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The Future of SatCom in Canada: New Technologies Needed

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New Technologies Needed

The Government of Canada has a clear goal of making Canada the most connected country in the world. The vast geographic topology and wide population distribution - some in remote communities - raise distinct technical and economic challenges in achieving this goal. In addition, communications are already used in virtually all space projects - either for the command of the Spacecraft, or as the raison d'être of the mission. Undoubtedly, to support the very nature of space projects and to achieve the goal of connecting all Canadians, ever-improved technologies are being sought.

The following lists the different technology requirements by category.

Need 1: Frequency Spectrum

Communication frequency spectrum is an increasingly scarce resource. The explosion of computer networking is driving technology development toward systems that make an efficient use of available existing frequency bands. Higher frequencies of operation will allow for a greater information throughput. Compatibility of space-borne networks with other networks is a key to the success of Satellite Communication systems.

Need 2: Internet Access - Personal Communications

The need for reliable access to the information highway, independent of the user's location, is creating a tremendous drive to improve existing systems and implement new ones. While there is at present an over-capacity in land lines for long-haul traffic, the "last kilometre" is not yet in place to ensure wideband, video-grade access to every user. Personal communications and faster Internet access require numerous, faster and sometimes mobile, communication access points. Data communication requirements for current and future systems requires continuously increased data rate. Multimedia systems like direct TV combined with Internet are examples that describe this increasing demand on data rate. The demand for customized entertainment at home will be satisfied with "video on demand" digital satellite channels and set-top terminals. A considerably greater information throughput will be required, with compatibility of space-borne networks to ground standards, along with improved data encryption to provide protection to content owners.

To satisfy the requirement to have a high data rate connection "on the go," the various data and communication appliances that a person carries - portable computing platform, phone, beeper, camera - will be wirelessly linked through a Personal Local Area Network that has a built-in satellite modem to allow seamless worldwide communication even when traveling on a plane, thus implementing the "one person, one number" connectivity. This could require some non-traditional implementation, i.e. non-GEO-stationary spacecraft.

Competition with fiber optic systems for point-to-point communications and cellular telephone systems for mobile communications has led space systems to concentrate on functions not easily served by these competing systems including mobile communications in remote regions, broadcasting, storage and forward transfer of data. Laser communications are also being explored and will provide high data rate communications while offering a secure communication channel. These systems will require the development of space-borne optical transceivers along with precision antenna pointing and tracking systems including gimbals, actuators and stabilization systems.

"Multimedia by Satellite" will considerably enhance the speed and capacity of two-way access and provide a variety of innovative services. We will see a maturing of remote access applications such as tele-medicine, tele-education and Internet, with more efficient and affordable access. The ground stations will be improved, making them more portable and easier to set-up.

Need 3: Data Flow

Future satellites with synthetic aperture radar (SAR) and high-resolution optical and hyper-spectral sensors will require that large quantities of data be relayed down to earth during the brief fly-by period over the receiving sites. The buffering and transfer of this data will require significant on-board storage and advances in modulation/multiplexing technologies. The leaps in capabilities that emerging technologies such as MEMS, higher frequency Tx/Rx systems reaching well into the optical/IR spectrum and advanced on-board processing/networking will result in space systems that are significantly more efficient. Since some sensors such as SAR and hyperspectral imagers generate very large amounts of data, novel modulation schemes and improvements to microwave components will allow a more efficient usage of the spectrum, which is now a scarce commodity.

Need 4: Interplanetary Exploration

Future space exploration of nearby planets, such as Mars, will require space communication technologies that can provide an interplanetary satellite communication and navigation infrastructure via space systems that are significantly more compact and efficient. A longer-term commitment is necessary to resolve the challenges of efficient planetary communications due to the great distances involved. To support planetary exploration, techniques developed for Earth-bound usage will be ported to other planets: Exploration of nearby celestial bodies such as Mars will require a high-accuracy positioning capability such as a "Martian GPS" as an aid to exploratory roving vehicles, and clusters possibly involving adaptive formation flying.

Deep space exploration and the search for extra-terrestrial life will pose an even greater challenge in the longer term, with "off-shore" installation of autonomous listening stations in deep space or on the far side of the Moon or other planets.

Novel communication techniques will extract meaningful signals from background noise and relay the correlated results to Earth.

Need 5: Global Navigation Satellite Systems

Global positioning systems and satellite communications systems are becoming intrinsically intertwined and are now a ubiquitous function in cars, sporting goods and security devices. In fact, most cars on the road in the future will be linked to service providers for the entertainment, security, location, communications and diagnostics functions. The European Space Agency is developing its Galileo system, the first navigational system entirely devoted to commercial/personal usage. Through significant investment, the Canadian Space Agency is securing the participation of Canadian industry in key technology development areas related to this program through a significant investment securing its participation. Future space exploration of nearby planets such as Mars will require that similar technology be developed as an aid to exploratory roving vehicles.