Global Communications Newsletter

April 2004

DLT in Latin America

Speaker: Hikmet Sari, Supelec, France

Dates: 18 - 30 August 2003

Cities: Lima, Peru;, Bogota and Bucaramanga, Colombia; Quito, Ecuador; and Panama City, Panama

It all started at the Welcome Reception of ICC 2003 in Anchorage last May when Bhaskar Sengupta, Director, Membership Programs Development, asked me if I would be ready to go on a Distinguished Lecture Tour (DLT) in Latin America. I presume he had had positive feedback from the Asia-Pacific Region, where I went for a two-week tour covering Taipei, Hong Kong, Seoul, Tokyo, and Singapore in November/December 2002, and wanted me to go to another region. Since my only trips to Latin America in the past were to Rio de Janeiro and San Salvador, I wanted to see more of this region, and I gave a positive answer to Bhaskar. He immediately introduced me to Jorge Hedderwick, Director, Latin America Region. I then had a short conversation with Jorge and volunteered to go on a tour in Latin America provided there was sufficient interest from the Local Chapters in my topics and we could find a convenient time period. I indicated to him that the best time would be August, just before the term starts in our schools and universities.

I had almost forgotten that conversation in Alaska when I received an email from Jorge on 4 July confirming that there was strong interest from Peru, Colombia, Ecuador, and Panama, and asking me to inquire about flights. In terms of timing, it was just perfect: I was invited to give a series of lectures during the last two weeks of August, just between my summer vacation and the beginning of the term. Jorge informed me that Ms. Araceli Garcia Gomez, Guadalajara Chapter Chair, would be organizing my tour working with the Local Chapters in the host countries. Araceli did a great job making the contacts and arranging the logistics. The tour was organized over two weeks so I had two days of lecture in each country and one day for traveling from one country to another.

In my previous tour in the Asia-Pacific Region, I only gave one talk in each visited country, and the topic was broadband wireless access, which is my primary talk advertised on the ComSoc Website. For this tour in Latin America, there was a bigger expectation from the Local Chapters, and I was asked to give two or more lectures on different topics in each country. Fortunately, in addition to my usual lecture on broadband wireless access, I had a presentation ready on broadband cable access. With the exception of Colombia, where I was asked to give the first lecture in two different cities, I gave the two lectures in each country and thus covered the fields of both wireless and cable access.

The tour started on Monday, 18 August, with a flight from Paris to Lima via Miami. Every time I have an overseas flight with a connection, I get worried about missing it. The flight to Miami was perfectly on time, and I immediately proceeded to the check-in counter of the airline for the flight to Lima. I had a real fright when the lady at the counter looked at my ticket and said "Sir, your reservation to Lima is for Wednesday, 20 August." Suddenly, my talks in Lima scheduled for the next two days seemed in jeopardy. I was preparing myself to tell her that I needed to get to Lima whatever it cost when she unexpectedly tore my ticket and handed a boarding pass to me. It seemed unbelievable, because sometimes when something goes wrong, everything goes wrong. But I was lucky this time; I had just been given a boarding pass to get to Lima that same day and at no additional charge. I felt so relieved, and thought, always double check and even triple check the work of your travel agent and assistant!

On my arrival at the Lima airport, Mr. Jefferson Lopez Goycochea from the University of San Martin de Porres was waiting for me. My two talks in Lima were scheduled as invited talks within the framework of INTERCON 2003 (the 10th edition of an international conference on electrical and systems engineering) organized by the Student Branch of that university. I gave my talk on broadband cable access on Tuesday morning, and my talk on broadband wireless access on Wednesday afternoon. The attendance was about 40 people. One of the reasons for not having more people was perhaps that the talks were a part of a large conference with a number of parallel sessions. The talks were translated into Spanish by a student working with me in ping pong mode. Every half a minute, I would stop to give him the floor to translate what I had just said.

My short stay in Lima was memorable. The Local Chapter had some other guests from Brazil, Argentina, and France, and they organized a tour for us in the old city on Wednesday morning. We visited the places of interest of Lima, and I learned quite a bit on the history of Peru. I will also remember the restaurant Los Cantaros, where we had two lunches and I discovered the delicious Seviche and Pisco Sour. You should try these specialties in Los Cantaros whenever you have a chance to visit Lima.

My flight from Lima to Bogota on Thursday, 21 August, was at 6 a.m., so that night was very short for me. Fortunately, I was able to get some sleep during the flight and was in a good shape when I arrived in Bogota. There, Aldo Forero, Chair of the Colombia Chapter, was waiting for me. After

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Designing an Advanced Regional Research Network

Arturo Azcorra, Ignacio Soto, Iván Vidal, Carlos García, and Francisco Valera (Universidad Carlos III de Madrid); Rafael Sánchez (Nortel Networks); and Angel Pérez (Telefónica de España)

Background

The Spanish authorities are fostering the development of high-speed regional research networks as a better way to guarantee that adequate infrastructures can be built at the regional level to access the Spanish and international research networks. In this context, the government of the region of Madrid imposed on itself the challenge of creating a high-speed regional research network to be one of the most advanced within Europe. It established a collaboration with Universidad Carlos III de Madrid in order to introduce the most advanced technology, yet find a cost-effective solution. This has led to the design and deployment of REDI Madrid, a regional research network for the research and education institutions of the region of Madrid that is under the supervision of a non-profit organization called Fundación Madrimasd para el Conocimiento.

In this article we share our experience in setting up the requirements and designing this advanced network.

DWDM allows sharing the expensive fiber optic infrastructure and provides a straightforward growth path. It also allows network self-restoration when ring fiber topologies are used.

Requirements

After a consensus process with different institutions, the design requirements for the new REDI Madrid network were listed as:

- High performance: Provision of a minimum access speed of 1 Gb/s.
- Reliability: Institutions are day after day more dependent on their data communications to be able to attend to their daily activities, so high reliability was considered crucial.
- Scalability in terms of capacity: Network technology is constantly evolving, and new and more bandwidth-demanding network-based applications are appearing. This means that to be able to keep pace with these developments, the network must provide easy ways to update capacities and access speeds.
- Scalability in terms of number of connected institutions: This would allow a phased network deployment, in which institutions could progressively join the network.

Regarding the institutions to be connected, it was decided to opt for a phased approach. Out of the 70 relevant research and education institutions in the region of Madrid, nine very relevant ones (in terms of size, bandwidth demands, and research results) were selected for the first phase, defining at the same time a roadmap to gradually incorporate the others. The institutions to be connected in the first phase were Consejo Superior de Investigaciones Científicas (CSIC), Instituto Nacional de Técnica Aeroespacial (INTA), plus the public universities located in Madrid: Universidad de Alcalá (UA), Universidad Autónoma de Madrid (UAM), Universidad Carlos III de Madrid (UC3M), Universidad Complutense de Madrid (UCM), Universidad Nacional de Educación a Distancia (UNED), Universidad Politécnica de Madrid (UPM), and Universidad Rey Juan Carlos (URJC).

Network Design

After studying the different available possibilities, dense wavelength-division multiplexing (DWDM) was chosen as the core transmission technology. DWDM allows sharing of the expensive fiber optic infrastructure and provides a straightforward growth path. It also allows network self-restoration when ring fiber topologies are used.

It was decided to use DWDM equipment selected from the Metro product family in order to reduce costs, taking into account the involved distances. Using long-haul DWDM equipment would have resulted in two disadvantages: first, equipment costs surpassing the savings derived from the shared optical fiber infrastructure; and second, lack of efficient multiservice capability support. However, it would have made the physical fiber design easier because of greater distances supported.

Commercial equipment from four different vendors was analyzed, resulting in the selection of the Nortel Networks Optera™ Metro 5200 family. The reasons for this are that Optera provides carrier class reliability, is well suited to the involved distances, provides enough capacity (up to 32 protected lambdas in one ring), and is designed for scalability (10 Gb/s in one carrier are already available, which gives 320 Gb/s over the ring).

Another design decision was to use a ring fiber topology with protected carriers to satisfy the high-reliability requirement. The initial topological design, based on direct distances, was to use a single dual-fiber ring to connect all the institutions. However, this had to be discarded when measuring the fiber distance over the actual physical paths of the telecom providers and the actual attenuation of the existing fibers. After considering several topologies, a topological design jointly performed with Telefónica (the chosen telecom provider) was selected. This design was composed of three dual-fiber rings that connected the CSIC premises with all the institutions in the network. This configuration has the added advan-

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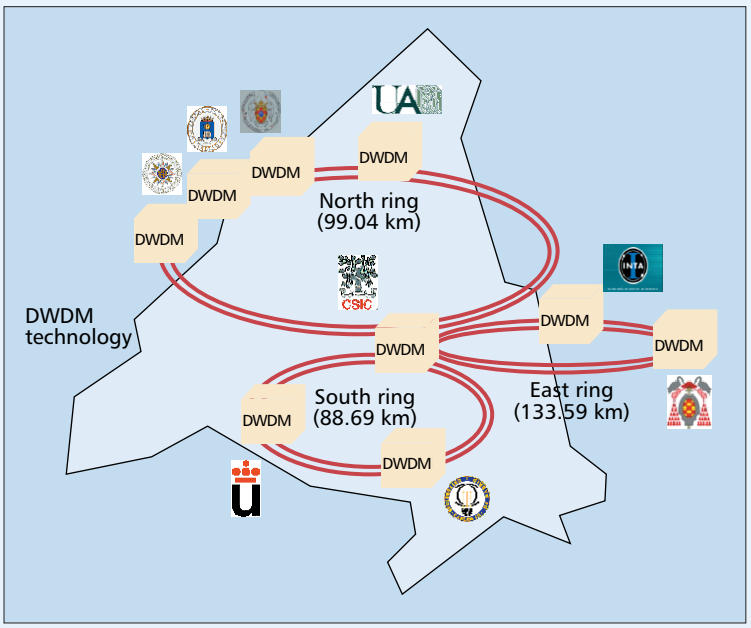

Figure 1. *Physical topology of REDI Madrid.*

Designing an Advanced Regional Research Network
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tages, over the single ring one, of allowing more growth capacity in each ring, and improving reliability because a failure in one ring does not affect the remaining ones. The physical topology of the network is presented in Figure 1.

The target topology of carriers over the rings was a logical star that supported, for each of the connected institutions, a protected optical carrier (lambda) to the central node (CSIC-CTI). It was then necessary to design, for each ring, the optimal way to provide these carriers. The carrier design implied reaching a compromise between optical amplification and electrical regeneration on one hand, and between initial investment in optical equipment and scalability in terms of carriers on the other.

New institutions may be connected to the network by incorporating additional DWDM shelves to the rings. This is not a trivial task; the fibers of the ring need to be re-routed to reach the newly connected institution.

Optera Metro DWDM equipment uses an optical filter to extract sets of four lambdas from the ring. The usage of the same set of lambdas for up to four institutions in the same ring allows costs savings in equipment (fewer optical filters), but implies that the carriers are optically extracted at each DWDM shelf in the ring. This implies that equipment failures, in addition to fiber cuts, would also interrupt the ring. Additionally, extracting the carriers implies that electrical regeneration must be performed. An alternative solution would have been to use lambdas from different sets, passive passing through intermediate DWDM shelves, and optical amplifiers to overcome the attenuation (chromatic dispersion limits the fiber distance, but this is not a problem in the considered scenario). The balance is therefore between the cost of additional optical filters and amplifiers minus the cost of the electrical regeneration equipment, vs. slightly better reliability and improved scalability (cheaper than adding a new DWDM site). The solution in this case was to place all the carriers in the same carrier set.

The carriers that connect each institution with CSIC-CTI are terminated by 1 Gb/s Ethernet interface cards, over which virtual LAN and IP services are provided. A high-performance switch/router is located at CSIC-CTI where all GbE interfaces are connected. This equipment also provides a redundant connection to RedIRIS (the Spanish research network) with a 2.5 Gb/s packet over synchronous optical network (POS) interface.

Network Evolution

New institutions may be connected to the network by incorporating additional DWDM shelves to the rings. This is not a trivial task, since the fibers of the ring need to be rerouted to reach the newly connected institution, and the whole ring is affected (attenuation, equalization). An alternative approach is to deploy a point-to-point fiber pair to one of the existing institutions and include a new carrier at the existing DWDM shelf. It is also possible to provide direct links between any two institutions, even if they are not in the same ring, simply by connecting the DWDM equipment in the central node, although an optical-to-electrical-to-optical conversion would be needed.

It is also possible to increase the capacity for each institution. Cards supporting one 10 Gb/s Ethernet or 10 1-Gb/s interfaces per lambda are already available, allowing a 10× bandwidth increase. Finally, new technologies and products that are appearing (e.g., allowing increased reach) will also contribute to optimizing the optical network.

Call for Submissions

IEEE Global Communications Newsletter (*GCN*) seeks original papers of general interest in the field of communications and related areas. Topics include, but are not limited to:

- National and regional developments in communications technologies, services, markets and standards
- Pilot experiences in communications
- Communications research and development
- Reports on national and international large-scale projects (e.g., NSF, EU IST)
- Telecommunications convergence, regulatory, and legal matters
- Information and knowledge society
- New applications of communications in politics, health, education, commerce, security and defense, surveillance, agriculture, standard of life, handicapped people care, industry, tourism, space, transportation and navigation, environment, sustained development, globalization, and so on
- Research trends
- Market trends
- Historical perspectives in communications
- Education in communications
- Reports on key workshops or conferences
- ComSoc chapter activities

Authors willing to present research results in communications are encouraged to avoid exhaustive or theoretical descriptions and focus on the general interest of their work. In that case, they should cite the sources (project URLs, journals, conference proceedings) where detailed descriptions can be found.

Authors willing to submit reports on workshops or conferences are especially encouraged to do so in case of IEEE-backed ones, although *GCN* is open to disseminate the conclusions of any event in the field of communications.

Please check previous issues in *IEEE Communications Magazine* or contact Joang.Haro@upct.es or javier@det.uvigo.es if there are any questions about the suitability of a paper.

Prospective authors should prepare their manuscripts preferably in plain ASCII or MS Word format, with a maximum length of 1200 words, and send them to either of the submission addresses below. MS Word files may have pictures and tables embedded (subtract 200 words per each figure or table). Alternatively, provide them as separate files using any standard coding. Only send screen dumps if strictly necessary, since they will be subjected to a minimum resolution of 300 dpi in the final version.

Submission addresses:

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DLT in Latin America
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lunch and some rest at the hotel, Jose David Cely, Treasurer of the Chapter, took me to Distrital University to visit the local Student Branch. I was impressed by the number of students who came to talk to me. After the visit, a group of students took Jose-David and me for dinner, and we continued to exchange our views on different topics. The group was so friendly!

My talk in Bogota was scheduled for Friday, 22 August, 9 a.m. at the University of San Buenaventura. When I arrived at the university, I saw a big line of people waiting to register for the lecture. Obviously, the lecture was strongly advertised. At 9 a.m., the amphitheater was completely full. I was told that the main amphitheater had a capacity of 160 seats only and that, since over 270 people registered, videoconferencing facilities were installed so that the remaining people could attend on a large screen in the amphitheater next door. I was honored when Mr. Frey Fernando Garzon, Rector of the university, welcomed me in both Spanish and French, and most of all, when they played the French national anthem, La Marseillaise, for me. This was the first time in my life that had been done!

In the afternoon, Jose David took me to the airport and we traveled together to Bucaramanga, where my next lecture was scheduled. During the flight from Bogota to Bucaramanga the sight from the airplane window was truly impressive; even more impressive was the landing at the 2000-m-high airport at the top of the mountains. When we arrived at the hotel, a group of students from the local Student Branch were waiting to take us for a short city tour and dinner. On this Friday evening the city was very lively, but still seemed very peaceful.

My lecture was scheduled for 9 a.m. on Saturday morning. The attendance was around 200, mostly students from local universities. This is a huge number for a mid-size provincial city like Bucaramanga. After my talk, I was interviewed by representatives of the local Student Branch. They asked me a long list of questions on my view of the future of telecommunications in Latin America, the possibilities of local research, and so on. I tried to advise them as much as I could.

In the afternoon, Jose David and I flew back to Bogota, and the next day (Sunday, 24 August) I left Bogota for Quito, the capital city of Ecuador. At the airport, I was welcomed (in perfect French) by Galo Gascante Lopez, the local Section Chair. Taking advantage of my visit, the chapter had organized a two-day seminar entitled "Broadband Access: State of the Art and Future Trends." My lectures were scheduled as the morning sessions of the seminar, which had some 50 attendees. The Monday afternoon session was a presentation entitled "Broadband Services" from the national operator Andinatel. The Tuesday afternoon session consisted of a presentation followed by a demo on ADSL technology from the local Alcatel organization. In this way, the seminar covered all broadband access technologies including wireless, hybrid fiber/coax cable, and ADSL. No translation into Spanish was provided for my two talks, but the afternoon sessions by local speakers were in Spanish. The audience was from industry, service providers, and universities. This seminar was a good example of how a local ComSoc chapter can combine a DLT with other presentations and organize a larger event.

Quito is almost on the equator. Galo took me to the monument erected on the equator at longitude 78° 27' 8" west, which is a major attraction for both visitors and locals. There, you can have your picture taken with one foot in the northern hemisphere and one in the southern hemisphere, which we both did. The next day we visited the historic part of Quito, where I admired the numerous churches and other colonial buildings. The old city is truly worth seeing, particularly after dark with its magic illuminations.

On Wednesday, 27 August, I had my flight from Quito to Panama City, the final stop of my DLT. At the airport, I was welcomed by Gustavo Giaz, Chair of the local ComSoc Section, and Eduardo Gonzalez, Treasurer. After checking in at the hotel, I was taken to the office of the local IEEE chapter, where the Chair, Tania Quiel, was waiting for us. After signing the Guest Book and having a few pictures taken in the office, we all went for dinner in a splendid seafood restaurant.

My lectures in Panama City were scheduled as late afternoon sessions from 6 to 9 p.m. (on Thursday and Friday, 28 and 29 August) so that people from academia and industry and other organizations could attend after their daily work. A professional interpreter was hired to provide simultaneous translation of my talks into Spanish. Attendance was quite modest (30–35 people), essentially because it was still the summer vacation period, but there was a lot of interest in the lectures, judging from the number of questions and the discussions after the talks.

During my stay in Panama, Gustavo took me on a tour along the Panama Canal and a city tour. At the canal, we visited the main operations center, where you can still see a lot of machinery from the 1930s. Panama City is an interesting city that gathers the characteristics of Latin America and U.S. cities.

Overall, this tour was very rewarding. On one hand, I was happy to serve the local chapters and help student branches in several countries of Latin America. On the other hand, I discovered new countries, met very friendly people, and enjoyed the Latin hospitality. With many of them, I will be keeping in contact, and we will surely meet again in the near future, be it in Latin America or here in Paris.

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