

THE EARTH PROJECT: A TELECOMMUNICATIONS CASE STUDY

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ABSTRACT

This is a case study for use in an undergraduate course on telecommunications. The case deals with the analysis and design of a network infrastructure for an Indian reservation in consisting of three bands of Chippewa Indians in Northern Minnesota. The case provides students with the opportunity to grapple with the issues in developing a complex network in a well defined setting.

OVERVIEW

The “Educational Advancement on Reservations using Technology and Hearth” (EARTH) Project is a joint effort of the White Earth, Red Lake, and Leech Lake bands of Chippewa Indians to develop a telecommunications infrastructure that will further educational opportunities on Indian Reservations in Northern Minnesota. The three goals of EARTH are as follows:

1. “To provide a technologically advanced telecommunications infrastructure ... for reservation schools, tribal offices, homes, and regional colleges and universities.”
2. “To develop new educational technologies, which will enhance distance educational opportunities.”
3. “To enhance the educational opportunities of at-risk and low-income Native peoples on reservations.”

The telecommunications analyses and recommendations outlined in this case focus primarily on the first goal. For the purposes of this analysis, the following *simplifying assumptions* about requirements are to be made:

1. The system should have the capacity to transmit and receive streaming video, data, and voice.
2. The minimum bandwidth capacity to each village should be equivalent to a T-1.
3. The primary user of the system should be the educational user (instructor and/or student).

4. Other users of the system should be the Tribal Councils (government) and tribal health services.
5. All three reservations should be interconnected.
6. The system should be scaleable.
7. Existing facilities should be used as much as possible.

The system design should be based on existing and emerging technologies. Cost should not be considered a limiting factor. (The Chippewas have a very nice casino business.) The design should take into account the anticipated applications to be included in the implementation. At a minimum, those applications are:

1. Multimedia Services.
2. Desktop Video.
3. Distant Learning, both between the reservations and to outside institutions.
4. Limited telemedicine (home monitoring).

The recommended system should be scaleable to allow for future growth. Prior to finalizing a specific design, an in depth user analysis **MUST** be complete to ensure that the functional capabilities of the system will realistically meet the user's real needs.

BACKGROUND

The EARTH Project is a coordinated effort of three Northern Minnesota Chippewa Indian Tribes to utilize telecommunications systems to increase the quality of life of their people. The three reservations involved in this process are the Red Lake, White Earth, and the Leech Lake Bands of Chippewa. The three are geographically separated (Figure 1, below), governed by separate Tribal Councils, and are wholly within the State of Minnesota. There are a number of challenges to this project; therefore, to put it in perspective, a brief discussion of the geographic region is needed. Northern Minnesota consists of a combination of farmland and heavily wooded national forests. The distance between the reservations averages 60 miles ('as the crow flies'). Existing telecommunications media within reservation boundaries consists of mostly twisted pair. Along the major trunk highways, fiber optic cable has been installed.

The major commerce hubs of the region are Bemidji, Crookston, Grand Forks, and Moorhead, none of which lie within reservation boundaries. Different local telephone companies serve each reservation.

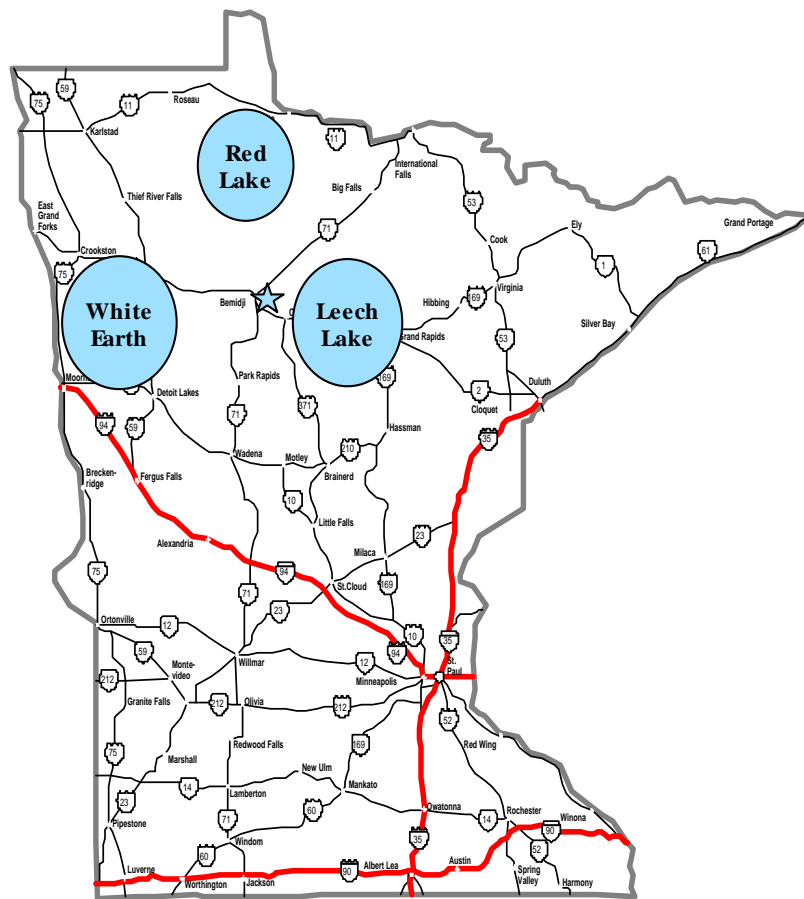


Figure 1: Reservations

The preliminary planning phase of this project has resulted in a determination to conduct an analysis and design process to define a telecommunications system that will:

1. Link the villages of each reservation to a central location (Intranet).
2. Link the three reservations together (Extranet).
3. Link the reservations to Minnesota higher education institutions (Internet).

The specification should document a two-part approach. First, the *analysis phase* should consist of a technology assessment of each reservation that identifies, at the macro level, the current telecommunications infrastructure and service providers. The results of these assessments should be used to specify required modifications to the existing systems and determine a telecommunications infrastructure that can be used to meet the goals of EARTH.

Second, the *design phase* should recommend alternate connectivity schemes to meet the goals of EARTH. The communications design should address internal reservation requirements (Intranet), communications circuits between the reservations (Extranet), and communications circuits to non-reservation higher education institutions (Internet). The recommendations should

also allow for scalability and should be based on an appropriate combination of existing and emerging technologies.

Prior to the final selection of the telecommunication infrastructure to be deployed, the EARTH consortium should undergo a comprehensive user assessment to identify specific user applications. However, based on prior discussions with EARTH membership, those applications will most likely include:

1. Linking reservation multimedia centers together.
2. Providing limited telemedicine support (home health monitoring).
3. Linking Reservation Villages to a central location to enhance distance learning capabilities. Possibly creating “Village Technology Centers”.
4. Distance learning applications with external higher education institutions.

Finally, telecommunications resources will be better utilized if the entire community is engaged in the EARTH Project. Partnerships between schools, government, business, and health care institutions should be better served if the three reservations aggregate their needs. If such partnerships are formed, the overall cost to each user should be proportionally less.

EXISTING INFRASTRUCTURE ISSUES

The first goal of EARTH is “To provide a technologically advanced telecommunication infrastructure including fiber optic and wireless transmission options and an integrated network of hardware and software systems for reservation schools, tribal offices, homes and region colleges and universities.” The telecommunications infrastructure will have the capacity of carrying voice, data, multimedia, and desktop video. The primary application will be educational; secondary will be government services, including tribal health services.

This analysis contains three elements.

- First, each Reservation has its unique telecommunications requirements based on existing infrastructure, Tribal Council goals and objectives, and geographic area. To that end, the analysis will identify the requirements of the individual Tribes.
- Second, it is understood that a common bond of culture and language ties each of the separate Reservations together. For this reason, the three independent Tribes will be electronically connected to leverage existing resources, exchange ideas, and further enhance the cultural experience of the Chippewa Nation.
- The third element of this analysis is the link to external higher educational institutions. Although keeping one’s culture, language, and beliefs intact is crucial to the ongoing survivability of a people, the external linkages are equally important for survival in the “Global Village”. For this reason, the link to external organizations is key.

The analysis process will consist of an assessment of current and emerging infrastructure within the reservations and will include a profile containing: List of services provided; description of technology being used; identification of service providers; and an inventory of existing facilities.

White Earth Reservation – Existing Capacity

The White Earth Reservation encompasses about 1300 square miles and includes the villages of Rice Lake, Roy Lake, Naytahwaush, Pine Point, Elbow Lake, Menohman, and White Earth. The population is approximately 5,000.

Existing communications services and facilities include:

1. Basic telephone service using twisted pair.
2. Low speed, (56kpbs) Internet access from the public school in Menohman.
3. Low speed (56k/bps) Internet access from the White Earth Tribal College, also located in Menohman.
4. Access to/from the telco central office is fiber. Two TELCOs provide service to the reservation, USWest (soon to be Qwest), and the privately held company; Garden Valley Telephone Cooperative.

Presently, there are no plans to expand telecommunications services in the entire service area. The reason is twofold: First, there is no return on investment for the local TELCOs due to the low customer ratio. Second, there are no major “anchor” tenants that would utilize a high speed, high capacity network. Business consists of a Tribal Casino, and small retail outlets. However, limited ADSL service is being offered.

Red Lake Reservation – Existing Capacity

The Red Lake Reservation is located approximately 27 miles northwest of Bemidji and is the largest of the three Tribes with an enrolled membership of about 8,300 (5000 live on the reservation). The geographic region owned by the Tribe is larger than the state of Rhode Island. Tribal headquarters are in Red Lake, with villages in Redby, Ponemah, Little Rock, and Fourtown.

Existing communications services and facilities include:

1. Basic telephone service using twisted pair.
2. Low speed Internet access (T-1) from the local public school.
3. The school operates a fully Interactive Television studio. (The source of funding for this connectivity (the MN Public Utilities Commission) precludes business use of the T-1).
4. Low speed Internet access (T-1) at the Public Health Service (PHS) Hospital located in Red Lake.
5. A Central Office (CO) owned and operated by Paul Bunyan Rural Telephone Cooperative located in Red Lake and Ponemah. The interconnectivity of the CO is on a fiber backbone. The CO is capable of providing Digital Subscriber Line access to the local loop as long as the loop is within 18,500’ from the CO. (That’s 18,500’ if the cable were stretched out straight!)
6. Within the next year, a T-1 connection will be terminated at the Red Lake Education and Training Center (located in Redby).

Leech Lake Reservation – Existing Capacity

The Leech Lake Reservation is located 15 miles east of Bemidji and has approximately 7,800 enrolled members and encompassed about 1050 square miles. Villages on Leech Lake include Inger, Onigum, Squaw Lake, Ball Club, Bena, Spring Lake, Oak Point, Pennington, Mission, Remer, and Cass Lake.

Existing communications services and facilities include:

1. Basic Telephone Service,
2. T-1 Internet access to the local public school in Cass Lake.
3. T-1 Internet access to the Tribal College, also located in Cass Lake.
4. A Central Office (CO) owned and operated by Paul Bunyan Rural Telephone Cooperative, also located in Cass Lake. The interconnectivity of the CO is on a fiber backbone. The CO is capable of providing Digital Subscriber Line access to the local loop as long as the loop is within 18,500' from the CO. Paul Bunyan serves the villages of Cass Lake, Pennington, Ball Club, and Bena.
5. A second Central Office, owned and operated by Arvig Telecommunications, is located in Remer. The infrastructure is entirely copper. Arvig serves the villages of Remer, Onigum, Oak Point, and Mission.
6. A third telco, Peoples Telephone, serves the villages of Spring Lake and Inger. Peoples Telephone Company's infrastructure is entirely copper.
7. Blackduck Telephone, the fourth telco to serve the Leech Lake Reservation, serves only the village of Squaw Lake. Their infrastructure is also entirely copper.

Additional Considerations

Other than voice (Plain Old Telephone Service, or POTS), the only connectivity between the reservations is via Internet. A fiber backbone is installed between the existing telcos that serve the Reservations. A number of local ISP's are serving Northern Minnesota. All are associated with the local TELCOs. Paul Bunyan Rural Telephone Cooperative is in the process of installing a fiber to the neighborhood (FTTH) system using 'very high bit rate' digital subscriber line (VDSL) technology. The system will eventually be available on both Red Lake (in Red Lake) and Leech Lake (in Cass Lake) reservations. The system has a potential capacity of 100Mb/s. Garden Valley Rural Telephone Cooperative is in the process of installing ADSL technology in their service area. The system will eventually service the city of White Earth on the White Earth Reservation.

The State of Minnesota is in the process of installing a fiber optic ring throughout the state that will parallel major trunk highways (the Connect Minnesota Project). The purpose of the project is to link state agencies to a high-speed backbone and it also allows private businesses to lease capacity. Both Leech Lake and White Earth reservations are in a position to take advantage of the Connect Minnesota Project. The Village of Cass Lake is located adjacent to a major trunk highway and will have access to the Connect Minnesota fiber when installed. The White Earth

Reservation is about 15 miles south of a major trunk highway and will also have access to the project.

Bemidji State University, centrally located between the reservations, has one T-3/DS3, the University LAN, a Desktop Video Conferencing suite using a VDSL T-1, and POTS. The City of Bemidji has a fiber ring provided by Paul Bunyan Rural Telephone Cooperative, and a Cable TV infrastructure operated by Bresnan Communications. (Cable modems are not employed.) The city is on a major trunk highway and Bemidji State University will be an access point to the Connect Minnesota project. Also, the University of Minnesota - Crookston, located between Red Lake and White Earth reservations, is also on a major trunk highway and will be an access point to the Connect Minnesota Project. Their current capacity consists of one DS3, Interactive TV, the University LAN, and a Cable TV infrastructure. The local Telephone provider is USWest.

ANALYSIS & DESIGN ISSUES

White Earth Reservation – Design Issues

The tribal headquarters are located in Menohman. The telco has a CO in Menohman that will be installing ADSL this year. Hence, White Earth may serve as a hub for the White Earth reservation.

Red Lake Reservation – Design Issues

Of the three reservations, Red Lake is by far the most “wired”. Both the cities of Red Lake and Redby house Central Offices with VDSL capabilities. These two cities could serve as the gateways to the Internet and other reservations. Because Red Lake has access to frame relay and fiber optics, it may be beneficial to design the configuration so that all sites have their own independent Internet access.

Leech Lake Reservation – Design Issues

Unfortunately, Leech Lake is served by a number of telcos and is the least wired reservation of the three. Other than Cass Lake, twisted pair serves all other villages on the reservation, with typical access to a central office at distances greater than five miles. This distance precludes any DSL connectivity. The use of wireless technology appears to be feasible. It is extremely unlikely that the TELCOs would build a high-speed infrastructure due to the lack of a customer base. A reservation built and maintained wireless system may be possible. However, as in the case with White Earth, user fees would have to be established to offset the cost of installation and follow on operation and maintenance.

Additional Considerations

When the infrastructure associated with Connect Minnesota is built, partnerships could be formed with the private parties to install additional fiber to key locations on Leech Lake. It may

be cost effective to partner with a local telco to use Connect Minnesota as opposed to building a wireless system. The fiber backbone currently in place between existing telcos might be used in support of the Extranet. If required, the use of tunneling may offer security as well as ensure dedicated bandwidth. If a direct Internet connection is required for each reservation, both the White Earth and Leech Lake reservations should have access to Connect Minnesota. Red Lake should have high-speed access using the existing infrastructure.

END-USER CONNECTIVITY

The preceding discussion has been minimal regarding the topic of end-user connectivity. The solution to this case should take into account the systems and tools employed at typical user sites to provide services needed in a generic way and to establish linkage with the network infrastructure proposed. These user premises configurations will be highly cost sensitive in the real world, but there are no economic constraints in this case.

ASSIGNMENT

The objective of this case is to design and document an appropriate network infrastructure for the organization and situation described in the case. An effective solution will include the following:

- An overview narrative description of the overall network infrastructure and a written statement of the rationale for the basic architectural approach as envisioned by the network analyst.
- A set of topology diagrams of the network design showing the overall architecture of the network, its components, and the detailed layouts of typical nodes and stations that are envisioned for the network.
- An enumeration of any simplifying assumptions made during the development of the network design discussing each assumption and explaining why it is needed and why it is a reasonable assumption to make, given the circumstances of the case.
- Any further analysis and/or discussion as warranted by the facts of the case and/or the individual analyst's design criteria.

SOLUTION

There is no one solution for this case. It is adaptable to several different uses in a traditional telecommunications course, for example, as a group project during a course or as a take-home final exam for individuals at the end of a course. The state of the art in telecommunications is changing rapidly and the result is that the solution to this Chippewa telecommunications case study depends upon the content of a particular course and the context of the available technology when the course is taught. Even within these parameters, acceptable solutions from different students are not only possible, but likely. The solutions provided by different students will vary

greatly, just as the design of a network by separate and independent technical analysts in a given business setting tend to vary greatly.

For example, fiber optic backbones with a variety of protocols might be employed successfully. The network could be wired or wireless (cellular or satellite); it might be piggybacked on a cable TV infrastructure or even a power grid to some extent. Or the design might include all of these. It will typically include wide area and local area components, and protocols and configurations of equipment and software at end user locations in some sort of consistent and compatible configuration. Essentially, how the solutions progress with this case in a particular class depends upon what technology has been taught and emphasized in the course and what the individual professor deems as appropriate in terms of technologies and level of detail in that context.