

White Paper:
How to Attain Regional Critical Mass on the Internet
By Jere Retzer, NWAX Executive Director

The Internet is Critical to Oregon's Future

Most people agree that the Internet is critical to the future economic health of Northwest communities. This makes intuitive sense, based upon history because in the past as a new dominant technology emerged and matured it always brought tremendous economic benefits. This happened, for example with steam engines, railroads, steel, telephones, factory assembly lines, automobiles, airplanes, television and recently the personal computer.

We've seen some of the tremendous transformation of everyday life that the Internet may bring. I believe that we're still early in this process and that there are many profound changes ahead that can boost productivity and improve the quality of life for people everywhere. We're only now starting to see the adoption of Internet technology for critical applications like health care, for example and teleworking¹ is still in a relatively early stage of development. These two applications in particular hold significant promise for mostly rural states like Oregon.

The Internet however is important not only for the applications it enables but also because it is a critical new infrastructure for the future, much as railroads and highways were critical infrastructure in the past. In the future, those communities that are well connected may attract opportunities that would otherwise go somewhere else. Rural Oregon has recognized the value of high-speed telecommunications access for some time, with improving rural access the goal of annual conferences and legislative initiatives.

As critical as the Internet is for rural areas, it is equally or more important for Oregon cities because cities tend to be the telecommunications hubs, just as they tend to be transportation hubs because they generate most of the demand. Therefore, if the cities are poorly served, service in rural areas will likely be worse.

Location Matters.

Not all places on the Internet are created equal. Service in rural areas is significantly more expensive than urban areas. In addition, service in Portland is significantly more expensive than service in Seattle or large California cities. Service quality and availability differ greatly from city to city. This is due mainly to the nature and history of the Internet, as well as the volume of demand expected in each location.

Although the Internet began as a government and education sponsored-network, it now consists of many interconnected parallel networks. The largest Internet networks are

¹ Telework is a recently adopted word for working from a remote location using telecommunications; often called telecommuting.

commonly called the “tier one” networks. These worldwide networks connect to exchange traffic (“peer²”) at major Internet exchange points. The tier one networks people typically list vary from six to around 30 and include MCI (formerly Worldcom), Level3, Qwest, AT&T, Sprint and XO. The Internet is the sum of all the connecting networks so your ISP has to connect in some fashion to all the other ISPs in the world to give you complete access. One generally accepted definition for tier one networks is the networks that, connected together provide access to the entire Internet. The tier one networks generally peer with one another for free and the other networks buy service (“transit³”) from them. The other networks also peer with one another to improve their quality of service and reduce their cost for transit – more on this later.

There are two common misconceptions that are important to this paper: (1) that there exists an Internet “backbone” network to which you can connect directly and that (2) location does not matter on the Internet. The Internet “backbone” in reality consists of those Internet exchange points that bring together all or most of the tier one networks. There are currently 30 to 50 of these major exchange points worldwide. These are the only locations on the Internet where you get a fairly direct path to any other location on the Internet. If you try to connect from anyplace else, even if your destination is physically next door your data will probably travel across several states and possibly several interconnection points in various cities before arriving at its destination unless you and your destination happen to have the same Internet Service Provider (ISP).

Location not only matters on the Internet, it is becoming more important all the time. The Internet evolved as a way to connect local networks without leasing a circuit between every possible pair. Each network connected to the Internet has one or more boxes that serve as “routers” that know where to find other routers on the Internet. The routers examine all the messages (“packets”) that go through and decide the best “route” to send them to their destination. This happens very fast, especially with the best modern equipment but it still takes time and each step (“hop”) along the way introduces a small but real possibility of losing or garbling a packet, which then may require retransmission.

The delays and errors introduced by long distances and lots of router hops were not important in the early days of the Internet when the main applications were e-mail and news groups. It was fine for delivery to take hours. Some ISPs only connected to the Internet a few times a day to exchange traffic.

Today, however people increasingly want to use the Internet for “real time” “interactive” applications such as videoconferences that are sensitive to delays, lost or garbled data, and also sensitive to variable time delays, called “jitter.” These applications typically do not perform well over long distances with lots of router hops. People begin to find latency

² Peering is a business and technical arrangement, usually bilateral where two networks agree to accept traffic from one another, and from one another’s customers. This typically includes their customers’ customers. Networks sometimes peer just a portion of their customers, for example those in a particular geographic area. Peering does not include the obligation to carry traffic to other third parties.

³ Transit is a bilateral business and technical arrangement, where the transit provider agrees to carry traffic to third parties on behalf of the customer, most commonly its other customers and the entire Internet.

(delays) on a video or phone conversation annoying when it exceeds about 150 milliseconds (1000 milliseconds (msec) = 1 second). They tolerate this for occasional but not regular use if there are other alternatives. Some current videoconference systems also begin to degrade with as little as one half of one per cent packet loss.

Put into perspective, a thousand miles at light speed takes about five msec. Each router hop adds from less than five to 30 msec. It is not uncommon for a “local” connection across a city the size of Portland to travel 3000 miles and 30 router hops because of the need to connect between networks. If all goes well then even videoconferences may be ok, but unusable if there is any congestion. We have seen cross-town connections with 300 msec round trips and 30% dropped packets.

Some major ISPs “guarantee” the latency and packet loss for their services. There are a few things to be aware about this however. Here is an example: we guarantee “a network-wide monthly average delay of 60 milliseconds and a network-wide average packet loss of less than 0.7%. If we miss our performance targets, you'll receive a one-day credit to your monthly connection charge.”

First, you should be aware that Internet performance guarantees are generally stated as a monthly average. If you have an important videoconference with your boss, client or an expensive cancer specialist who your physician has referred you to, the last thing you want is for the network to experience a bad half hour during your scheduled call, even if the “average” monthly performance stays in limits. Second, in this case even average packet loss may cause marginal videoconference performance on some systems.

Third, perhaps most importantly the guarantee only applies if connecting to a network served by the same ISP. No Internet provider currently guarantees performance for connections between multiple ISPs. Since the majority of Internet connections involve multiple ISPs, this guarantee is not worth much. There are two typical strategies to deal with this situation: (1) buy much faster service than you need in order to minimize congestion; and (2) connect to multiple ISPs and let your router find the best path. More about these later. Finally, recent independent tests question whether any of the major networks actually meet their latency guarantee.

The critical things to remember are that (1) people want to use the Internet for increasingly sensitive and critical applications and that (2) the alternatives to the Internet are usually expensive leased (dedicated) point-to-point circuits or forgoing the application. The migration of mission-critical applications to the Internet is one of the most important Internet trends today and essential for companies and communities that want to compete in the future.

Location matters because being far from a major exchange makes it less likely that sensitive applications will work well; performance is worse and costs are higher. The result of this is that network-intensive uses are disadvantaged compared to regions with better connectivity and so business opportunities that need the best possible performance at the lowest cost migrate to cities that have access to major Internet exchanges.

While the recent history of Internet business is hopefully atypical, we have seen Internet hosting centers, corporate web sites and e-business for example migrate from Oregon to cities with major exchanges. We've also seen at least one example of new Internet product development units started in Portland moving to locations with better access.

Perhaps even more important, however is that the additional cost of access and inability to use applications that need high quality increase the cost of doing business and reduce opportunity. Given the continued migration of critical business applications to the Internet, the comparative disadvantage of this region compared to cities that have major exchanges may worsen unless we take action.

NWAX for Regional Critical Mass.

Oregon has so far failed to achieve critical mass as great place to do business on the Internet because we are isolated from major exchange points. The Northwest Access Exchange (NWAX), <http://www.nwax.net> recently adopted attaining regional critical mass on the Internet as one of our primary goals over the next few years. The following paragraphs describe how we think NWAX can help this happen.

Given Oregon's proximity to Seattle and California, as the Internet evolved the major ISPs installed minimal local equipment and backhauled local traffic to their aggregation point in some other city (commonly the Puget Sound, Sacramento and San Francisco Bay areas) and from there to major Internet exchanges. This brought about the scenario described on the NWAX web site where a connection from OHSU to Portland Community College took 29 router hops and 300 msec via Sacramento, San Jose, San Francisco and Everett, Washington to travel five miles.

NWAX is currently a regional Internet exchange. This paper has so far discussed major Internet exchanges. Internet exchanges come in several forms from small local to major exchanges with a variety of business models, as discussed in a separate white paper on the NWAX web site. There are currently over 300 Internet exchanges worldwide. Small local exchanges generally provide a place for local ISPs to peer with one another to save on upstream transit, while major exchanges connect the tier one networks and others. Regional exchanges fall in between.

Oregon Health & Science University (OHSU), <http://www.ohsu.edu> and Portland State University (PSU), <http://www.pdx.edu> started NWAX to improve access for our universities and to enable us to provide education and healthcare services, and engage in research partnerships throughout the region without buying a lot of expensive leased circuits. We currently use virtual connections across the exchange for videoconferences and to save on Internet transit.

NWAX currently has several commercial ISP, content providers, and government and education members. The exchange has been operational for 18 months and has provided nearly perfect reliability. As of June 2003, availability (as defined on the NWAX web

site) for members connected to both switches was 1.0 and singly connected member enjoyed availability in excess of .9995. We recently expanded our services to include transit provided by current and prospective members and private network connections across the exchange.

The NWAX plan to attain critical mass is to expand membership and traffic across the exchange. As of Spring 2003, traffic across the exchange regularly exceeded 150 Million Bits Per Second. This could increase several times given current plans to expand the exchange to major transit customers including healthcare providers, high tech and tier one networks. As the tier one networks connect to the exchange, it will in turn become more attractive to large Internet customers and this will bring in more ISP. Once this “virtuous cycle” of growth leading to more growth has momentum it should only be a matter of time before the tier one networks begin exchanging traffic with one another locally. When this happens, the region will have attained critical mass.

Major transit customers will join the exchange in order to reduce the cost of leased circuits and transit, improve service quality and connect to regional partners. Currently, many major transit customers buy service from two or more ISPs for better reliability and performance. In order to do this, they lease high-speed circuits to each ISP. If they need to connect satellite facilities, suppliers or business partners, or teleworkers, or buy network services such as off-site storage and disaster recovery, network operations or security these commonly require additional circuits. This is very expensive.

Large Internet customers can save money and improve performance several ways by joining NWAX. First, since NWAX will connect to multiple tier one as well as regional networks, customers will be able to easily select the best combination of services, a strategy suggested earlier. Using this method, the customer’s equipment can select the best provider to improve performance.

Second, a significant proportion of local customer traffic is destined for local partners, employees and customers. If these destinations are connected to the exchange either directly or through a member, then the customer can also improve performance and save money by peering this traffic directly across the exchange, rather than send via the Internet. This can be especially attractive for local content and service providers including television and radio station web sites, network operations, storage, disaster recovery and security services. Many local companies also have employees or contractors who regularly work from home. If these teleworkers use ISP peered to the company via the exchange, they can potentially get higher quality connections to the company and use videoconferences to reduce time and money for travel and face-to-face meetings.

Third, buying transit from providers in a high volume exchange allows customers to get the best possible deal because they are buying in a highly competitive market and can potentially change suppliers easily and quickly. This could be very important should the Internet undergo another turbulent business environment like the past three years. Finally, since the exchange is located in large neutral data centers, the customer can use the same high-speed circuits to connect to multiple services either in the connected data centers or

connect to the exchange. This approach, along with peering can save substantially on leased dedicated circuits.

Tier one, regional and local service providers also benefit from joining the exchange. Tier one and other service providers that sell services via the exchange can access many customers with a single set of circuits and equipment. This can be far more cost effective than provisioning separate ports for each. It can also increase total sales volume and cut time to market. Traffic volumes are key to attaining critical mass because commercial network operators compare potential sales to cost in determining where to invest. The exchange creates a high volume, low cost connection point with the sales potential to attract service provider facility investment.

Creating a Regional Network Infrastructure.

High quality network access will be critical infrastructure in the future just as highways, electric power, airports and shipping are critical infrastructure today. Despite extensive high tech industry and a highly sophisticated population, Oregon has not benefited as much as it should from the Internet. National surveys consistently find that Oregon has a leading percentage of homes with Internet connections and recently a leading number of wireless hot spots. We also lead the nation in number of teleworkers according to the state energy department.

Despite these obvious advantages, customers in Oregon are currently disadvantaged because local services are provided remotely from service points outside the state. NWAX plans to reverse this situation by providing a highly reliable, high volume connection point that will enable the state to attain critical mass on the Internet so that network access in Oregon is among the best in the nation.

State and local governments can help NWAX reach this goal through policies and strategic infrastructure investments to encourage customers (including government) as well as service providers connect to the exchange. Infrastructure investments can include subsidies to reduce the cost of infrastructure such as fiber optic cables to connect customers and service providers to the exchange and to expand the exchange to additional locations. No such subsidies or policies currently exist.

NWAX is a public-private partnership to enable creation of a next-generation network infrastructure for Oregon. NWAX does not compete with any existing or proposed commercial service. It is not a telecommunications provider or an ISP. Rather it is simply a hub designed to connect service providers and customers of all kinds together to lower costs, improve access and provide the network infrastructure Oregon needs.