The Wider the Band the Quicker the Pace

Defence industry engineers and architects piecing together new puzzles of combat networks enjoy ne'er a moments' rest, as the ever-growing demand for more battlefield bandwidth keeps them up nights squeezing their information packets ever tighter, designing lighter and smaller equipment and creating broader information tunnels to transfer more at a faster rate.

Johnny Keggler

The airwaves in and around today's battlefields are so saturated with military voice, video and data streams that if this information were in the visible spectrum the air would resemble a London fog at the turn of the 19th Century.

Moreover, the military communication signals are but a part of the traffic that congests the airwaves. Cell phones, ham radio operators, commercial radio and television signals, local emergency radio traffic – then there is interference from foliage, buildings, metal structures, even the meteorological situation plays a part. All this combines to create a veritable pot-pourri of electronic 'weather'.

And still those on the ground scream for more bandwidth, better networks and smaller equipment that can handle it all and yet provide room for growth.

Top-down Solutions?

The development of and progression in high data-rate network technology and the associated equipment has opened doors to an increase in the pace of information transmission, collection and distribution on and about the battlefield – which has engendered today's warfighters with heightened situational awareness.

A Boeing-led industry team was awarded an initial contract in 2001 to develop three Wideband Gapfiller Satellites (now called Wideband Global Satcom) that will each provide between 2.4 and 3.6 Gbps of high-speed data routing to all branches of the US military services.

In late 2006 Boeing received authorisation from the US Air Force to begin production on the fourth WGS satellite – thereby exercising the first option which could lead to a total of six satellites overall and bring the aggregate value of the programme to $ 1.3 billion.

Unlike the AEHF (Advanced Extremely High Frequency) or Tsat (Transformational Communications Satellite – the space-borne element of the Global Information Grid) projects, the WGS system will not be protected against jamming or nuclear electromagnetic pulses.

Tsat and AEHF

Boeing is also on the move with the Transformational Satellite Communications System (Tsat) programme. Working on the risk reduction and system definition phase of the Tsat, and under a $ 512 million US Air Force contract, Boeing has tested the system's Next-Generation Processor Router for data transmission and lag time from a user's perspective. The Tsat is being designed to provide Internet-like connection for communication-on-the-move, airborne intelligence, surveillance and secure communication through the satellite constellation and ground control, network and gateway elements.

The Boeing-led Tsat team has to-date successfully demonstrated laser communications, the router mentioned above, delivery of MP-3 files, streaming multicast video and VoIP (Voice over Internet Protocol), using Boeing's Spaceway satellite, which is currently in orbit.

Harris has recently unveiled its high-speed broadband Ethernet radio, the 7800W, which transfers IP traffic out to 50 km under clear line-of-sight in a fixed point-to-point configuration. The 2.3-kg radio transmits 70 Mbps in secure mode through its 256-bit AES encryption. (Harris)

The command and control system for the first Wideband Global Satcom satellite successfully completed testing in June 2007 in anticipation of the launch of the first WGS (originally Wideband Gapfiller) satellite sometime in mid-2007. (Boeing)

On 14 June the Boeing team formally reported that it is preparing its response to the US Air Force's request for proposals for the next phase of the programme, the development and production of the Tsat Space Segment. The Boeing-led Tsat team includes Harris, Cisco Systems, Hughes, IBM, Ball Aerospace, LGS Innovations, Raytheon, General Dynamics, L-3 Communications, BBN, EMS Technologies and SAIC (with a list such as this one could 'almost' wonder which companies would be left to bid against this team). The US Air Force is scheduled to select the primary contractor for this segment sometime in the fourth quarter 2007.

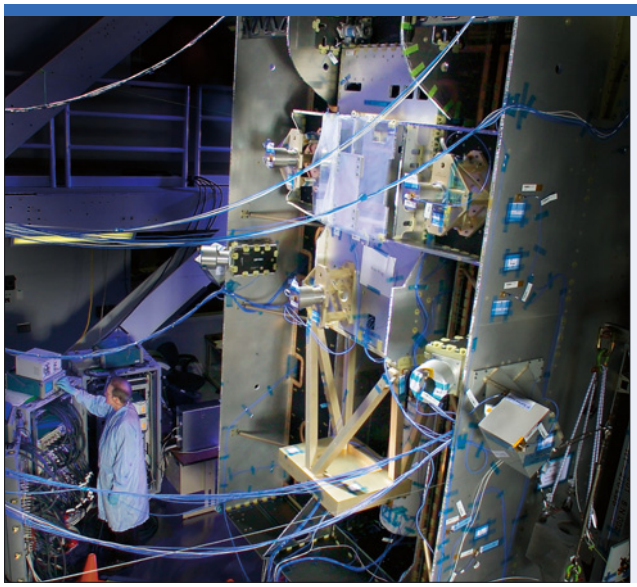
Lockheed Martin recently integrated the spacecraft propulsion core structure and payload module of the Advanced Extremely High Frequency (AEHF) satellite that is designed to provide highly-secure, survivable communication for all manner of US forces.

Under a contract worth almost three billion US dollars awarded in 2001, Lockheed Martin (AEHF prime contractor) and Northrop Grumman (payload supplier) are producing the satellites with an 8.2-Mbps data transfer rate through 50 channels (on each satellite) via multiple, simultaneous downlinks. The system will use an array of inter-satellite cross-links which will eliminate the need to route messages via terrestrial nodes. At time of writing the programme had a first-satellite launch date planned for mid-2008.

The Warfighter Information Network-Tactical (Win-T) is yet another system clamouring for battlefield bandwidth; a telecommunication system that provides C4ISR capabilities supporting tactical multimedia information systems. The Win-T was designed to replace the Cold War-era communications architecture with a link to the tactical Global Information Grid infrastructure.

The Win-T allows tactical networks to utilise wired or wireless telephones, computers or video terminals to exchange inter-theatre information over wide and local area battlefield networks, through commercial information technologies and provides a link to the Defense Information System Network. A combination of land-based, airborne and satellite-based media options are on tap for the transfer of voice, data and video information.

It is planned that the Win-T network will carry the bulk of information for the higher echelon (division, corps and theatre-level) commanders. This is to be achieved through asynchronous transfer mode backbone switches, ISDN access, high-capacity line-of-sight radios and wireless networks. The terrestrial layer will leverage the Joint Tactical Radio System (amongst other assets), the airborne layer will use tethered air vehicles and drones, with the space layer leaning on the WGS and AEHF satellites to provide reach-back to the Global Information Grid.



Four Lockheed Martin/Northrop Grumman-built AEHF satellites are in the works to provide cross-linked satellite coverage for deployed US military and defense department units. The high data rate of 8.2 Mbps will shuttle real-time video, battlefield maps and targeting data through any of the 50 channels that each satellite will provide. A fifth satellite could be in the wings to add to the planned constellation. (Lockheed Martin)

Stay on Task

A team of industry leaders has banded together to form the Direcnet Task Force, and together are proposing the development of a highly-mobile, one-gigabit-per-second, open-standard, directional, IP-enabled ad hoc mesh networking system that will be accessible by any ground, air or sea-based unit within hundreds of miles.

The life you save might be your own? That phrase applies to the soldier who was carrying this PNR-9000 radio from Tadiran Communications. A recent press release from the company reveals that a soldier in a Latin American country was shot at but saved by the radio on his back – as evidenced in the photo. One could therefore surmise that tapping into a high data-rate network is sometimes only a part of a radio's job. (Tadiran Communications)

Although a formidable task the consortium is committed to publishing its 'standard' in final form (these are the directives) by July 2008. The guidelines will be based on open standards and open interfaces, multi-vendor development, system modelling shared amongst consortium members, ad hoc networking using adaptive data-rate and bandwidth (dynamic channel capacity), Type 1 encryption, anti-exploitation measures... the list continues.

Essentially, with the plethora of high-bandwidth networks being designed today the Direcnet consortium is looking to create an open-standard network specifica-

ITT's High Capacity Data Radio (HCDR) is the epitome of soldier-proof equipment. The radios autonomously form self-healing, ad hoc UHF networks configured by the user simply switching it on. . . the radio does the rest. (ITT)

tion with a data rate that far exceeds those networks currently under development. The consortium includes Harris, BAE Systems, Boeing, ITT, L-3, Rockwell Collins, Raytheon, Cubic Defence, et al.

Viasat is scheduled to provide an upgrade for the US Army's main tactical situational awareness system – the FBCB2-BFT – which is yet another (one of many) system vying for the rapidly diminishing communication talk-space. The company was awarded an initial contract worth $ 9.3 million from Northrop Grumman (the follow-on Force XXI Battle Command Brigade and Below - Blue Force Tracking programme system integrator) to build a prototype network and associated terminals that are designed to increase network capacity, and to deliver a working system by 2008.

To wrestle the most available bandwidth for this system Viasat will incorporate its proprietary Arclight spread-spectrum technology into the BFT improvements. Arclight takes advantage of Code Reuse Multiple Access and Asymmetric Paired Carried Multiple Access, the latter enables any data transmissions returning to the hub from remote sites to be combined within the same bandwidth as the outbound channel. This allows Arclight to use the outbound space segment to support two-way services (somewhat like cell phone traffic – but more secure).

Sculpting the Mould

In June Rockwell Collins introduced its new Software Defined Radio (SDR) Software Communications Architecture Waveform Development System (SCA WDS), and promoted this offering through a relationship with Prismtech. The idea is to allow international customers and SDR users to develop their own new or reformatted legacy SCA-compliant waveforms (a veritable slap-in-the-face to the standardisation idea) into SCA-compliant military radios.

With this in its view Rockwell Collins will bundle its Flexnet Four radio with Prismtech's Spectra Software Defined Radio development products. The first SCA WDS offering includes the Flexnet 2 MHz to 2 GHz multi-channel SDR. This radio offers, amongst other features, support for the high data-rate ad hoc networking Flexnet waveform.

The Bricks and Boxes

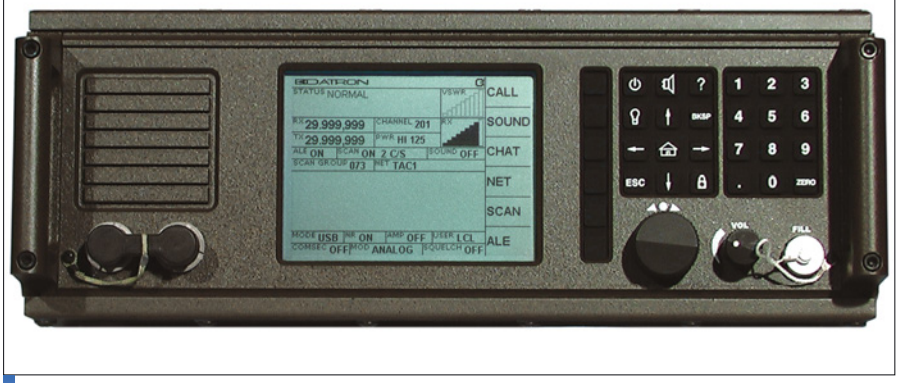
ITT has long been at the fore of high data-rate network equipment and stands apart from the crowd with its HCDR ad hoc networking radio.

ITT has developed the Soldier Radio for linking dismounted troops to each other, to their mount and provides for the ever-critical reach-back loop. The SDR radio supports both narrow and wideband waveforms and provides dynamic ad hoc network capabilities with Type III communication security, an internal GPS receiver and supports Ethernet, USB and headset interfaces. (ITT)

In 2006 Sagem introduced its RHD high data-rate radio, which is optimised for the high-electronic warfare urban environment. The RHD, which offers four Mbps at full-duplex operation, was tested by France's Centre d'electronique de l'armament. (Armada/JK)

ITT's HCDR, a data backbone of the British Bowman programme, does not require a base station but automatically forms and maintains high-throughput IP-based data networks to follow the dynamic movement of battlefield units. The radio shuttles up to 500 kbps of data without the need for a network control station and provides open-architecture IP networking for land, sea or airborne platforms.

In March of this year Harris and BAE Systems announced the availability of their co-developed Highband Networking Radio (HNR). The HNR is a fully-mobile, high-bandwidth, long-range radio that provides line-of-site connectivity for small combat units or to support higher echelon network backbone applications. The radio features a base-band processing unit and a directive beam antenna, which can be mounted on a mast or vehicle roof.



The RT7700 tactical HF software-defined radio from Datron provides AM, AME, LSB, ISB, USB, data and digital audio coupled with digital comsec over IP addressable channels and a 10/100BaseT Ethernet port. The radio can capture and transmit maps and tactical data, secure voice and e-mail transmission between 1.6 and 30 MHz. Shown is the RT7700 transceiver, capable of supplying over 125 watts (single sideband), which could be used in combination with a series of VHF feeder networks for long-haul transmission of prioritised data. (Datron)

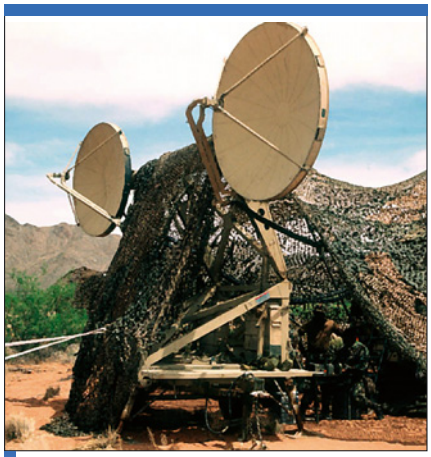
The HNR provides on-the-move communication via VoIP (Voice over Internet Protocol), video teleconferencing, high-definition video and e-mail communication at more than 30 Mbps.

A Lighter Touch

Rafael has recently released information on its Lightlink point-to-point datalink that transmits secure digital video and telemetry information for drones through its downlink channel and command data in the uplink channel. The system uses Coded Orthogonal Frequency Division Multiplexing (COFDM) modulation and multiple antennas. COFDM uses 2000 carrier signals spread across the total bandwidth to transmit and receive its information.

Using a six to eight MHz bandwidth for 1.5 to 20 Mbits video and up to 230.4 kbps for command data transfer the Lightlink data transfer illustrates but one of the myriad systems pushing and pulling with communication networks for the available bandwidth.

The emergence and increasing use of drones – Hales, Males, tactical and hand-launched – only adds to the bandwidth traffic congestion. Cell telephones, PDAs, weapon telemetry transmissions, even television signals to the troops add to the clutter of the airwaves.



The US military has been using the troposcatter solution for years (as have many countries worldwide). Here is one US Army mobile solution, the dual 9.5-inch AN/TRC-170 troposcatter microwave dish assembly. Comtech Systems provides an upgrade to double the bandwidth from four to eight Mbps. (US Army)

In May 2007 Raytheon was awarded a $ 14.5 million contract to develop the high-bandwidth Global Broadcasting Service for the US Air Force. The contract covers the building of 59 Army receive suites and 69 air force Internet protocol receiver suites that will provide theatre-specific command and control information – heavy multimedia and bandwidth-intensive mission critical files – to computer network operators, command centres and field users worldwide.

Retro Waves

Raytheon is also developing enhanced Troposcatter capabilities for US military communication systems. Troposcatter or, correctly, tropospheric scatter, is the scattering of distant broadcasting station (usually TV and radio) signals by the troposphere (the lowest and densest layer of the earth's atmosphere).

Raytheon has developed tactical troposcatter systems for the US Army, and recently established an industry-first 20 MBps (Megabytes/sec – not Megabits) Ku-band link, and kept it operating for several months in varying weather conditions. The feat was accomplished using the company's new Dual Mode All Band Relocatable Communications Transport Terminal (Dart-T), which is a mobile, self-contained terminal that can operate in satellite, troposcatter and line-of-sight modes. Following this, in June 2006 Raytheon doubled the stakes with a 40 MBps troposcatter transmission (industry standard is around 16 MBps).

In December 2006 Comtech Systems received a $ 4.3 million contract award for engineering and support (inspection, repair and upgrade installations) of US Army AN/TRC-170 Troposcatter Terminals. Comtech will also provide formal classroom and practical hands-on training for personnel operating the upgraded AN/TRC-170 terminals.

One relative rare form of radio propagation takes advantage of the sporadic E cloud, which 'sporadically' rests in the E layer of the ionosphere (between 90 to 160 km in altitude). Single, or multiple layers of extremely dense ionisation, or 'clouds', form when certain atmospheric conditions are present, this is mostly dependent upon the solar zenith angle and the level of solar activity. When this phenomenon becomes available, communication transmission distances of between 800 and 2300 km are possible by bouncing off one 'cloud' (which are usually around six km apart). The best propagation frequencies rest between 27 and 220 MHz.

This information has simply been included to illustrate the plethora of signals that can add to communication congestion, bandwidth 'bulging' and, eventually, saturation. Whilst more and 'wider-pipe' solutions continue to become available to get the message across there is still only so much airspace to absorb this electronic storm.

Wave Upon Wave

The importance of the bandwidth used in respect to RF saturation was illustrated by the author in issue 5/2005 with the article *Pathways to Enlightenment*, an excerpt of which follows:

An increase in bandwidth and decrease in information packets are but a small, albeit critical, part of the solution: a single Global Hawk [drone] uses around 500 Mbps of bandwidth when operating – this is equal to 500 per cent of the total bandwidth used by the entire US military during the 1991 Gulf War campaign. The problem, then, is obvious.

Bandwidth Used for Recent US Military Operations	
Desert Storm 1991	99 Mbps
Kosovo 1999	250 Mbps
Enduring Freedom 2002	736 Mbps
Iraqi Freedom 2003	3200 Mbps

The increased requirements for tactical bandwidth is consistent with the growth of drone use and the emergence of new communication equipment.