

Why National Lambda Rail is the Most Cost Effective Approach for the US Research and Education Community

CEO Tom West Explains the Advantages of Do-It-Yourself

Editor's Note: Tom West, CEO of NLR, has served as a small college president, a vice chancellor for administration for regional campuses in a public university system, and 26 years as the Chief Information Technology Officer (CITO) for two large public university systems—Indiana University (1973-1981) and the California State University (1981- 1999),

From March 1999 through June 2004 he served as the President and Chief Executive Officer for CENIC (Corporation for Education Network Initiatives in California). He served as CEO for both CENIC and NLR from September 2003 through June 2004 when he resigned from CENIC to devote all his time to NLR.

I interviewed Tom on February 3, 2007.

COOK Report: Please tell me about the formation of NLR and especially about how you arrived at the conclusion that you would “own” and operate your own infrastructure.

West: CENIC had been leasing OC48 SONET rings - one

in the SF Bay area and one that linked the LA basin and San Diego together. We decided to upgrade this capability in 2000 and we requested input. There were 16 different vendors who gave us proposals. One of the offers was a partnership suggestion from Velocita. It stimulated our notion that some degree of ownership of the asset would be very good.

Why Not Own and Operate Your Own Network?

Velocita's Bob Collet had made the partnership proposal. He understood research and education networking having been involved with Sprint in the international connections program with the NSFnet backbone in the 1991 to 1996 90s time frame. Bob came up with this very creative solution. Some other things were happening at the same time. Our colleagues in Indiana were building fiber between Bloomington, Indianapolis and West Lafayette – the two major universities. In Illinois they were doing it between the University of Illinois

and the NCSA and StarLight in Chicago. The notion of ownership of infrastructure was starting to take shape.

Meanwhile Ron Johnson, my colleague at the Pacific Northwest Gigapop at the University of Washington was on the CENIC Board. He and I agreed it would be very important to connect Seattle to San Diego. And, if at all possible, to go into Alaska because of the atmospheric and environmental research that was going on there.

We selected Velocita to partner with for CENIC's network upgrade but, before that could happen, their Vice President for Development, Victor Braud came to me and said they were not going to be in a position to develop the West coast as quickly as possible. I told them sorry but we can't wait to do business Velocita and by the way why don't you quit that firm and come to work for CENIC? As an aside, for the past four years CENIC has shared Victor with research and education groups across the country to acquire the fiber

and design the infrastructure to implement owned regional optical networks.

When Velocita fell by the way-side, I turned to Level 3 which had been our second choice. We were negotiating an arrangement with them for leased waves. In the midst of that our chief architect, Dave Reese said why don't we try to own the asset from here to San Diego like Indiana is doing from **West** Lafayette to Bloomington? And three weeks later we said: oh hell, let's do the whole statewide backbone as owned and managed infrastructure.

COOK Report: And what did that involve?

West: We basically negotiated with Level 3 for a price for a twenty year IRU for 1200 route miles within California. CENIC then took proposals from three vendors for the optics. Cisco came out on top.

At the same time Ron Johnson and I were still working on going from Seattle to San Diego. We believed that if we were going to do Seattle to San Diego we needed a redundant path. Therefore we called our friends at NCAR and Los Alamos to see if we could intrigue them into joining a partnership to go from Seattle to Denver and down to New Mexico and back to San

Diego. While NCAR expressed interest, Los Alamos did not feel it could join us in a timely fashion.

Ironically while Ron and I were cooking on getting from Seattle to San Diego, Javad Boroumand and Bob Aiken, from Cisco Systems, were developing a case for mounting a major initiative to develop a fiber-optics based testbed for network research. Cisco had been having conversations with an outfit called Celion. They were an optics firm that had very impressive extra long haul optonics capabilities. However early in 2002 and we were not thinking about a national infrastructure but a regional one.

Ron and I sat down with Celion and Cisco and listened to their separate proposals. When they finished we said: we can't do that. First of all it is too much money and secondly we came here expecting that Cisco would announce either that they had acquired Celion or that they had a strategic partnership with Celion. We stood up packed our briefcases when Cisco said: wait a minute give us a week to see what we can do and then let's talk again. I will tell you: Cisco was very interested in moving the network research agenda of this country.

COOK Report: You were of-

fering then a really good network research testbed?

West: That is correct. Boroumand and Aiken were very instrumental within Cisco securing a corporate commitment to leading a network research agenda that used to be carried out by NSF and would be very important to the future of this country.

Consequently, Cisco then came back and offered us their optics and a strategic relationship to which we replied by asking: "How far East can we go with the money we have?" They came back and said we can get you to Chicago. Oh and by the way, we – Cisco - have given a grant to the Pittsburgh Super-computer Center to get to Chicago, if Pittsburgh can join your initiative then we can get you to Pittsburgh

COOK Report: Did you say "How about New York City?"

West: No. By this time other people from our community were hearing us and people from Duke and Virginia Tech, Georgia Tech and Florida said: "well how about us?"

The idea that we had about owning and managing your fiber assets began to spread. Internet2 also joined in on the activity and by January 2003 we formed NLR llc – a limited liability company. However

the vast majority of the potential participants were very reluctant to become a part of a limited liability company because of the tax implications. Therefore by May of 2003 we formed as a 501c3 Inc. We had eight founding members—CENIC, PNWGP, Virginia Tech, Duke, Georgia Tech, Florida LambdaRail, CIC and Internet2 and a 9th, the Pittsburgh Supercomputer Center that could not join initially but was ready to contract for wavelengths between Pittsburgh and Chicago for the Teragrid.

Meanwhile in December 2002 while I was still president of CENIC, CENIC bought 5000 miles of fiber as an IRU from Level 3. The fiber ran from Sunnyvale California up to Seattle and down and across to Washington DC. CENIC did this without any national organization behind us. We believed in the potential.

COOK Report: Are you at liberty to give some idea of what this cost?

West. Not really. You can characterize it by saying we caught the market at the bottom of the barrel. You cannot buy fiber today for the price CENIC paid for what has become NLR's footprint and, in fact, we paid more for CENIC's fiber in April 2002 than we did for the much longer

NLR route that December. I have to say that during that period we were offered a number of fully equipped network infrastructures for purchase except that they were so debt laden that it was better to build our own.

By early July of 2003 we had consummated our agreement with Cisco in terms of their becoming a Strategic Participant in our efforts. NLR embraced Cisco's network research agenda as a central part of our mission and Cisco provide a price point to buy the optics, routers and switches that we needed. While building our network infrastructure we leased waves for Pittsburgh to get to Chicago starting July 1, 2003 and in August we began to implement the rest of the network. We were in business delivering services two months after we formed.

Over the ensuing year between July 2003 and 2004 another group of folks along the southern region and across New York – Louisiana, Texas, Oklahoma, Front Range Gigapop, New Mexico and Cornell – all signed up. Pittsburgh Supercomputing Center converted to a member. We now had 15 members giving us the resources necessary to build out the full national footprint. This is how it "came to be."

Early Operations and Services

COOK Report: What was the role of Internet2 in all this?

West: Internet was founding member. Every founding membership committed to invest five million dollars over five years. Internet2 committed \$10 million.. We had 50 million dollars committed before we launched phase one and 80 million with the launch of phase 2. We had the money to implement and operate this national infrastructure for five years. We had that in written membership agreements from 15 members;..

COOK Report: A membership was like a share in some sense?

West: With a 501c3 while you can't actually call it that, in a real sense these entities were equity members. Each membership entitled the holder to name a person to the board of directors, and then we named two additional researchers to the board to represent the research community.

COOK Report: You have a huge commitment to Ethernet that makes sense. What led to that?

West: We made a couple of major commitments. First of all we committed to 10 Gig E LANPHY. At that time the

common architecture was WANPHY. Also if someone desired the transponder cards to be turned up as OC192s we could do that. But we don't push that. In 2002 we were pushing the envelop with 10Ge LANPHY.

We also said that we wanted to have a Gig-E switched network. At this time most people saw Gig-E as a LAN technology. We now have 18 switches across the country providing Gig-E frames or less or more all the way up to 10 gig depending on what our customers want.

COOK Report: Does this allow what Bill St Arnaud would call user controlled light paths?

West: It is close to that. I think Bill is talking about provisioning lambdas. We have three different offerings. One we call Packet Net. This is a routed IP production network. Using the CRS-1 router we all provide a second routed IP network which is for experimental uses. We have a FrameNet that is the Gig E switched network. I think FrameNet is one of our sleeping assets. We can set up point-to-point FrameNet lengths and then tear them down when the member no longer needs the traffic. This can be after a month or a year for that matter. You can have point to point or point to multipoint. Then we

have WaveNet where people can have 10 Gig dedicated waves between locations. "Big" science applications are increasing in need of this capability.

COOK Report: Can you go with a lightwave directly from a research department of a university directly into a research department at another university by passing the rest of the campus infrastructure?

West: Yes. But it means interconnecting the campus infrastructure with a regional optical network that is connected into NLR. This is taking a mind shift. You have to remember we have spent the last decade trying to get everything integrated and consolidated into one campus network so that it could be easily managed. Now network people have to understand that they are network infrastructure managers rather than network managers. Now we are asking them to manage multiple networks on their campus network infrastructure.

This mind shift and the fact we are implementing a vertically integrated owned and managed infrastructure at the campus, regional optical network and NLR level mean that we are making good progress, but we are not there yet.

COOK Report: Does the ease

of configuration of Calient switches help what you are doing?

West: Potentially yes. We are in the early stages of working with four such switches – linking them together to better understand their optical switching capabilities. At the moment this is not one of our mainline core services that we are offering generally. Provisioning dedicated lambdas and gig E switched channels are our bread and butter offerings for now.

The Cost of a Wavelength

Depending on your optical equipment, you can have 30 to more than 80 on a single fiber strand. Our systems enable 32 10 Gig paths on our backbone in any segment. On the northern segment we can do 40 there. We use Cisco's 14454s. Downstream that capacity could be upgraded or replaced in favor of any higher capacity. While in some respects bandwidth limitations may be subject to some technological limits. Downstream it may simply be money.

COOK Report: You could increase you capacity dramatically by purchasing new optics, something which itself is not cheap?

West: Yes. Initially we capacity for 32 10G waves across the footprint but only implement enough transponders to light four waves. We have considerably more installed and operational now because people have come along and said we want this capacity and we are willing to pay for it.

For every wave you want to light, you need to put transponders in the network. Lets say you want a wave from Chicago to Denver. You start by putting in a transponder in Chicago facing Kansas city. In Kansas city you put in a transponder facing Chicago and a second one facing Denver. In Denver you put one in facing Kansas City. In essence to traverse two network segments you need four transponders.

If someone says they want a wave from Jacksonville to New York City and they are willing to pay the marginal cost, we put a transponder in at Jacksonville, two in Atlanta, two in Raleigh, two in DC and one in New York. We could also bypass Raleigh if the purchaser wished because of the way we have the network designed.

We have 30 segments in the entire national footprint. If you count Ogden to Salt Lake and Chicago to Starlight, those bring the total to 32. If you

wanted a total national footprint, you'd have to buy 60 transponder cards. It would cost an NLR member 800,000 per year for that 10 gig wave. The cost for a ten gig wave from Jacksonville to New York would be 100,000 a year.

COOK Report: Very impressive.

West: For what you get it is cheap and it will be come less expensive in the future.

COOK Report: If you set up a national footprint for the Commons what might it cost?

West: With emphasis on "might" somewhere close to a million dollars per year. This is just for the backbone. If we get to Cleveland, it doesn't take it to the router of the local community network. The transponders can last up to ten years. There are additional operational and maintenance costs. These costs include the installation, maintenance and support of the network operations center, and an amortization cost. This is the model that would be followed.

COOK Report: How does running your own network differ by way of cost and flexibility from that of buying the network as a Managed Service?

West: Let me answer this by

way of example. Tom de Fanti and Larry Smarr have a lambda that runs from San Diego to Chicago. I don't put any restrictions on how they use it. In a managed service this would not be the case.

COOK Report: Why?

West: I would say it is the need on the part of the commercial provider to run their infrastructure in the way in which they are accustomed. They have a return on investment they have to make and a customer base to satisfy and they can't operate as cost efficiently as we can. If NLR provisions a wave, we can do that for considerably less than a managed service provider could. Close to half their price.

COOK Report: What makes this so dramatic? Is it the cost efficient flexibility that you gain from configuring your own infrastructure?

West: I think so.

COOK Report: Given the propensity of the carriers for non disclosure of their costs, (especially the 3 incumbent local carriers) its really just about impossible for the rest of us to know what their costs really are.

West: I have no evidence other than what they quote me

and when they quote a price, I say: “oh my lord that is too high!”

COOK Report: And having run these kind of services yourself at CENIC and now at NLR you know what you can get out of your own equipment and what they cost you to provide. Therefore you have very good grounds for comparison?

West: Right.

Economics, Organization and the Regional Optical Networks

COOK Report: Please say more about your organizing structure. It seems you have a small number of direct members encompassing many institutions?

West: We have 14 members and about 190 institutions behind these 14 members. There are about 20 regional or state optical networks that are connected to us. A “RON” or Regional Optical Network could in fact be a state network. A regional optical network goes beyond state boundaries. For example CENIC is a regional now because it includes both Nevada and Arizona. OneNet includes only Oklahoma – except – guess what Arkansas is now tying into them. While Arkansas has its own network

these two nets are coming together to interconnect with each other. A RON therefore can be limited to a single state, but it can also be multi-state in its coverage.

COOK Report: Is NyserNet part of Lambda rail or Internet 2?

West: NyserNet is a state based regional optical network. They are connected to Internet2 but they are also a member of the Cornell Group that is a member of NLR. NLR actually has collocation space in the NyserNet facility in downtown New York. NLR leases space from NyserNet. Our equipment sits in the same room.

COOK Report: Ohio Academic and Research network? (OARNet)? And CICNet?

West: OARNet is not linked to us - yet. There is not CICNet, however, CIC representing the Big Ten universities is a member . . . Instead many of the institutions are part of a RON--OARNET covers Ohio, MERIT in Michigan, I-light in Indiana, I-wire in Illinois, Wisconsin Minnesota and Iowa have just gone together with the BOREAS network that goes from Chicago to Madison to Minneapolis to Des Moines to Kansas city and back to Chicago. Lots of dynamics are happening in the development

of these Regional Optical Networks (RONs).

New Mexico Lambda Rail has just come into being. In many ways NLR stimulated the development of a number of RONs. Florida –LEARN, LONI, NMLR and to some extent Arkansas and the University of Alabama system – all of those are fiber networks owned either by state educational institutions or 501(c3)s.

COOK Report: Let me make a hypothesis. Would it be correct to say that given a growing demand for more bandwidth that, the way you are doing it, is the cost effective answer. Furthermore, given tight budgets and growing demand, a Managed Service is simply not cost effective. Therefore the growth in state fiber shows that you have really the only cost effective answers.

West: Let me put it this way – I don’t think every institution feels it has a need for advanced networking. I simply don’t think that all university presidents sit around saying that owning it delivers more cost effective service than managed services. I do believe that demonstrating that value is incumbent on key researchers and CIOs.

In the short term in some instances owning and operating

your own infrastructure may not be cost effective because in many respects it is a capital-intensive move.

COOK Report: It's like buying a house as opposed to renting?

West: That is a perfect analogy. One of my arguments that differentiates us what others have done is that this is a decision to own. Owning means that you have a capital investment. You may have a down payment but you have a higher degree of flexibility as to what color you are going to paint the rooms -- to use the home ownership analogy.

COOK Report: The point is not just we need more bandwidth but that we need more bandwidth for the long term? We are going to be doing this year after year?

West: It is a boundary-spanning question. For example a company that has distribution needs must make a decision: do I own my own fleet of trucks or do I buy that service? A decision maker must ask him or herself: is this something that is absolutely strategic to our mission? And if it is - having ownership and control of it is extremely important.

If it is not, then I am willing to pay a rental fee that may be

higher than the annualized cost of ownership. If you go back over 30 years of renting you may find that you paid more than you would had you purchased and operated the infrastructure directly. You didn't buy however because you could never quite manage to make the strategic decision that you should invest.

Transit Rail

COOK Report. That makes sense. Would you tell me about Transit Rail? How did that begin and evolve.

West: Transit Rail is a good example of how we operate. NLR is not managing and operating Transit Rail. Two of our members: CENIC and the NorthWest Gigapop came up with the idea and said this is something that we think is critically important to the members and since we have a history of cooperation between Seattle and LA where we have created what is called Pacific Wave so that we can transit traffic between the two in such a way that it doesn't matter whether another network (international in many instances) lands at Seattle we can get it to Los Angeles and vice versa. Pacific Wave has established peering relationships with a number of other networks around the globe. They believe that making these peer-

ing relationships will be of extreme value to other NLR member networks and other regional optical networks.

They said to me what we would like to do is to set up a national transit program running on a dedicated wave separate and apart from NLR's PacketNet production network. We will take on the burden of installing co-location facilities in major peering points in Los Angeles, Sunnyvale, Washington DC. And by the way we'd like NLR to help us by providing certain resources to us in this start-up phase.

Consequently, while we are not a partner, we have contributed the use of a wave, some routers and things of this nature that will benefit all of our members. But they are going to manage it and run it as a separate capability.

COOK Report: Who will their customers be?

West: They will be our members and other regional networks who, if they can handle a sizable proportion of their traffic through peering relationships as opposed to doing it through the commodity internet, will benefit from significant cost savings.

COOK Report: How does this work? Say for Duke Univer-

sity which is a member.

West: If Duke has commodity internet traffic as opposed to lightwaves to their institutions and they can route it to the rest of the internet they will save by being able to peer with other members and they may have to pay x dollars for the traffic for which they buy transit. If they bought transit locally on the commercial market it might cost them two or three times “x” dollars that they would have to pay a local commercial ISP.

COOK Report: I think this strategy is critical to what the Commons wishes to accomplish.

West: It is a central concept. Correct.

Rural Health Care

COOK Report: Can you say a bit about the Rural Health Care initiative?

West: Our view is that the most important work that needs to be done as part of the FCC RHCP is building out on a regional perspective. It has less to do with the NLR backbone than it does with health facilities getting connectivity with specific state networks whether it be New Mexico, Florida, Oklahoma, California and so on. The regional opti-

cal networks that are connected to us are the ones that are going to have to work with the medical and health field to see how their infrastructures can service this need. For example CENIC has CalRen that goes into all of the 58 counties in California. CalRen is a natural infrastructure to work on in extending tele-health services to the folks in more rural areas of that state.

COOK Report: And the FCC said it is OK if those entities extending services under the tele-health program run that traffic either over Internet2 or your backbone. Correct.

West: Correct. As of a few days ago FCC agreed that winning groups could connect to either to NLR or Internet2 and the two would peer. The FCC was extremely responsive to our request to participate.

I want to emphasize the extremely hard work needs to be done locally to make this program successful. NLR stands ready to help them make that happen. We also stand ready to work with Internet2 to provide as transparent, and economical backbone capabilities to the user as possible. We want to make things simple and useful rather than complicated.

COOK Report: If I remember

correctly the FCC has announced that it will pay up to 85% of the costs of connecting a qualifying institution to the infrastructure?

West: Correct. The real gain here is at the regional level. What we are saying in essence is that it is an opportunity for these health institutions and our regionals to work together and build out the state infrastructure. We would expect that the health facilities to affiliate with our members.

Why the NLR - Internet 2 Merger Talks Are on Again - Stakes Are Extremely High

Gordon Cook: On March 10 an event the outcome of which will be critical for the future of the Internet in the United States occurred. [Tracy Futhey, Chair National LambdaRail](#) and [Jeffrey Lehman, Chair Internet2](#) issued a joint letter that began:

Dear Colleagues,

Over the past four weeks, we have conducted private conversations aimed at finding whether circumstances have changed sufficiently over the past year that our organizations might consummate a merger.

This week, we reached agreement on a process and a plan to bring the two organizations together, which we both support, fully and wholeheartedly. To be sure, it involves compromises on each side. But in the end, we believe that it provides the framework for an organization which will provide a significantly improved environment for stakeholders in Internet2 and NLR.

We are pleased to announce that the Boards of both Internet2 and National

LambdaRail have yesterday endorsed and agreed to a Memorandum of Agreement that outlines how we will pursue this plan.” [snip]

[Giga Om](#) and [DSL Reports](#) published congratulatory notices over the weekend. While I respect these two sources immensely in this case they essentially passed on a press release without knowledge of the background.

In fact merger talks between the two organizations began in the late summer of 2005 and lasted until the early summer of 2006. In the [NLR Annual Report for 2006](#) we read:

“One 2006 setback should be noted: From August 2005 to June 2006, NLR expended significant energy, time, and financial resources in merger discussions with Internet2 (an NLR founding equity member), until the Internet2 Board chair called off negotiations. In October 2006 NLR and Internet2 signed a Cessation Agreement severing Internet2’s membership responsibilities in NLR.”

I have a lot of contacts in the global education and research networking community. Consequently I was informed of the merger proposal in July 2005. Conversations with a number of folks gave me the picture that Doug van Houweling wanted to swallow up NLR and meld its vital approach of managing its own fiber into the I2 approach of letting someone else do it. Doug is a strong willed character with whom I had my first contact back at OTA in December 1990. The Internet2 that he went on to play a significant role in founding was - it seemed to me much more about giving universities access to high bandwidth *applications* at affordable prices than fundamental network research. The research leaders were Surfnet in Holland and Canarie in Canada. I have written extensively about both and have had no contact with Doug for at least a decade.

I have watched NLR with considerable interest over the last few years. Here at long last in the USA some researchers were taking the really cost effective approach

of owning their own fiber. Hooray! And about time. then in November 2006 I discovered [the Commons project](#). Last month I was able to interview the principals, including Tom West who has agreed to provide the platform for what is in my opinion the single most important effort underway to ensure the survival of the Internet in the USA as something other than a platform for the delivery of TV. I asked Tom to explain to me how he came to understand that rolling your own fiber was the way to the future. His response was quite fascinating.

Let me be very blunt. I am very strongly biased on behalf of NLR. The plunge in cost of opto - electronics needed to light the fiber on a per-gigabit basis since 2000 is stunning, and the capacity running in production with Infinera gear capable of running upwards of 100 wavelengths on a single strand, and in the labs at upwards of 1000 Gbps, is essentially infinite. The cost of the fiber itself has appeared to have finally bottomed. For what it delivers, it is still cheap. To my knowledge NLR's national footprint of Level 3 fiber owned by NLR with a 20 year IRU is the only one of only a few fiber of such arrange-

ments that could more or less be considered more or less "public" hands. Given the duopolization of broadband in the US, it is critical that both Level 3's and NLR's fiber survive.

But the question still lingers: "how could what was "off" suddenly be on again?" I think I have a sound hypothesis. Both Doug and Tom are **strong willed** men. Both insisted on controlling any merged entity. The consensus of a range of people with whom I talked and none of whom would be quoted on record was that Doug van Houweling of Internet2 was determined to run the merged organization. Indeed on one Internet2 web page that I found he was listed as CEO of the to be merged organization and Tom West as Deputy CEO. While I have not been as thorough in talking to the Internet2 side, I am convinced that the consensus there would be that Tom West was determined to run the combined organization - no matter what.

A Coup d'Etat?

What happened was - I surmise - a coup d'etat. The announcement was executed by the Board chairs of the two organizations. It contained neither the name of Tom

West nor Doug van Houweling.

Fridays announcement said that a new CEO for the combined organization would be recruited:

- *Internet2 membership categories will be carried forward into Internet2-NLR. In addition, a new membership category, called "Investors," will be created for the current NLR members.*
- *During the next two years, while a transition plan is developed for the Board election element of the GNC report, Internet2-NLR will be governed by a Board that consists of a 21-member group of individuals. This group includes members from each current board, together with other members of our community. Advisory councils of the new organization will include the broad-based constituencies recommended by the GNC, with the addition of Investor representation.*
- *In June 2009, the governance structure of Internet2-NLR will follow the GNC's approach to multi-stakeholder participation.*
- *A new CEO will be recruited to lead Internet2-NLR.*