

January 2014

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UNMANNED UNRESTRICTED

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MOBILE SATCOM



A batch of Globalstar second-generation satellites is readied for launch aboard a Russian Soyuz 2 rocket. Credit: Arianespace.

REMNANT

Constellations vie for new business

One thing satellite operators Globalstar and Iridium have in common is a knack for survival. Each spent time in bankruptcy in the early 2000s after terrestrial cell phone coverage expanded faster than expected, gobbling up potential mobile communications customers for their low-Earth-orbit satellite constellations.

After a decade of ownership changes, financial restructuring, and brainstorming supplements to their phone businesses, Globalstar and Iridium are about to do something that seemed unlikely in the dark days of bankruptcy. The time has come for them to modernize their networks of satellites and ground equipment.

The success of this modernization work could determine whether one or both of these phoenixes manages to stay clear of the flames in an age of smartphones, terrestrial networks, and a fierce competition between the two firms.

Competing strategies

As it stands, Globalstar is the proud owner of 24 new satellites in orbit, and it is now working to win back voice customers it lost because of electronics troubles on its first satellites.

Globalstar's total of 32 satellites—eight survivors from the original constellation, plus the new models—is well short of the 48 it operated 14 years ago, but Globalstar

says this reflects its lean-and-mean strategy. “With the growth of cellular and with the growth of other satellite communications companies, we only need 32 satellites to serve our business plan very, very competitively,” says Tony Navarra, Globalstar's president of operations.

Globalstar's modernization plan counts less on global coverage than on boosting data speeds, and that will not be complete until the company finishes rolling out its second-generation ground network by 2016.

After cellphones decimated the projected market for satellite-based mobile communications, rivals Globalstar and Iridium rose from the flames of bankruptcy promising a mix of voice and data comms. The companies have vastly different strategies for how to do that, and those strategies are now unfolding in orbit and in ground networks. We'll soon learn whether one or both of these phoenixes can stay out of the flames.

Unlike Iridium, whose satellites bounce data or calls over intersatellite cross links, Globalstar moves signals around the world via its satellites and 26 ground gateways. The best data rate Globalstar can achieve today is 40-50 kilobits per second, by combining multiple channels of 9.6 kilobits. Once the second-generation ground system is deployed, the rate will jump “upwards of 144 kilobits per second,” says Navarra.

by Ben Iannotta

Iridium's plan is bolder still. In 2015, the company plans to start launching Iridium NEXT, an entirely new \$3-billion constellation of 66 satellites plus spares, whose blueprint passed the critical design review in October. These spacecraft will be launched on SpaceX Falcon 9 rockets and will outweigh the second-generation Globalstars by 100 kilograms. Iridium CEO Matt Desch predicts a big improvement in data rates too. Consider small antennas like those on an aircraft: "If you use that same size of antenna with an Iridium NEXT system, we would be able to take that [rate] from about 2.4 kb up to almost 100 kb," he says. Certain antennas could crack a rate of "about a megabit and a half," he adds.

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Matt Desch
Iridium

Globalstar and Iridium have entirely different technology strategies for modernizing. Globalstar is counting on the ground upgrades to make the biggest impact. Iridium's networking brawn will remain on its satellites. Just as with the original Iridiums, the NEXT spacecraft will have K-band cross links to relay data or voice calls around the world.

Hosted payloads

Iridium's modernization plan now extends beyond Iridium NEXT. In September, the company held a press briefing in Paris to announce plans to create a parallel constellation called Iridium PRIME starting in 2017. These satellites will be built specifically for the hosted payload market, in which customers pay to fly sensors on satellites they don't own. It's unclear how many Iridium PRIME satellites will be built, but Iridium says it could control up to 140.

The Iridium PRIME satellites will be similar to the Iridium NEXT spacecraft, except that designers have removed a set of electronics for the airline industry and a large L-Band antenna that would normally provide ground coverage. The PRIME satellites won't need the airliner tracking equipment because the NEXT satellites have that market covered. The L-Band an-

tenna won't be needed because the PRIME satellites have another strategy for getting data to the ground. Each PRIME satellite will use cross link antennas to feed data into the NEXT constellation, which will route it from satellite to satellite and to the ground via feeder antennas.

Removing the airliner comms and L-band equipment frees up a lot of volume and power for hosted payloads. "With Iridium PRIME, we expand that space, essentially, to the whole nadir deck," Desch told reporters, referring to the side of the spacecraft that faces Earth and has connections for power, data, and command and control. Each Iridium PRIME satellite will have at least 17 times more volume available for hosted payloads, and as much as 30 times more volume for versions launched on the largest rockets.

Harris, one of Iridium's potential hosted payload partners for Iridium PRIME, is billing the satellites as manna for cash-strapped agencies looking to keep gathering weather data, Earth observations, and surveillance information.

"Government obviously cannot continue to do things as they have in the past," said Janet Nickloy, director of aerospace mission solutions at Harris, during the briefing.

Harris designed a payload electronics box, called AppStar, that will fly on the Iridium NEXT satellites. Much of the volume will be reserved for the Harris-built data receivers needed for Iridium's planned airliner tracking service. But under an arrangement with Iridium, Harris has marketed the remaining electronics slots to support other hosted payloads.

Harris reports it has sold all the extra slots on the forthcoming Iridium NEXT satellites. "With minimal marketing, the interest in leveraging just a few card slices and a little bit of deck space has just been amazing," Nickloy said.

Iridium and Harris hope that means a brisk business for Iridium PRIME.

Retired Air Force Col. David Anhalt, the new general manager of Iridium's hosted payload business, sees a new way of thinking: "My whole background on this subject has been perhaps imprisoned by this idea that a hosted payload is a secondary payload, and therefore has limited rights on a primary platform."

He views Iridium PRIME this way: "Iridium will be hosting this payload on its net-

work. It's not hosting it on the spacecraft."

Survival plan

While Iridium was growing and making bold plans, Globalstar climbed out of bankruptcy by innovating in the face of faulty satellite electronics that limited some of its spacecraft to one-way communications. "We never did find the event, the anomaly itself, that caused that failure," says Navarra.

What the company knows for sure is that the S-band amplifiers on its satellites began to fail. The affected spacecraft were limited to one-way, or simplex, communications instead of real-time voice communications. Globalstar suspects that the electronics were not adequately protected from radiation. The company made a dramatic decision in 2006 when it ordered its second-generation satellites. It shifted from Space Systems/Loral as its satellite prime contractor to Thales Alenia Space, a joint venture between Paris-based Thales and Rome-based Finmeccanica. It didn't matter that Loral had been a founding investor in Globalstar.

Engineering changes followed: "We've tucked all of the active components for the S-band frequencies inside the spacecraft, protecting them with additional metal and gold foil," says Navarra.

In the meantime, Globalstar survived in the marketplace with two innovations. It created a website-based Call Times Tool to tell subscribers when the optimal time would be to make a call or share data over the remaining duplex satellites. Chairman James "Jay" Monroe III also sat executives down and asked them to think of valuable things Globalstar might do with simplex services. Monroe had a lot at stake, having arrived at Globalstar in 2004 as the majority owner of Thermo Companies, whose investment arm purchased the Globalstar assets out of bankruptcy in 2004.

"We said, 'Okay, now let's go for the market for children'—parents that want to be backpacking with the girl scouts and boy scouts and want to always know they can send an SOS message where they can ask for help," Navarra recalls.

Globalstar launched the SPOT messenger service for nervous parents, hikers, boaters, and adventurers. Today, subscribers

can send GPS coordinates and one-way status messages from SPOT handheld devices.

The Globalstar executives also got busy restructuring financing to launch the 24 second-generation satellites on Russian Soyuz rockets. The last of the 24 was put into full commercial service in August 2013. In an earnings call not long after, Globalstar said its two-way calling business is coming back strong, with a doubling of subscribers in April, May and June 2013 and a 41 percent increase in minutes used.

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Tony Navarra
Globalstar

As pleased as Navarra was with the SPOT location service and the machine-to-machine business, he says there's nothing like voice communications: "People never stop talking."

Growth plan

Iridium is arguably in a stronger position than Globalstar, and it owes a lot—some say everything—to the U.S. military, which was interested in Iridium's wireless comms and its ability to automatically track objects equipped with location transmitters. Iridium, in fact, has a gateway in Hawaii specifically for the military. The Pentagon assisted Iridium out of bankruptcy with a \$72-million contract award in 2000 to provide communications for 20,000 troops. That was followed by classified business and a wartime innovation called the Distributed Tactical Communications System, or Netted Iridium.

ITT—now ITT Exelis—manufactured push-to-talk Iridium radios for troops in Afghanistan and tweaked the Hawaii gateway to handle the new service. Iridium and Boeing figured out how to program the satellites to accommodate the netted communications mode.

Mark Adams, now general manager of specialty applications for Exelis, was on the team that purchased Iridium LLC's assets and led the reborn company out of bankruptcy with Netted Iridium and new services in the data relay market.

"The world had shifted," says Adams, then Iridium's chief technology officer.

NEW MARKET

SPECS (BOTH): Launch mass — 860 kg
Altitude — 780 km

IRIDIUM NEXT

Airliner Tracking

GPS coordinates are received from planes and fed into air traffic control networks via Iridium's Aireon subsidiary.

48 Beams to Ground

L-band main mission antenna creates 4,400 km-wide coverage track.

Iridium plans to turn the blueprint for its next-generation communications satellites into a parallel constellation for hosted payloads — scientific instruments, weather sensors, intelligence equipment, or other devices supplied by customers.



IRIDIUM PRIME

Making Room for Payloads

- Main L-band antenna removed.
- Airliner tracking components removed.

Hosted Payload Area

300 cm x 160 cm x 30 cm
(up to 55 cm deep on larger launch vehicles)

Cross Links and Feeder Links Retained

Data gets to ground by transmitting it into the Iridium NEXT constellation.

Graphic by Mark Hofmann/AIAA
Source: Iridium

everyone in the network could hear them. Iridium, however, was a dial-up phone service. Could Iridium be made compatible with push to talk?

If so, that had to be done without crimping Iridium's growing consumer and data services.

"I think one of the cool things that we were able to do is make it so you're not utilizing system resources until you actually push the button to communicate," explains Adams. "At that point, the system configures the channel, sets it up within the net, and you're only occupying one channel to provide that communication, which could go to a large number of listeners that are in the net."

Up next, Exelis and Iridium hope to demonstrate that they can reduce Netted Iridium's voice latency—currently 1.5 sec— and expand the service so that troops can use it wherever they need it around the world. The work is being undertaken for the Defense Information Systems Agency.

The current version of Netted Iridium relies on a single satellite passing overhead, which limits the range of a network to 250-500 miles. DISA and its contractors think they can go worldwide by tapping Iridium's K-band intersatellite links.

"I could extend that [voice net] into different areas, and then make it global, and that's exactly what we're doing," Adams says.

The constellations

Iridium's future hinges on the success of the Iridium NEXT satellites. The company plans to buy 81 of them to maintain a constellation of 66 operational spacecraft in six orbital planes. Thales Alenia Space, which built the new Globalstar satellites, is also Iridium's prime contractor, but with an American twist: Orbital Sciences will assemble and test the 860-kilogram satellites at its facility in Gilbert, Arizona.

"The parts will come in one side and out the other side—every 56 days will come an Iridium NEXT satellite," says Desch.

They will then be sent to Vandenberg Air Force Base, Calif., for launch.

"Data became extraordinarily important, and so there was a whole host of data services that we tried to deploy rather rapidly to keep pace with customer demand," he says.

Data helped Iridium grow, but there was also work to do in the voice realm. Netted Iridium was born out of feedback from the military.

"One of the things that became apparent when I started talking to the different military communities about how they support an operation, was [that] for them, push to talk is fundamental," Adams says.

Soldiers doing dangerous jobs were comfortable pushing buttons on radios so

For its part, Globalstar thinks it can get by with 32 spacecraft, and it readily acknowledges that this will mean ceding coverage of the polar regions.

“The reason we did that, to be perfectly honest, is there’s not a lot of people, not a lot of surface up there. So why waste the energy?” says Navarra.

New markets

For Iridium, satellite coverage isn’t just about people on the ground. It is increasingly about aircraft, especially airliners flying Asian or Atlantic routes over ocean and mountain areas that air traffic radars can’t reach.

Iridium and Globalstar are vying to provide space-based versions of what are called automatic dependent surveillance broadcast services. ADS-B messages are sent by transponders on aircraft. They include GPS location, identity, speed and altitude. The idea is to save fuel: For years, controllers had to wait five to six minutes for position reports to come in via high-frequency radio links. With almost instantaneous reporting, controllers in the U.S. and abroad can decrease the separation between planes and put them on more efficient routes. The surveillance information has started flowing over a new network called the Future Air Navigation System, or FANS. After real world trials, FAA approved FANS over Iridium in 2011.

Iridium set up a subsidiary, called Aireon, to prepare for a new version of the surveillance technology on Iridium NEXT. In late 2012, Nav Canada, the company that runs Canada’s air traffic control system, agreed to join the Aireon venture as a first user. Each Iridium NEXT satellite will have a Harris-built receiver to listen for location and data reports from airliners and relay the information to air traffic controllers.

Globalstar has been testing its version with a company called ADS-B Technologies. They call their version ALAS, for ADS-B Link Augmentation System. ADS-B says on its website that it’s anxious to use Globalstar’s second-generation satellites. It anticipates starting essential services in 2015 and critical services in 2017.

An issue for Globalstar is that its bent-pipe approach means transmitting GPS coordinates up to a satellite and down to a ground gateway. As it stands, Globalstar’s

gateways leave uncovered 40 or 50 regular flights, Navarra says. Also, Globalstar’s satellites are in Walker orbits that top out at 70 degrees latitude, which means a new polar orbiter would need to be added to cover airliners at high latitudes. “That’s absolutely possible, and it’s low cost,” Navarra says.

“The world had shifted...Data became extraordinarily important, and so there was a whole host of data services that we tried to deploy rather rapidly to keep pace with customer demand.”

Mark Adams

Exelis

Data volume won’t be a problem for the Globalstar network, Navarra predicts. “It’s not even a challenge for our ground stations to handle thousands of aircraft that are simultaneously transmitting,” he says.

Desch doesn’t see how more ground stations will solve the airliner problem for Globalstar: “You can’t put a ground station in the middle of the Atlantic, or the middle of the Pacific.”

He views the ADS-B aircraft surveillance market as fresh vindication for Iridium’s decision long ago to install intersatellite links on the first Iridium satellites and the Iridium NEXT versions too. “I remember everyone talked about what a crazy idea it was putting intersatellite links on satellites. That was only done by militaries for spy satellites,” Desch recalls.

Even as they push to modernize, Globalstar and Iridium are being careful not to make the mistake of overreaching, as they did in their early years. Communications services that rely on expensive space launch vehicles and dozens of radiation-protected satellites can never take on lower cost terrestrial communications where those services exist. The companies are focusing their efforts on markets where they can add value.

As Desch puts it: “We still view ourselves as complementary long term to many other technologies that are even faster and lower cost than ours.” ▲