Connections amidst the emptiness: internet protocol in space

By Richard Sanford

Space, once the empty realm of disparate satellites relaying information to and from the Earth, is now at the forefront of the technology revolution. Newly arrived competitive forces and technology experts, such as Cisco Systems, have enabled commercially viable inter-satellite communication. The advancement has brought space to life and portends great things.

Internet protocol-enabled satellites, pioneered by Cisco and first launched four years ago, are now forming the core of a converged services network in the sky. It will be able to provide interoperability among unrelated systems and similar hardware running in different modes — advantages that produce significant efficiency and cost savings.

Indeed, the U.S. Defense Department recently signed on to an industry-government collaboration to test the viability of conducting military communications through an Internet router in space. The importance of these new routers cannot be understated, as the potential of the innovation resembles that of when the Internet was first born.

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A brief history of the internet universe

Built by Cisco's founders, the very first router connected two disparate land-based networks, enabling messages — what we now consider email — to flow from one university department to another. Initially considered an esoteric means of communications, this "Internet" soon showed enormous promise — for military, public and commercial applications.

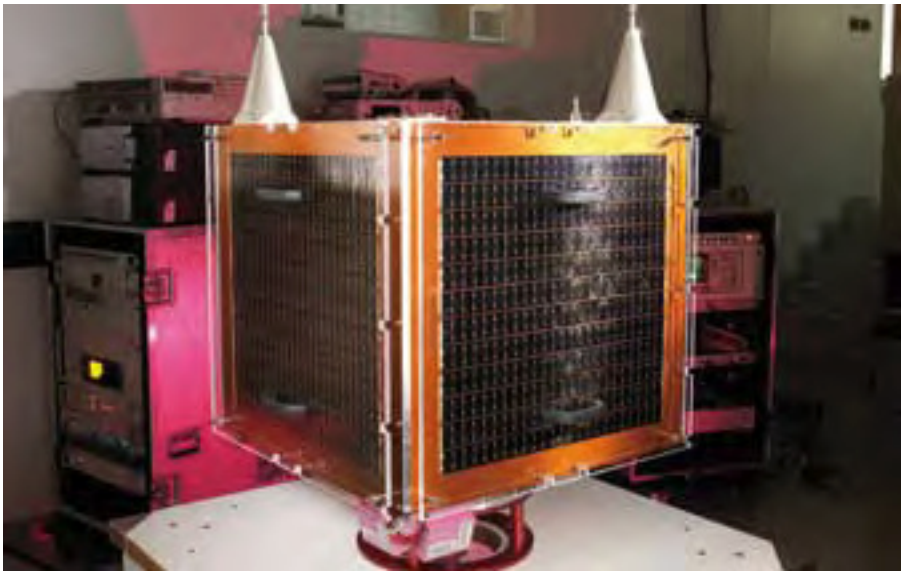
As we have seen, within two short decades, the basic router has transformed from a simple interconnection device to the core of a system that provides multiple services over a converged network. Advancements rapidly employed space satellites, which relayed information across the world — bouncing from routers on the ground to the sky and back.

As an advancement, though, land-based routers remained adequate for only so long — as technology has evolved and budgets shrunk. In recent years, downsized defense and civilian budgets for new technology infrastructure have propelled the need for more efficient communications systems. New players in the satellite communications market added to this challenge.

Recognizing the opportunity, Cisco began testing a commercially available router — the 3200 Series — in low earth orbit (LEO) in 2003. The router re-

An assembly room for the DMC in Surrey, England.

quired a few modifications for the LEO environment and is now a secondary payload onboard the UK's IP-based Disaster Monitoring Constellation satellite (MC — photo). For years, the system has undergone testing without failure and is now poised for broader use.



Above the earth, satellite routers bring life to space

As a basic concept, placing routers on spacecraft seems like an obvious move. A router aboard a space platform promotes significant operational and interoperability efficiencies. With an IP-based management platform, operators can reduce costs in tools and training while increasing configuration flexibility. Plus, when new services are deployed over IP-based satellites, the satellite can be treated as just another "node in the network" and existing terrestrial service management tools can be used. With an IP-based network, interoperability between the next-generation IP version 6 and the current-generation IP version 4 is seamless, and data formats such as MPEG and IP can easily be converted back and forth depending on the requirements of the end device.

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A space router adds a level of flexibility that gives a space platform higher-quality service over its lifespan. The ability to adapt a range of devices on multiple radio frequencies, greater mobility and operational interoperability are but a few examples of this increased flexibility. Space routers enable capabilities like onboard switching, which allows operators to directly switch frequency bands, such as from Ka to Ku, RF to RF (bent pipe) or direct coupling of data from modem to modem.

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Benefits to date go far beyond efficient connectivity. Internet routers in space have an incredible impact on mobility solutions — mainly, they allow virtual private networks among disparate services in a deployed environment; communications systems on completely different platforms are able to interact with each other.

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Internet on the move

Related to the greater mobility space routers provide is the fact that satellites are getting more and more spot beams, allowing smaller and better-performing terminals. By routing onboard the satellite, handover from one spot beam to another is a faster local decision (in the satellite), which translates into increasingly seamless connectivity as a user moves from place to place. Satellites already send localized content to home or commercial users and could send the same content (in a reduced form) to mobile users via the local spot beam. As users move from one area to another, their local content would change to suit their local environment. As the Department of Defense has recognized, this type of feature is applicable to military operations in forming communities of interest and distributing common operating pictures.

The platform also offers RF legacy protection, so an organization can migrate to new terminal hardware with different coding or frequency allocation while preserving its legacy investment. The satellite-based router forms a virtual bridged network in space between new and old terminals. And service remains steady — even in the face of a strong signal that may jam an uplink. Any attempt to jam an uplink with a strong signal can be prevented by blocking access, and using an uplink to another connected transponder to get traffic onto the satellite, before routing it to the jammed transponder to go down to that transponder's downlink.

Expanding services, expanding benefits

The benefits of IP routing in space grow exponentially when greater services are supported natively by a network. Several revolutions in the way the Internet is used on the ground will

have a direct impact on how services will be deployed in space. Today, for example, nodes in the network are changing on the ground, and this will impact how nodes are going to be built for space. Other changes will include:

- **Web-based services:** Web services are based around a user seeking information from the World Wide Web. Users not only get information by searches or subscription; they handle many self-service offerings such as personal banking, online ticket sales and community blogs.

- **Convergence and the quad play:** IP technology has been evolving to support converged services for a long time. The cable industry provides the "triple play" of voice, video and data today, and the drive is on to add mobility to form the "quad play." Routing in space is an essential first step to provide such services.

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- **Web 2.0 and collaboration:** Collaboration is based around an increasing development in new services that allow people to contact each other and have productive conversations either via instant messaging, email, presence or high-end sessions in a virtual meeting room. The main building blocks to achieve these types of services are real-time services, always-on connectivity, presence and location.

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Space is the place

The space industry is on the threshold of an important period of change and innovation, and here only the tip of the iceberg of what might be possible has been addressed. Proprietary, customized products will begin to give way to those based on lower-cost, commercial-off-the-shelf hardware, technology convergence and open standards. This shift will drive speedier adoption, which will quicken the industry's pace and drive rapid technology enhancement. The space launch market is also moving towards this model offering more cost-effective services.

Communications technologies will also evolve. In time, the Internet will be more fully extended to space, with orbiting assets taking an active role in moving information in the form of IP packets around the globe. Satellites will then become, in essence, just another node in the network. In achieving this change, vendors and satellite service-providers will be better able to remove existing bottlenecks in space communications and unlock the full potential of space-based networking.

Although Cisco is a relatively new player in this well-established market, we are confident that IP in space has the ability to deliver benefits that can transform the way we live, work, play and learn. For more information on IP in space, visit www.cisco.com/go/space.

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