC carried in the back seat of the aircraft. For the original test, a quarter wave rubber duck" antenna was strapped to an unused VHF antenna on the belly of the aircraft.

An operator at the keyboard 'of the WB2WPA-5 BBS in Naples established a contact with the aircraft before takeoff (the airport is about 2 miles from the EOC, and the antenna is at 140 feet). A CAP operator in the EOC was to maintain voice contact with the aircraft and CAP HQ on CAP VHF frequencies.

The aircraft departed Naples on a heading of 045 degrees, and was directed to fly to LaBelle in Hendry County, about 50 miles north-northeast of Naples, while climbing to 6,000 feet. At the EOC, an additional 2 meter radio monitored the packet frequency in use, 145.050. The frequency was selected because it was the Naples LAN frequency and local operators were encouraged to access the aircraft. The frequency is also used as a LAN frequency in the Tampa Bay area on the west coast, and Stuart and Daytona Beach on the east coast.

Over the LaBelle VOR the aircraft was full quieting, both on packet and voice. Connects were made and broken repeatedly to be sure that they could be made when needed, covering both coasts and virtually the entire southern half of the state. The aircraft was also used to connect through a landbased node to the Daytona Beach area (Figure 3). During connections, messages were up to and downloaded from the PBBS in the TNC. Heard lists were downloaded to determine how well the aircraft was hearing.

From LaBelle, the aircraft was sent north toward Wauchula, maintaining 6,000 feet. As it continued north, Key West became less and less apparent, but more and more stations were heard in the Lakeland (30 miles east of Tampa) and Daytona Beach areas.

From Wauchula, contacts were made between Naples, Tampa and Daytona with ease, until the aircraft reached its northernmost point in Hardee County (Figure 4). Signals were still usable, but collisions on such a busy frequency were slowing things down.

The aircraft returned to Naples, and continued providing **excellent** coverage of the southern half of the state, almost to touchdown.

This initial experiment indicated that at 6,000 feet, we could expect good communications from the 140 foot high omni antenna at the EOC to the rubber duck antenna on the plane to about 110420 miles. Some polarization problems were seen as the antenna flexed toward the rear of the aircraft, and plans were then discussed aimed at retrying the experiment at other altitudes, and with a more rigid, permanently mounted antenna.

In March of 1993, the Florida Wing of Civil Air Patrol held its annual Disaster Recovery **Exercise (DREX)** utilizing several bases around the state, and the state EOC in Tallahassee.

In Naples, it was decided to include some testing and training using the County's new \$125,000 Mobile Command Center, which is equipped with packet using both HF and VHF. Antennas are roof and tower mounted, with power levels of 5 and 40 watts available on HF packet.

CAP frequencies would be used, and two aircraft would be available carrying packet **digis**, but not nodes, as CAP is currently using digipeater technology instead of transport level nodes. One aircraft would fly from Naples and head north. A second would leave the Tampa Bay area and head up the coast.

Again, voice communications were available for coordination with the aircraft on VHF, as well as HF CAP frequencies for coordination with other CAP bases and Tallahassee. **FEMA's Operation Secure** frequencies were also used direct to Tallahassee and the State EOC.

The equipment on both aircraft was basically the same as in the original test, except that permanently mounted quarter wave rigid belly antennas were installed. This kept the packet antennas away from the CAP and aircraft VHF antennas on top of the cabin.

Because of poor performance and highly irregular connections between Tallahassee and the southern half of the state using the VHF/UHF network, state officials were skeptical at best. As the **exercize** continued, the aircraft, flying at 10,000 feet, moved toward there target areas.

Again, connections were made and broken repeatedly to test "connectability? Heard lists were dumped, and the Naples aircraft was hearing the Tampa aircraft very well. An operator on board confirmed good signals. .

From Naples a connection was requested of the Tampa aircraft TNC, via the Naples aircraft. Even though it was a digied connection, it was suprisingly fast. The heard list did not indicate that the state EOC was being heard. The northern aircraft was contacted via an HF request to its base. **Its** position was northern Hillsborough County at 10,000 feet. A request was sent to move farther north, as the heard list was downloaded repeatedly, looking for Tallahassee.

**On** HF, contact was maintained with the State EOG, which continued sending connect requests to the northernmost aircraft. Finally, a connect was reported. Both Naples and Tallahassee were connected to the same **airborn** TNC, Tallahassee directly, and Naples via a **one digi** hop!

The mission commander in Naples appeared in the bus, asking if we could send a priority message to Tallahassee. The message **was** created using a text editor in the **onboard** computer in the Command Center. Connections with the aircraft were broken from both ends. Coordinating on HF, the command center requested a connection with Tallahassee via the Naples aircraft and the Tampa aircraft, **now** orbiting near New Port **Richey** in Pasco County...and **running** a little low on fuel!

The Tampa aircraft was a bit farther 'south than had been hoped, right on the edge of capability of maintaining communications with the State. The connection went through! The first south Florida to Tallahassee packet connection via aircraft **was** made.

The text was sent, **in** formal CAP format. When the STA light went out (finally) in the Command Center, we knew it had **gone** through. A few seconds later came an HF voice confirmation: they HAD the message in Tallahassee!

A second message had been prepared, and the connection was broken, in an attempt to upload the message to the second aircraft's PBBS. It was loaded fairly easily, again digipeating through the first aircraft, which was now also running a bit low on fuel. From Naples, on HF, the Tallahassee station was advised

that the message had been uploaded to the Tampa aircraft PBBS, and that we had been told that the aircraft was returning to Tampa.

Sadly, the aircraft had moved too far south and had begun its descent into Tampa by then, and Tallahassee was not able to retrieve the message. The Naples plane was ordered home, and the experiment was concluded.

Plans were immediately discussed for a third experiment, this time flying amateur radio NET/ROM or TheNet nodes, or ROSE switches aboard the aircraft, in order to get TNC to TNC acknowledgement at each step improving throughput. We are also looking at using discrete VHF/UHF frequencies and higher speeds to allow more traffic to pass through the system. Some examples for future tests:

- 1: Fly single frequency nodes at 1200 baud to link north and south Florida on otherwise quiet frequencies.
- 2: Equip the aircraft with 9600 baud or faster **TNCs**.
- 3: Using sophisticated laptop computers, attempt flying full service BBS software, allowing land based BBS hubs to autoforward to aircraft 1, which would then forward to aircraft 2 which would then **downlink** to the north Florida hub BBS.
- 4: Develop cooperative plans between CAP and ARES/RACES to permanently equip at least 1 plane in Naples, Miami, Tampa, Orlando, Gainesville, Jacksonville, Tallahassee and the panhandle with high speed links to the ground and each other, capable of being quickly deployed in a rotation that will keep three aircraft in the air for as long as possible, or on a scheduled basis providing at least interim packet communications using both amateur and CAP frequencies linking emergency operations centers throughout the state.
- 5: Locate and assign packet equipped mobile communications centers for deployment along with amateur radio communications teams into disaster areas in coordination with the Florida ARES/RACES Communications **Assistance** Team Plan adopted in July 1993.
- 6: Attempt to connect the entire state of Florida using 3 aircraft (Figure 5) by flying a third aircraft north and slightly west of Apalachicola in the panhandle. If further linking were needed, say to FEMA in Atlanta, a fourth aircraft in Georgia might well provide that link.

Further testing is planned with these experiments in mind. We would be most interested in hearing from other groups who have done airborne testing, or who would be interested in assisting in our further tests.

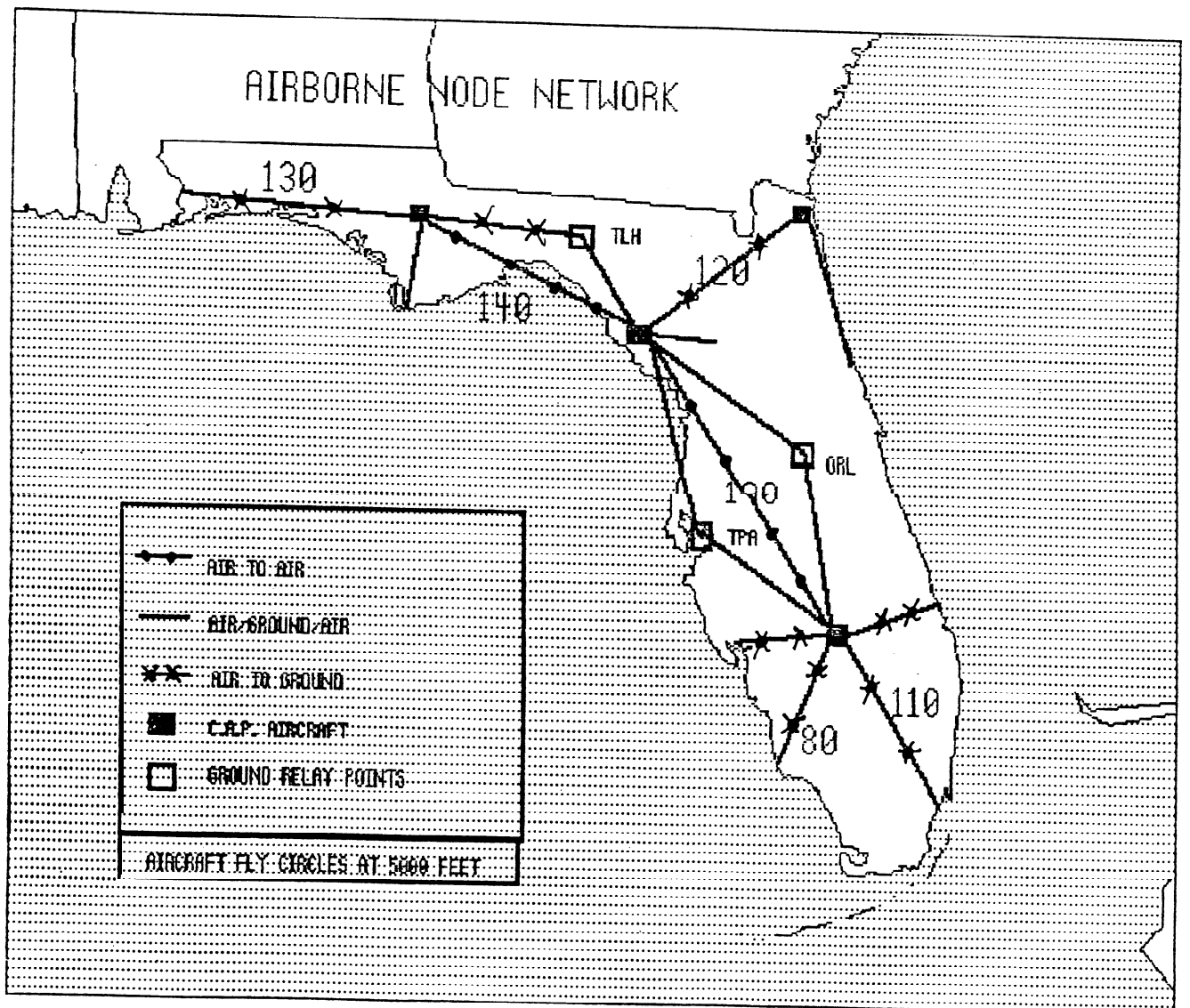


FIGURE 1: Airborne network and distances within Florida

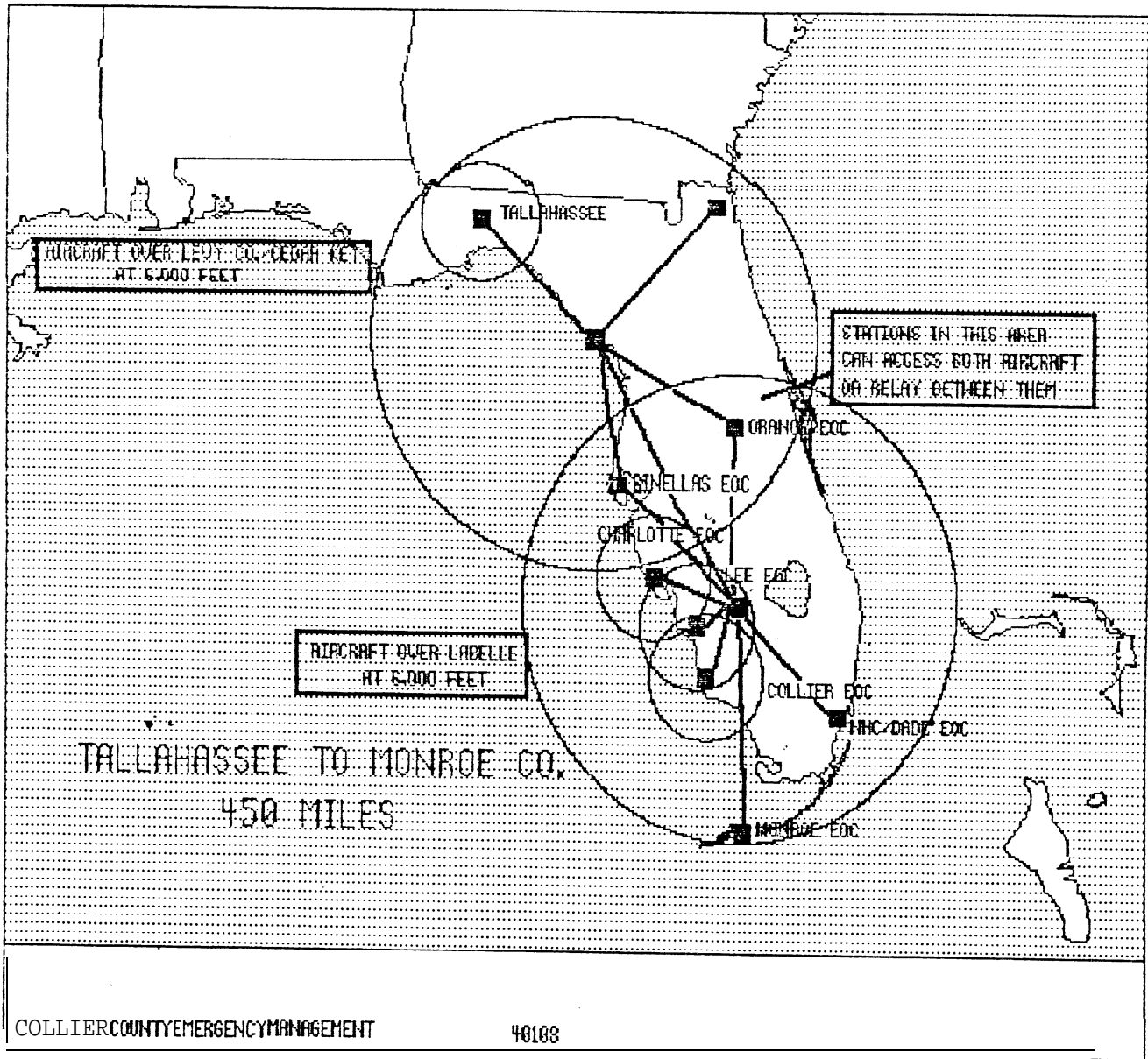
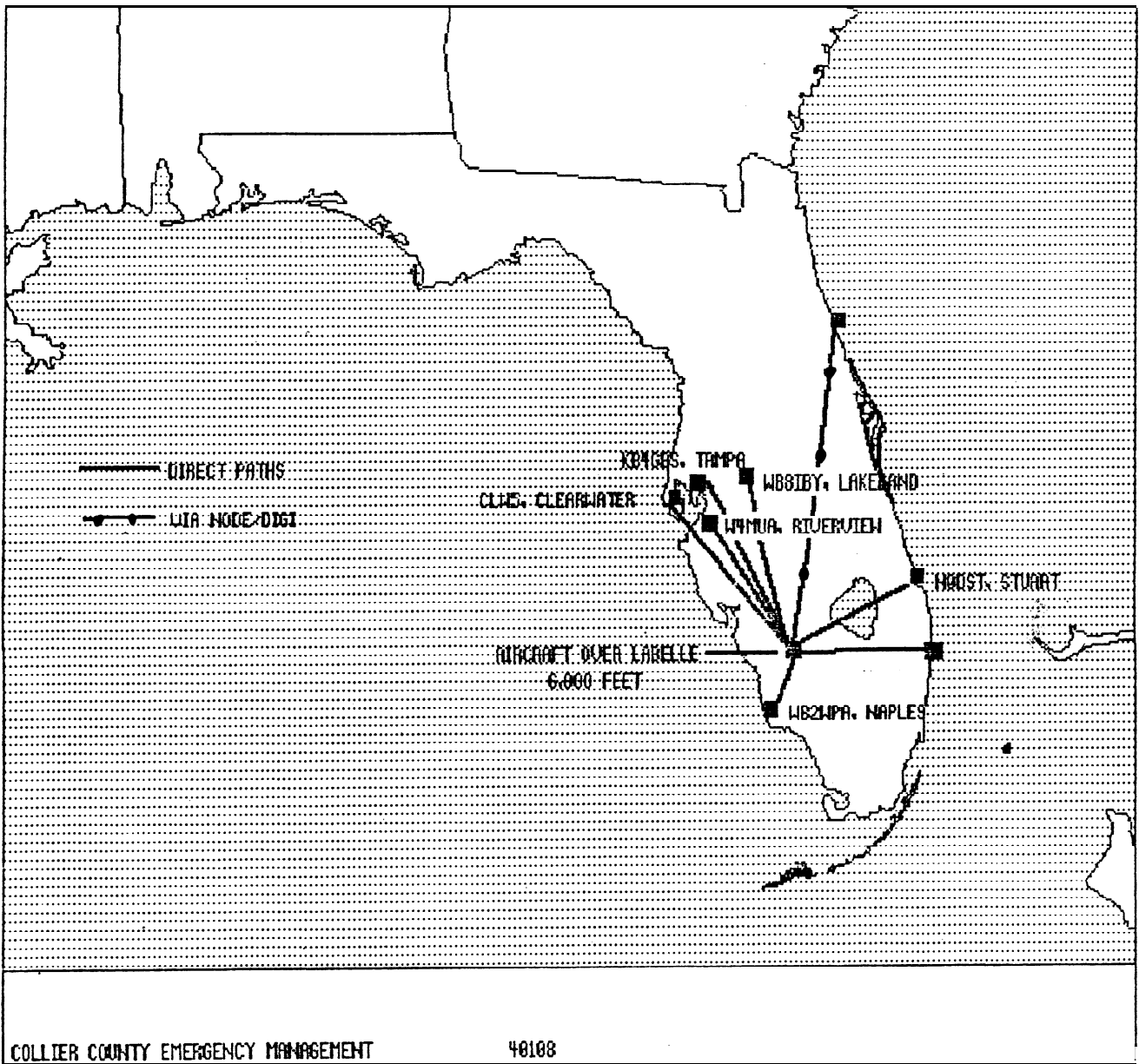


Figure 2: Two aircraft link from South Florida to Tallahassee showing approximate coverage from aircraft (large circles) and through terrestrial links normally used (small circles).



COLLIER COUNTY EMERGENCY MANAGEMENT

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Figure 3: Areas worked via single aircraft located at 6,000 above LaBelle, Hendry County, Florida on 145.050 MHz



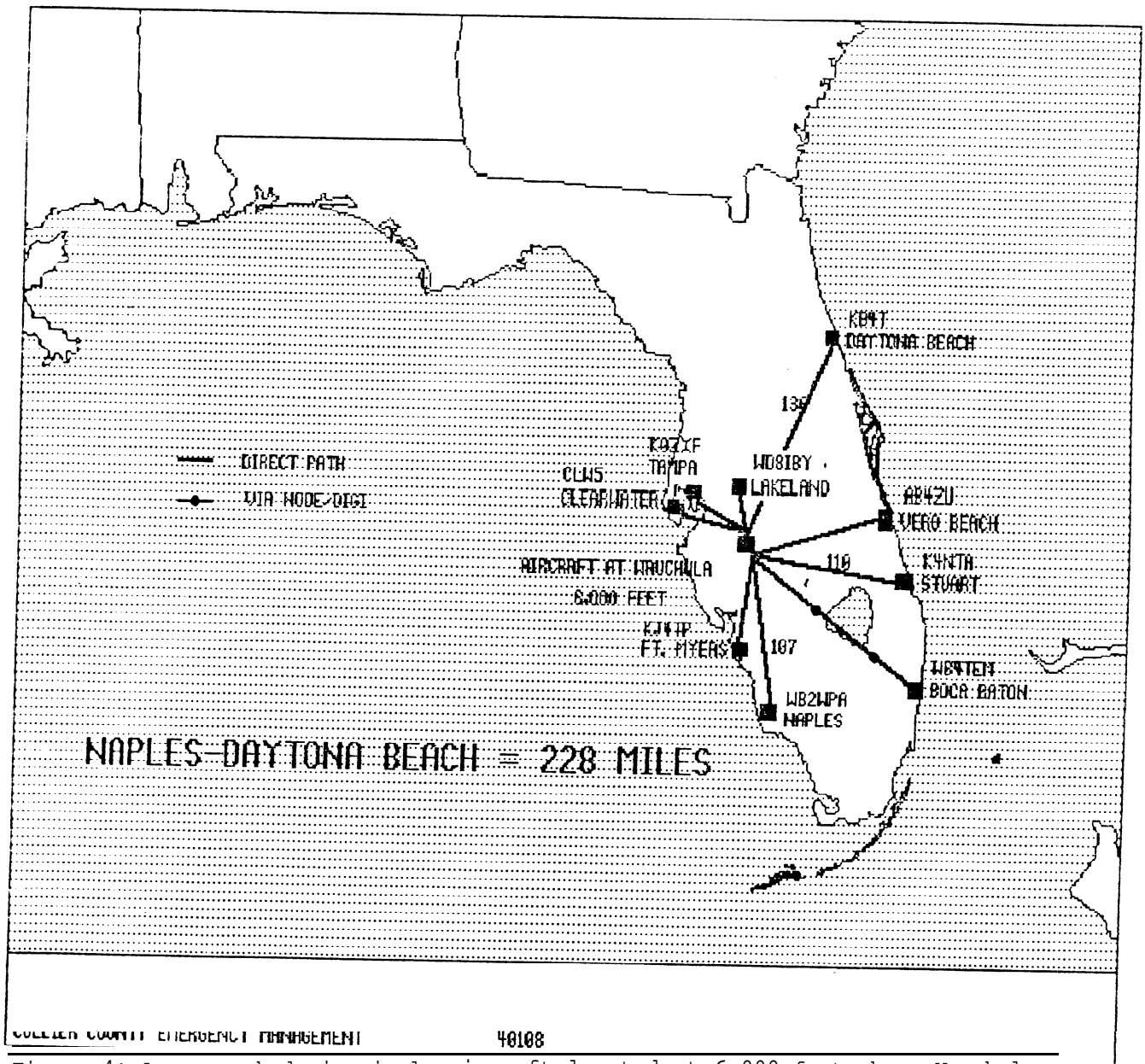


Figure 4: Areas worked via single aircraft located at 6,000 feet above Wauchula, Hardee County, Florida on 145.050 MHz, including 220+ mile path from Naples, Collier County, to Daytona Beach, Volusia County.

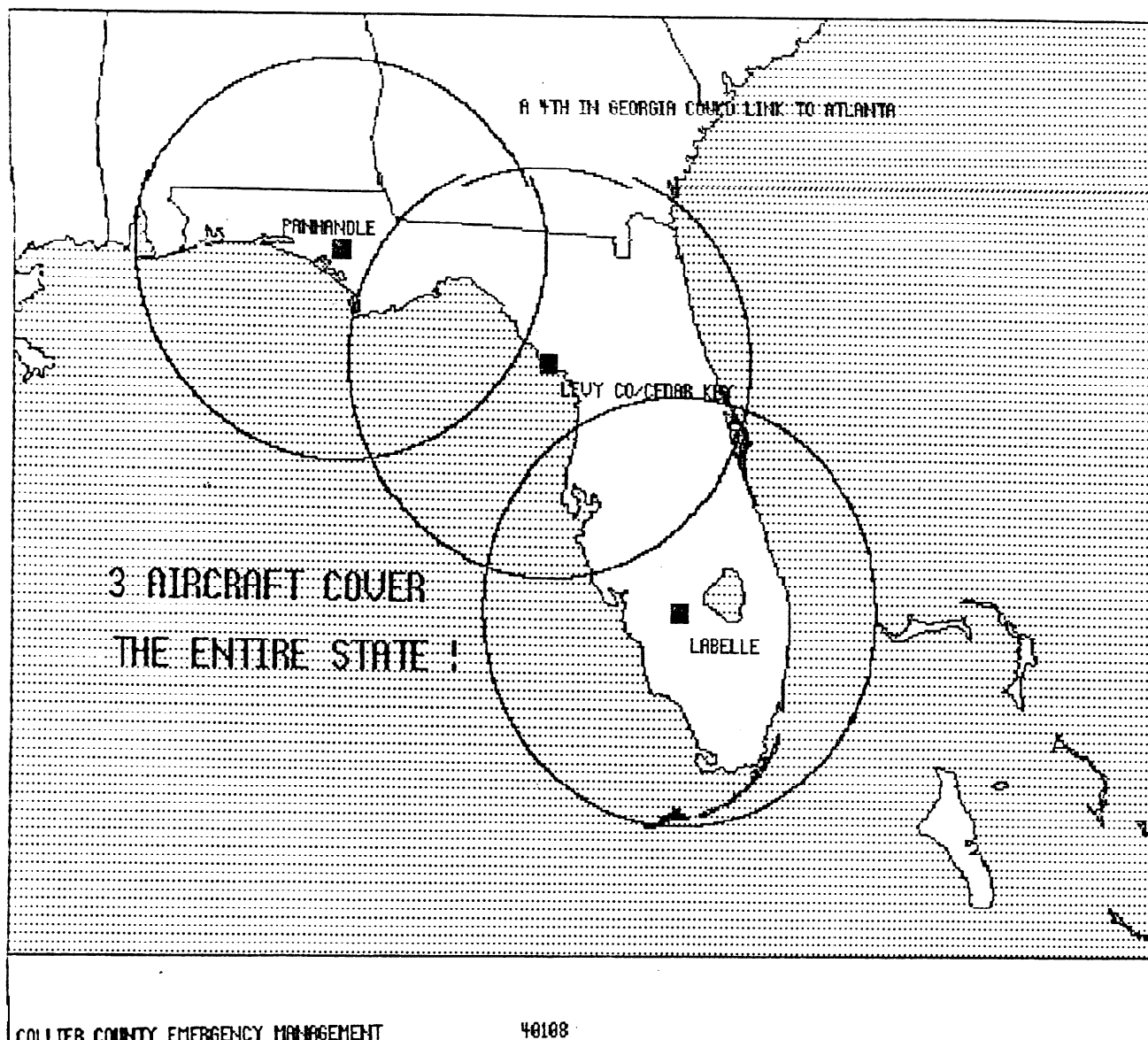


Figure 5: Theoretical three aircraft system, providing full coverage of the state of Florida, plus parts of southern Georgia and southern Alabama, with aircraft at 6,000 feet.