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IEEE 802.22 worldwide standard of special significance to Canada

Advancing technology for the benefit of humanity has become the motto of the Institute of Electrical and Electronics Engineers (IEEE). It is also the motivation of Gérald Chouinard of the Communications Research Centre (CRC) in developing wireless communication systems to extend broadband access to rural and remote areas.

On July 1, 2011, the IEEE issued the IEEE 802.22 Wireless Regional Area Network (WRAN) standard, designed to provide broadband access to wide regional areas around the world, and bring reliable and secure high-speed communications to underserved and un-served communities. For the past seven years, Chouinard has shepherded the standard from conceptualization to approvals, and he is currently completing the development of the technical guidance to support its implementation.

Bringing broadband to all communities has long been an issue in Canada. CRC launched a rural and remote broadband access (RRBA) research program in 2002, with Chouinard as manager. While early RRBA research explored the feasibility of using lower frequency bands, given their superior propagation properties to cover larger rural areas, momentum started to build in 2004 when the U.S. Federal Communications Commission (FCC) asked industry for input on the possibility of operating unlicensed[i] devices in the TV bands.

"We hadn't identified specifically that it would be in the TV bands," says Chouinard, referring to RRBA research, "but it [the FCC notice of inquiry, NOI] confirmed our original thrust toward using frequency bands in the low UHF range[ii] and below."

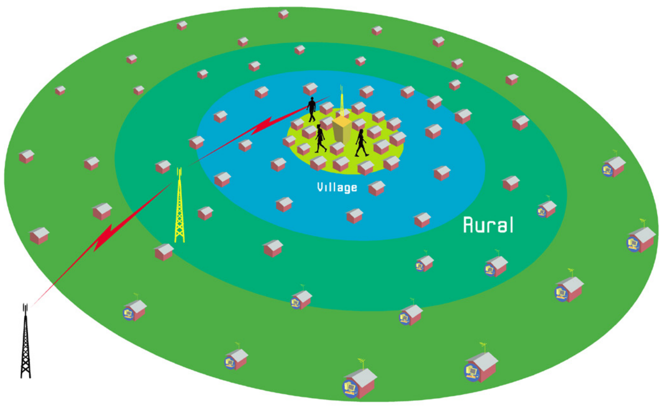
Industry responded to the FCC NOI. So too did the IEEE 802, the prime organization involved in developing international standards for wireless networks. Their feedback was that it's

i. Such devices are called "license-exempt" in Canada and other jurisdictions.
ii. The ultra-high frequency (UHF) range goes from 300 MHz to 3 GHz.

Another Emmy for CRC!

For the third time, the research efforts of the Communications Research Centre (CRC) will be recognized with an Emmy award! CRC's work in the standardization of loudness metering for use in broadcast audio will be honoured at the 63rd Annual Technology & Engineering Emmy Awards in January 2012. The CRC's Advanced Audio Systems group and alumnus, Dr. Gilbert Soulodre, will both receive Emmy awards for their roles in the global standardization of loudness metering for use in broadcast audio. Also sharing in the award will be the ITU-R Study Group 6, Dolby Laboratories Inc., and Craig Todd. The presentation will take place during the International Consumer Electronics Show in Las Vegas.

Eye on Technology coverage of CRC's loudness metering efforts are detailed in **Issue 15** and **Issue 10.** CRC's **first Emmy** recognized the significance of the Hermes satellite, while its **second Emmy** honoured CRC's Advanced Television Evaluation Laboratory for its work in standardizing digital television.



A base station in the centre of a village, covering the rural area around it and bringing broadband access to both fixed terminals and small portable devices.

technically possible for such devices to capitalize on unused spectrum in the TV VHF/UHF bands. TV broadcasters were involved in the discussions, so comments focused on the use of fixed unlicensed devices in these TV bands to limit the interference potential to broadcast-incumbent operation, while bringing broadband access to under-served and un-served rural areas where more unused TV channels happen to be available.

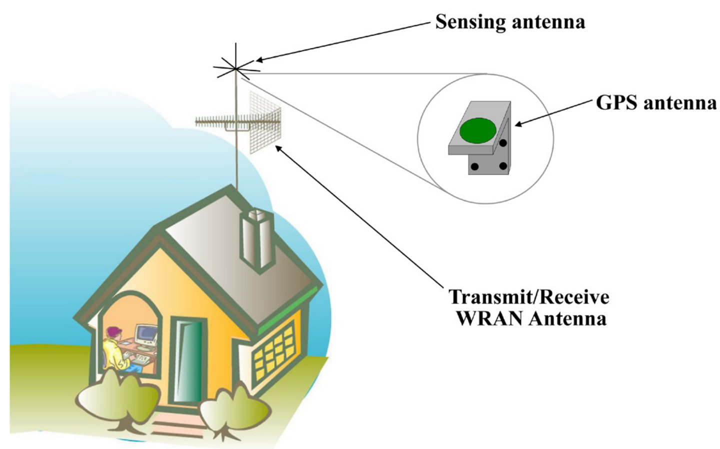
The IEEE 802 immediately saw the potential of new communication technologies designed to make such new type of service a reality. New technologies need new standards to ensure economies of scale and interoperability – key ingredients for industry to bring products to market. In November 2004, the IEEE 802 formed the 802.22 working group charged with developing a world standard for WRANs that would make broadband access via the TV bands possible. Chouinard was elected vice-chair of the group and later also became chief editor of the 802.22 standard.

But the potential of this TV band spectrum was not limited to rural regions. Industry envisioned fixed devices in urban homes, taking advantage of the low frequencies to transmit digital signals such as video through walls. It also envisioned the use of TV bands for portable devices to extend the range of local area networks, and made the necessary representation to the FCC. The term "Super-Wi-Fi" was conceived, the new regulations were extended to personal/portable devices. As a consequence, the scope of the 802.22 working group was expanded to include base stations serving such devices, and the standard was broadened accordingly.

"Imagine a base station in the centre of a village, covering the rural area around it and bringing broadband access to fixed terminals using outdoor antennas similar to current UHF TV antennas. You may also have small portable devices allowing people to walk in the village while connected to the nearby base station," Chouinard explains, adding that in all these cases, the operation is still point-to-multipoint. "The professionally installed base station is in control of all the necessary parameters to avoid interference with broadcast operation. Should interference arise, the base station operator is the one responsible, thus the one in charge of resolving the issue."

He points out that this is different than peer-to-peer Wi-Fi-like networks, where users of the terminals will unlikely be able to resolve interference issues on a case-by-case basis.

Chouinard and his international colleagues, working across world time zones, navigated the technical fine points of a number of new technologies to optimize system operation for the TV bands, and include all means needed to avoid interference with broadcast incumbents. In recognition of this successful effort that culminated with the publication of the 802.22 standard, the IEEE recently awarded the 802.22 working group with its emerging technology award for 2011. The most sensitive issues requiring technical solutions involved the safe use of "TV white space": the TV channels left unused by TV broadcast allocation plans in various areas. Ensuring an interference-free environment was paramount to the television broadcasters.



Typical installation to fixed terminals using outdoor antennas.

Chouinard and his colleagues first set to work on developing the standard to accommodate radio frequency (RF) sensing techniques that would pre-empt interference by using dynamic spectrum allocation when incumbent signals are detected. But RF sensing proved impractical because of the very demanding sensing threshold levels that were assumed, so another method – a database query method based on the devices' location – was included in the standard.

Chouinard explains: "Given that all these WRANs will be connected to the Internet, we opted to use the backhaul connection that the base station has to the Internet to query a database on behalf of all its associated terminals. Once the latitude and longitude of a device is known, the database can tell which channels are available and which are off limits for this device, to avoid interfering with local TV band broadcast operation, that is, TV signal reception and wireless microphones operation."

While RF sensing remains in the standard for use by regulators favoring the technique, the United States, the United Kingdom and Canada are favoring the database query method.

Beyond the protection of broadcast incumbents, the 802.22 standard was optimized to absorb long round-trip delays between the base station and its associated user terminals (up to 100 km) as well as to minimize the number of active OFDMA sub-carriers used on the return path by the terminals to reduce their maximum EIRP footprint, thereby minimizing potential interference. Each WRAN can deliver up to 22 Mbit/s, 25 Mbit/s and 29 Mbit/s per 6 MHz, 7 MHz and 8 MHz channels respectively. Also, means were developed to provide coexistence among competing WRANs operating in the same area through spectrum etiquette where different channels will be used by different WRANs and, if more than one WRAN needs to occupy a channel, an on-demand frame contention mechanism was included for equitable sharing of the channel capacity. Other features, such as precise ranging using inherent OFDM timing capability for integrated terrestrial geolocation, and intelligent antenna-terminal interface to control the actual transmitted EIRP rather than the conducted power, were included in the standard.

Chouinard sees value in supporting operators who want to provide service to rural areas, and he thinks the database is a great tool to enable this.

"If a country decides to give some protection to rural broadband systems to promote and facilitate their deployment, they would add them to the database so these systems would automatically be protected against other license-exempt devices, since they would be told by the database to steer-away from their operation," says Chouinard. He considers Canada's current "light licensing" regime, which can afford protection for specific remote rural broadband systems, a supportive approach that can take advantage of a database.

Shortly after work on 802.22 began, Industry Canada and the Radio Advisory Board of Canada collaborated on a policy to help this country capitalize on television white space for remote rural regions. Their initial policy on "other limited use of the broadcasting spectrum" was published by Industry Canada in June 2006. It was followed by the development of the Remote Rural Broadband Systems (RRBS) technical requirements, to which Chouinard brought his expertise. Under the RRBS, operators pay a relatively low fee for a local spectrum license to allow a base station to serve a number of terminals. "Light licensing" provides operators with assurances against interference, and in Chouinard's view, this assurance is a key asset for an operator's business case.

"Consider yourself as a potential operator who wants to install a service in a rural area. You go to the bank for initial funding and they ask 'Are you sure you're going to have your frequency for long?' That's what light licensing gives you," says Chouinard.

So why wasn't service to Canada's rural and remote regions deployed after the 2006 policy?

"To deploy a wireless service, you need two things: spectrum and technology. The technology was not there in 2006," says Chouinard. "There was a lot of technology in the higher bands, especially in ISM bands, but they needed to be brought to the TV bands. Given the limited market for such devices in rural Canada, no advantage could be gained from mass production and the cost could not be brought down."

Even with 802.22, Chouinard and his working group colleagues realize that rural and remote deployments will depend, in large part, on countries collaborating to identify the potential market.

"One of the goals of the WhiteSpace Alliance – the industry group formed to bring 802.22 technology to market – is to try to identify the potential market for this technology," says Chouinard. "For the lower power portable Wi-Fi-like wireless devices, the U.S and Canadian markets are likely large enough for volume production, but not likely large enough for the higher power fixed devices to bring broadband to rural and remote areas."

He explains that there is a need to gather interest from large emerging countries such as Brazil, China, India and Russia to identify a potential aggregate market that is sufficiently large.

"That's the dilemma we are in now: the standard is there but the market is hard to define because it has to be international. There are not enough customers in rural areas of one country to make it appealing to chip manufacturers to launch the chip design

CRC's Gérald Chouinard, vice-chair of the working group for the IEEE 802.22 Wireless Regional Area Network Standard, and lead editor of the Standard.

that would, once mass produced, bring the cost of the devices to an attractive level for the public."

Chouinard feels that industry will unlikely be able to do it on its own since it goes beyond the usual market approach. Involvement of governments will likely be needed since other aspects, that are more social and societal in nature, will need to be considered in the worldwide extension of broadband access to under-served and un-served rural areas.

"The ITU's Development Sector could be a way to unlock this dilemma," he says. "An international ecosystem could be developed where affordable devices would be available to extend broadband access to all regions of the world under sustainable business models."

Visit http://ieee802.org/22/ for more details on the 802.22 standard.

40-year-old antenna updated to advance communications for Canada's North

A high-frequency (HF) radio communications antenna is being given a brand-new lease on life, 40 years after its inaugural installation on Communications Research Centre (CRC) soil.

The HF antenna, which was originally installed in 1971 near the campus entrance, was moved to a different location in the late 90s. Last month, the HF antenna was taken down to be refurbished, and on November 4, 2011, the updated antenna was reinstalled. It will soon play an important role in a project aimed at bringing improved communications to northern Canada.

"Given the attributes of the Canadian Arctic – with its vast geographic area and remote communities – HF presents a feasible technology solution," explains Sergei Bantseev, a research engineer with CRC's Network Systems group.

Researchers at CRC are collaborating with Defence Research and Development Canada (DRDC) and the Department of National Defence (DND) on a northern communications project. The overall goal is to increase communications connectivity for DND units, as well as other government departments based out of northern regions, by investigating and developing a network architecture where HF connections are integrated with terrestrial networks and satellite communication systems.

One aim of the project is to advance HF communications in the Arctic. This involves investigation of the viability of using recently developed higher bandwidth HF radio modem technologies in the Arctic by assessing their performance over Arctic links, and studying the implications on radio spectrum use. Research will also focus on network architectures that provide greater coverage and reliability.

"It's such a large area, and you may need to be in any location at any time," says Bantseev. "Modern HF technologies, which allow for extending the Internet over HF, can be very useful in support of operations such as search-and-rescue or environmental clean-ups in the Canadian Arctic."

By complementing satellite and terrestrial communication connections with HF radio technology, CRC and its partners can provide additional link capacity for Internet applications and increase overall system survivability.

"The unique propagation characteristics of HF radio waves allow for communication across very long distances without any infrastructure between the transmitter and receiver," says Dr. Nur Serinken, a research scientist with CRC's Radio Communications Technologies group. "HF radio relies on the ionized layer above the earth, called the ionosphere, which acts as a natural radio repeater by refracting the radio waves."

"Characteristics of the arctic HF propagation are affected by geomagnetic storms. During these events, reliability of HF communication suffers," continues Serinken. "To address this challenge, we will investigate networking solutions over HF radio and study adaptive communications techniques."

CRC's newly refurbished antenna will be used in an upcoming experiment that will connect Ottawa with a station in New Brunswick. Once that has been achieved, the next step will be to create a third, northern-based link in Nunavut – tentatively planned for Resolute or Iqaluit.

Initial installation of the HF antenna in 1971 (left) and reinstallation of the refurbished antenna in 2011.

"We will be collaborating with the University of New Brunswick to establish a test station for wideband HF waveform trials," says Bantseev. "If that goes successfully, we will put up a third node in the North. It's expensive and difficult to set up in the northern regions, so the link with New Brunswick will be used to test the system prior to going into the Arctic."

Sergei Bantseev (left) and Nur Serinken (right) reinstall the HF antenna with the help of a team, including CRC's Benoit Gagnon (centre).

The initial stage of the project will see CRC's HF antenna used to connect with Fredericton, N.B., in early 2012. The third, northern-based node could be linked-in as early as next summer.

"In a year from today, we will have a better understanding of how integrating multiple communications links into a cohesive communications network can improve communications in Canada's North," says Bantseev. "We think that the wideband HF radio technology, with its ability to significantly increase HF data rates, will play a critical role in the overall communications network for the Canadian Arctic."

For more information, contact Dr. Nur Serinken at 613-998-2289 or nur.serinken@crc.gc.ca, or Sergei Bantseev at 613-990-5240 or sergei.bantseev@crc.gc.ca.

CRC-DABDetect offers solution for cost-effective coverage of DAB/DMB/DAB+ services at L-band

While Canadians continue to experience the sounds of FM and AM, many others countries are switching from these analog radio technologies to digital radio technologies, including DAB, DMB and DAB+.

Canada began preparing for a switch from analog to digital audio broadcasting (DAB) in the 1990s. At that time, CRC researchers built up considerable know-how in the DAB system to advise clients. But since digital audio broadcasting has yet to sweep this country, researchers are leveraging their DAB expertise to produce technology transfer opportunities.

To this end, CRC researchers have invented CRC-DABDetect, a module for DAB, DMB and DAB+ receivers to overcome distortion induced by the Doppler effect. Simply put, the Doppler effect is the change in the frequency of radio waves as a transmitter and receiver move relative to each other. The sound of a passing siren is one example.

"When the receiver [in a vehicle] is on the move, the Doppler effect causes each sub-carrier of the OFDM multi-carrier DAB signal to move about its nominal position in a random manner," says Louis Thibault, Manager of CRC's Advanced Audio Systems group that developed CRC-DABDetect. "When you have several adjacent sub-carriers moving randomly, they create inter-carrier interference. This causes signal distortion which produces performance degradation in the receiver."

Thibault and his team have developed the CRC-DABDetect algorithm to estimate the inter-carrier interference and remove it from the signal before the signal is passed to the error correction part of the receiver.

"DAB in Canada was intended to be carried at L-Band, which is at approximately 1.5 GHz. This frequency is 15 times higher than FM, which is at about

100 MHz," explains Thibault. "The Doppler effect is directly proportional to two things: radio frequency value and vehicle speed. The faster your vehicle moves, the more severe the Doppler effect. At 1.5 GHz, the Doppler effect is quite severe. This is what we're trying to estimate and cancel."

But the Doppler effect only induces distortion in certain DAB/DMB/DAB+ transmission scenarios. This introduced a deployment dilemma in Canada and it was the impetus for the audio team's research.

DAB primer

DAB+ and DMB are extensions of DAB. DAB+ features an updated, more efficient audio compression system, while DMB is capable of multi-media broadcasting.

Among their commonalities, the three use the OFDM (orthogonal frequency division multiplexing) modulation method. Common in many telecommunications systems, OFDM uses multiple sub-carriers to transmit data.

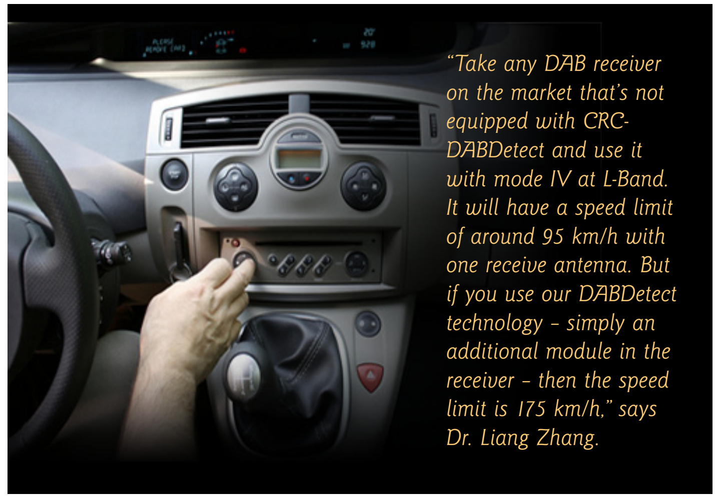
"You can transmit about 5 broadcast-quality radio stations with DAB. With DAB + you can at least double that over the same signal. Ten or more radio stations could share a common antenna and a common transmitter, reducing the equipment cost per radio station," says Thibault.

"DAB has been deployed in the U.K. for quite some time, Korea is employing a DMB system that allows you to receive mobile television, and Australia and Germany are migrating to DAB+," he adds.

Two frequency bands have been allocated for DAB/DMB/DAB+: Band III (174 –240 MHz) and L-band (1452 – 1492 MHz).

There are four transmission modes defined in the DAB standard, two of which work at L-Band, DAB's assigned spectrum location in Canada. The two modes – II and IV – are distinguished by the amount of space between sub-carriers: mode II has 4 kHz, while mode IV has 2 kHz spacing. Associated with each transmission mode is another distinguishing feature: the "guard interval." It absorbs the effect of multi-path, the portion of the signal known to be distorted as it bounces off obstacles in the environment and eventually echoes back to the receiver.

The guard interval actually affords broadcasters the ability to use a single frequency to cover a target service area that can be, ultimately, an entire country!



Such a Single Frequency Network (SFN) relies on multiple transmitters sending the same signal at the same time. While this creates a form of multi-path in itself, the guard interval absorbs it.

Mode II has a smaller guard interval than mode IV, meaning transmitters cannot be separated by more than 20 km in mode II, but they can stretch up to 40 km apart in mode IV. In short, mode IV is more economical in terms of transmission equipment cost, particularly for broadcasters wishing to cover a large area. However, the 2 kHz sub-carrier spacing of mode IV makes it more vulnerable to the Doppler effect than mode II, with its larger 4 kHz spacing.

"This was the rationale behind our research – to come up with a technology that would clean up the Doppler effect in the receiver and allow broadcasters to use mode IV," says Dr. Liang Zhang, research scientist in the Advanced Audio Systems group and main inventor of DABDetect. "Take any DAB receiver on the market that's not equipped with CRC-DABDetect and use it with mode IV at L-Band. It will have a speed limit of around 95 km/h with one receive antenna. But if you use our DABDetect technology – simply an additional module in the receiver – then the speed limit is 175 km/h."

Thibault and his team showed that when using two receive antennas with mode IV at L-band, one could achieve 150 km/h with a conventional receiver, and 250 km/h with CRC-DABDetect. Such high speeds are reached by high-speed trains and cars on autobahns in Germany. But some receiver manufacturers are likely to prefer the one-antenna solution offered by CRC-DABDetect. Hand-held devices, for instance, cannot accommodate two receive antennas. If kids want to listen to DAB radio on their portable devices while on a road trip, for example, CRC-DABDetect can enable this.

Closely related to the function of CRC-DABDetect is CRC-DABSync. In mode IV at L-Band, the receive signal is constantly varying because of receiver movement and multi-path. Individual sub-carriers of the DAB signal will vary from strong to weak; they will disappear and reappear. The resulting effect created in the spectrum is called "fading." When it occurs very rapidly, as in mode IV at L-band, it is "fast fading." A receiver operating in such an environment must be equipped with a robust synchronization scheme capable of coping with fast fading.

Louis Thibault, Manager of CRC's Advanced Audio Systems group and Liang Zhang, a research scientist in the group and the main inventor of DABDetect.

"A signal at L-band is fading 15 times faster than at FM, so if your receiver does not have a very robust sync module – the very first module a signal encounters after the antenna and tuner – it's the weakest link in the chain," says Thibault. "That's why we designed our own, so whoever uses our DABDetect algorithm can benefit from our DABSync algorithm."

"It is ironic to note that the solution to cut down the coverage cost of DAB/DMB/DAB+ at L-band lies in the receiver," says Thibault. "The next step for us is to promote our DABDetect and DABSync technologies to foster their endorsement by broadcasters and their adoption by DAB/DMB/DAB+ receiver manufacturers. We hope this will encourage the use of L-band for broadcasting digital radio and multi-media services."

CRC-DVBDetect, explored in Issue 15 of Eye on Technology, is another example of how CRC is using its expertise in OFDM to create technology transfer opportunities. That expertise is also being applied to long-term evolution (LTE) technology.

For more information, contact Louis Thibault at 613-990-4349 or louis.thibault@crc.gc.ca.

CRC's Dr. Nicolas Gagnon awarded Young Scientist Best Paper Award

Dr. Nicolas Gagnon was awarded the Best Paper Award by a young scientist at the 2011 joint International Conference on Electromagnetics in Advanced Applications (ICEAA) and IEEE-APS Topical Conference on Antennas and Propagation in Wireless Communications (IEEE-APWC), held in Torino, Italy, in September. To qualify for this award, the applicant could be not more than 36 years old and must have earned a Ph.D. or equivalent degree. Dr. Gagnon's paper entitled "In-Depth Examination of a 3-Layer Phase Shifting Surface (PSS) and its Use in a Thin Fresnel Lens Design" examined the application of the thin phase shifting surface (PSS) that he invented two years ago to design low profile lens antenna structures. CRC has a patent pending on this technology. Dr. Gagnon is a microwave antenna engineer in CRC's Advanced Antenna Technology group.

Nicolas Gagnon with a PSS Fresnel lens (insert) in a measurement jig.

New CRC public alerting system

Enabling communication is the Communications Research Centre's (CRC) raison d'être. Lesser known is CRC's custodial responsibilities for the Shirleys Bay campus. The 371-hectare site in the west end of Ottawa houses facilities belonging to Industry Canada, National Defence, Library and Archives Canada and the Canadian Space Agency.

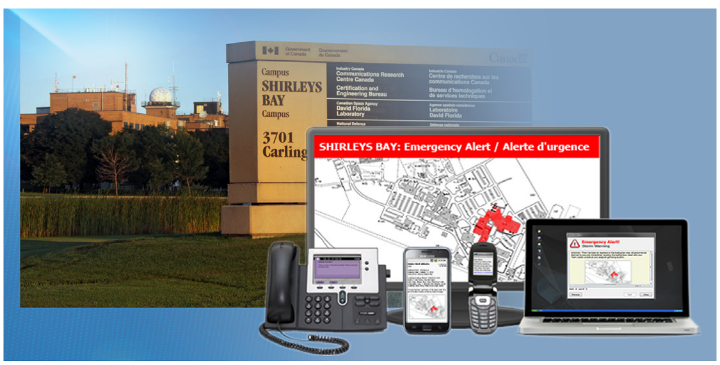
In an emergency situation requiring campus evacuation, it would be CRC's responsibility to issue the order. Enabling emergency communication across the campus to the roughly 1,600 employees, contractors and visitors is not a simple assignment. Over 100 dispersed buildings, distinct computer networks and security requirements, plus the mobility of employees are just some of the factors that contribute to the complexity.

These challenges also present an opportunity for CRC and a Canadian company, Amika Mobile Corporation. Supported by the Canadian Innovation Commercialization Program of Public Works and Government Services Canada (PWGSC), CRC and Amika Mobile have implemented the CRC Public Alerting System, based on the Amika Mobility Server™ - Emergency Alerting Edition (AMS), throughout CRC's facilities on campus.

The installation will not only help ensure the safety of staff, it will also serve as a test bed, showcasing Canadian technology to other government departments. This accounts for the support of PWGSC, specifically its Office of Small and Medium Enterprises (OSME). The OSME mandate is to improve small and medium enterprises' accessibility to government procurement opportunities.

CRC's Marc Primeau, Electronic Fire and Security Specialist, worked with Amika Mobile's team to customize the mass notification system to meet CRC's specific needs. CRC now has multimedia emergency notification capabilities from any location, on site or off, to the myriad of wired and wireless devices available to employees and contractors, both at work and at home.

The system exploits all avenues of transmission. Whether through their desk computers, via their mobile devices, or over network-enabled audiovisual equipment, staff will receive the emergency notification, which may consist of text, image and audio. A group gathered in a boardroom listening to a lecture, for example, could have their PowerPoint presentation interrupted with the emergency message appearing over the presentation.



The CRC Public Alerting System, based on the Amika Mobility Server™ - Emergency Alerting Edition (AMS), exploits all avenues of transmission.

Voice over Internet Protocol (VOIP) telephones can be enabled, so that an audio message is heard and a short text message appears on the screen. Another set of features that will soon be used by CRC is the AMS's ability to auto-discover and target roaming Wi-Fi devices by location – ensuring that visitors to targeted areas receive the message along with others on site. Additionally, the AMS ability to receive alarm input from third party equipment, such as fire panels, or other applications will be leveraged by CRC to automate alerting to operational staff any time of day or night.

The solution integrates directly with CRC's network as well as the phone directory, removing the need for day-to-day management of a database. Employees and external clients can opt-in via a web portal interface to add additional contact information such as external email addresses, cell phone numbers and pager numbers.

Generating messages offers similar flexibility, which is vital in the case of an emergency. Primeau or another member of CRC's Electronic Fire and Security team can send an alert from any computer or mobile browser. The process is straightforward from a computer on the CRC network. Simply by logging into CRC's AMS through a web-based console, Primeau demonstrates the ease of sending a customized message to only the Emergency Response Team (ERT), for instance, or to all employees in a particular laboratory complex. In addition, Primeau is able to pre-define message templates for emergency situations, simplifying operations in times of crisis.

"Implementing a system of this nature in an established environment with multiple communication barriers is quite a complex task," says Primeau, describing his role as technical advisor and system administrator responsible for coordinating and implementing the system across the campus. "But by working with CRC IT services we found ways to overcome these barriers with acceptable solutions. It's just another example of the capabilities of the CRC campus operational staff, and I am proud to showcase this."

Primeau also had to consider the circumstances necessitating emergency communications, two of which were experienced recently: a power outage in the region as well as an earthquake.

In the case of a power outage, Primeau reports to one of several buildings on campus served by a generator ensuring back-up power, or to any computer equipped with an uninterruptible power supply (UPS) unit. From there, he logs into CRC's AMS, ready to dispatch emergency directives from senior management.

What's more, there is a fully redundant backup in place: the primary server is synchronized with a secondary server in the event of a primary server failure. Primeau has full access to the secondary server and can complete the same tasks. The servers are located in separate locations and each location is serviced by separate UPS systems and generators.

Along with ensuring ease of operation in any eventuality, Primeau and Amika Mobile incorporated added features, including integration with CRC's ERT pager system. Incorporating the alpha-numeric pagers into the AMS enables location-specific messaging – a useful tool on a research campus with laboratories containing an array of hazardous materials. As Amika Mobile continues to enhance the solution with guidance from operational experts like Primeau, CRC staff will see further integration into internal systems such as the existing VOIP telephone system residing on the CRC network, and the CRC Emergency Public Address System being rolled out across campus using the Electronic Fire and Security Communication Network.

Next steps for Primeau include working with campus partners to deploy the system across the entire site, and with the CRC Communications and Promotion team to promote the system. This involves underscoring the importance of an up-to-date campus directory and encouraging users to subscribe to receive alerts on their mobile devices through a web-based portal that will be made available through CRC's Intranet site.

For more information, contact Marc Primeau at 613-990-2535 or marc.primeau@crc.gc.ca.

CRC and 3D-TV: Enhancing viewers' depth sensation with the stereoscopic J-Display

Today's television audiences are increasingly able to immerse themselves in the action taking place around them, rather than simply in front of them, with the help of stereoscopic television, i.e., 3D-TV. Not only are cameras changing audiences' visual experiences – showering them with 3D objects – the "window" through which they traditionally view video is also advancing beyond an upright, flat surface.

Researchers at the Communications Research Centre (CRC) are contributing to these advancements. Dr. James Tam and Dr. Carlos Vázquez in the Advanced Video Systems group have developed the J-Display, a curved surface that allows 3D figures to appear naturally "grounded" as opposed to being cut off in a standard flat window display. Moreover, the novel display allows the 3D figures to extend forward into the personal space of the viewer.

"Grounding" is one of several inherent problems with current upright, flat displays. It occurs when a depicted figure appearing in front of the screen seems disconnected – or clipped – from the ground, as if it is floating in space. Extending the bottom of the screen horizontally gives the figure a foundation on which to appear standing.

"I think we are the first to identify grounding as a problem that you could overcome and increase the sense of presence. But we still need to verify this enhancement in a study, objectively," says Tam, who brings a combined expertise in psychology and binocular vision to the design and development of advanced video systems.

"Standard 3D displays are upright, planar. Objects appear in depth as if through, or in front of, a window," he says. "If you look at the real world, however, things that are closer to you are usually at the bottom. In contrast to current displays, the J-display has a curvature that is consistent with this natural occurrence."

Tam further explains that when visually processing 3D video, complex demands are placed on the human visual system, particularly when faced with conflicting information such as the relative size and position of objects. These mixed messages to the brain can produce a sense of discomfort in some viewers. In the case of the J-Display, which provides a greater volume of space to accommodate and position 3D objects, there is a much closer match between the virtual depiction of objects relative to each other and how they would appear in reality. Figures are depicted as if they were in the same room as the viewer, thereby helping increase the immersive experience. Preliminary feedback is that people find 3D viewing on the J-Display more realistic and comfortable.

But arriving at an acceptable prototype took some tweaking, both of the display itself and of the 3D images shown. Researchers first had to experiment with the appropriate curvature to reduce distortion. They then performed a "controlled warp" of the 3D images so they would appear accurately on the J-Display. Each row of pixels was adjusted to compensate for the change in viewing distance of the curved screen surface relative to an upright screen, for which the original images were intended.

Drs. James Tam and Carlos Vázquez with prototype J-Display, designed, built and being tested at CRC. The patent-pending display is available for commercialization.

Tam and Vázquez will soon conduct a formal study to test the reactions of naive viewers to the J-Display. The experiment will involve the prototype tabletop version of the novel screen. (A larger version measuring 3.7 metres by 4.6 metres for life-size 3D objects is currently being built). In the meantime, CRC has initiated a patent application for the J-Display, and developed a plan to help transfer the technology to industry.

Technology transfer efforts such as these are off-shoots of CRC's research expertise that is also used to advise clients on technology trends and capabilities, and to advance standards development.

CRC has made a considerable contribution to standards development in broadcasting, including to the development of North America's digital television (DTV) standard that recently replaced analog television in much of the country. CRC's involvement in the roll-out of DTV continues through the Canadian Digital Television Technology Group (DTV-TG), which provides decision makers in government and industry with the technical information they need. DTV-TG includes collaborative research by specialized working groups investigating, among other subjects, 3D-TV.

For more information, contact Dr. James Tam at 613-998-2764 or james.tam@crc.gc.ca.

CRC's Demin Wang and co-authors awarded Best Paper Award

Representing his co-authors and colleagues, CRC's Dr. Demin Wang accepted the Scott Helt Memorial Best Paper Award at the 2011 IEEE Broadcast Symposium in October. Dr. Wang, as well as CRC's André Vincent, Liang Zhang, Robert Klepko and Phil Blanchfield received the honour for their two-part paper entitled "Motion-Compensated Frame Rate Up-Conversion-Part I: Fast Multi-Frame Motion Estimation and Part II: New Algorithm for Frame Interpolation." The papers present new algorithms for motion estimation and frame interpolation for high quality video frame up-conversion. Both papers appear in *IEEE Transactions on Broadcasting*, volume 57, issue 3, and on the IEEE Xplore digital library. The Scott Helt Memorial Award, established in 1957, was created to recognize the best paper published in the *IEEE Transactions on Broadcasting*.

CRC's Demin Wang (right) accepts award from Guy Bouchard, Awards Committee Chair of IEEE Broadcasting Society.

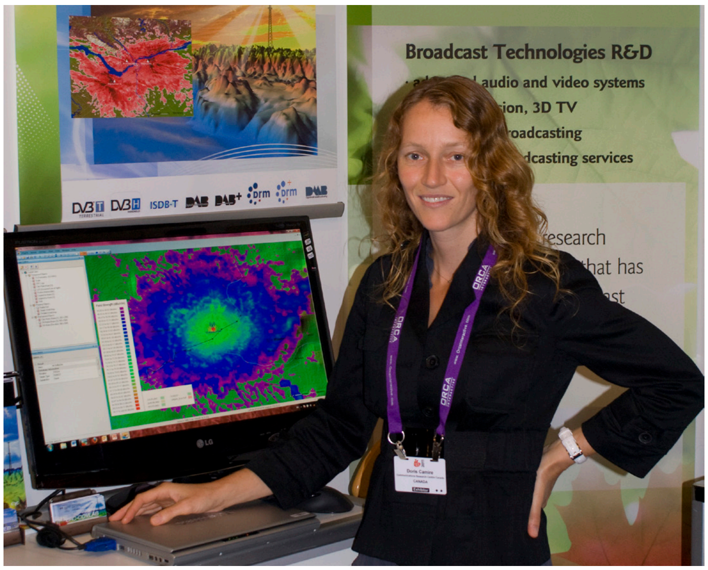
Showcasing CRC technology at home and abroad

CRC participated in the **Wireless Canada Technology Showcase 2011**, hosted by the Canadian Wireless Telecommunications Association (CWTA) in Ottawa. Among the technologies exhibited was CRC **FM TwoO**, the first independent FM-RDS radio decoding App on the Android™ market.

CRC also used **CORAL**, its cognitive radio platform, to establish Wi-Fi hot spots from the wired network at the conference. The demonstration enabled delegates to use their Wi-Fi devices to access the Internet within a range of about 300 feet. A second hot spot was dedicated to file and video downloads, including video streaming and interactive games.

*CRC 's Bernard Doray (left) explains CORAL, at the CWTA's Wireless Canada Technology Showcase 2011. CRC conducted a similar demonstration while exhibiting at **GTEC: Canada's Government Technology Event.***

CRC exhibited at **IBC 2011** in Amsterdam. Among the advances highlighted by CRC at the conference were: hybrid broadband/broadcast radio with CRC's FM TwoO App, which is capable of receiving RDS data to implement the RadioDNS hybrid radio standard and other new services such as tagging; open broadcast platforms for DAB, DRM and FM; M/DRM+ compatibility and DRM+ performance test results; advanced coverage planning and interference prediction software for single frequency networks DVB-T, DVB-H, ISDB-T, DAB, DAB+, T-DMB, DRM and DRM+; colour-based surrogate depth maps for real-time 2D-to-3D conversion; depth map editing and generating software for off-line generation of 3D video content from 2D content; depth estimation and stereoscopic video processing; and high quality frame rate conversion.



CRC's Doris Camiré demonstrated the advanced coverage analysis capabilities of CRC-COVLAB at IBC 2011.

In December, CRC participated in the **Canadian Interoperability Technology Interest Group (CITIG) workshop**. CITIG brings together representatives from public safety, industry, academia, government and non-governmental organization to collectively shape the future of Canadian public safety interoperability.

CRC also participated in **SDR'11-WInnComm,** the Wireless Innovation Forum conference on Communications Technologies and Software Defined Radio, in Washington, DC. CRC demonstrated how its Software Communications Architecture (SCA) core framework, SCARI-GT, enables Android™ smartphones to host Joint Tactical Radio Systems (JTRS) SCA public safety waveforms.

Claude Bélisle received the President's Award at the Wireless Innovation Forum conference. The award is given annually by the Chairman of the WinnF to an individual in recognition of a sustained outstanding contribution in support of the organization and its activities. Claude is Vice-President of Satellite Communications and Radio Propagation Research at CRC.