

FIBER OPTIC COMMUNITIES IN THE U.S.

- Their Deployment, Application, and Spatial Planning Strategies
for the Suburban and Rural America

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Abstract

Some of the fiber optic communities in the States are taking advantage of fibers for the betterment of communities. This paper first identifies the relationship between organizations which run fiber-optic communities and the geographical distribution of those communities. There are three patterns. Among three organizations which represent two of these patterns, they differ both in deployment methods and in applications of fibers for the public purposes. The main findings include the emerging understanding of fibers as the public infrastructure, the Minnesota method as a probable model for rural fibers, and the slow development of relationship between fibers and the spatial planning.

1. Introduction: Background, Objectives, and Meanings of Study

While the U.S. is considered to be slow in expanding broad band, we see more deployments of fibers to residential communities there. They are called “Fiber Optic Communities”, and their number is rapidly increasing. In general, a fiber optic community¹⁾ is a certain geographical area with fibers. Yet there is no definition of it agreed upon by scholars and those in related trades. Its appearance, nature, running organization, and development schemes have never been fully studied and described. Yet recently, authors have noticed that some of these fiber optic communities in the States have started to take advantages of fibers strategically and insistently for their economic and social advancements²⁾.

This paper holds two objectives. First, it explicitly depicts overall picture of expanding fiber optic communities in the U.S., including their geographical distribution, their running organizations, and backgrounds of their expansion. Second, through case studies of chosen examples, current strategies in deploying fibers, in applying this communication tools, and in planning physical space of the communities are to be found. The literature study and interviews at Fiber-to-the-Home Council (FTTH) were conducted to achieve the first objective. Series of interviews and site visits were carried out and referential materials from governments were studied for the second.

The study contributes to our understanding of current issues and future plans of suburban and rural America in three different ways. So far, the majority of fiber deployments in the U.S. are in metropolitan areas leaving smaller cities, outer suburbs, and rural areas behind, because their markets are too small to cover the construction cost with the expected revenue. This suggests that, if the Information Communication Technology (ICT) deployment were left to follow only to the market principles, it could further retain or enlarge the existing digital divide between metro and non-metro areas. We have already observed that the number of broadband providers in non-metro areas decreased, while the investments to the ICT infrastructure in metro areas have dramatically increased³⁾¹. This paper will show, in detail, how the recent fiber optic communities were brought into the world. Through this, it could suggest important hints in exploring alternatives in ICT deployments in non-metro areas in the States.

Second, emerging efforts in suburban and rural America to use fibers strategically for the community could help solving their recent problems, such as economic down-turn and dependency to the metropolitan areas, and the decreasing sense of communities. In general, ICT is said to have effects of isolating individuals from the society, or sometimes, rural areas and suburbs from the metro areas². However, at the same time, ICT brings various social activities back to residential communities (from metro areas) in the forms of, for example, telework, remote education, and tele-medicine⁴⁾. It therefore could re-network people and places within each community which had become solely residential over decades. This paper, through uncovering the strategic uses of fibers, will show model(s) for rural/suburban communities to conquer common problems among them.

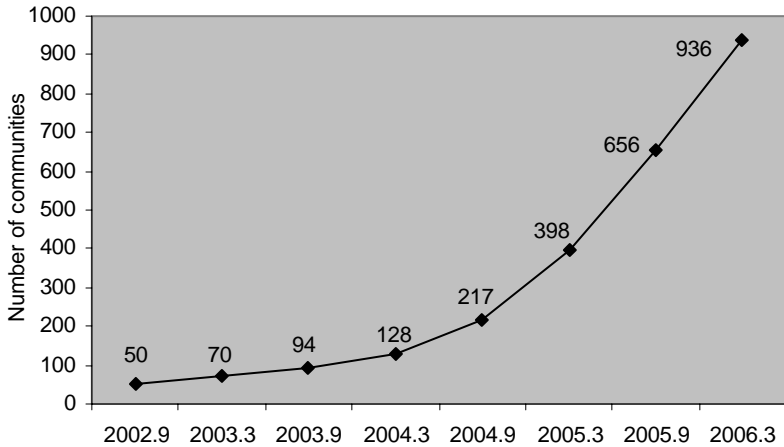
In suburban and rural America, as a result of long-term economic dependency on metropolitan areas, we see less and less land-use (or building-use) programs other than residential for last decades. Even if these areas were to be armed with new ICT infrastructure and to use it for economic and social activities, the spatial conditions of these communities are not ready to house them. The third contribution of this study is, therefore, to present important resources for the communities to create land-use plans and housing plans which respond to the new spatial demands resulted by ICT infrastructure and activities surrounding it.

2. Fiber Optic Communities: Who Run Them Where?

2-1. Expansion and Distribution

The number of residential units which are “home-passed” by fiber optics⁵⁾ has increased forty-two times for three years since March, 2004, and is 7,911,000. For the same period of time, the number of homes subscribed to fibers doubled⁶⁾³. This increase is not particularly fast compared to other countries. “Home-passed” houses account for only 1 % of all residential units in the States, while the ratio is 19.6% in Korea and 16.3% in Japan. United States ranks 11th on the list⁴.

Fiber optic communities in the States started to increase steeply from around 2004. There were only 398 of them in 2005, and then were 936 in 2006 (Figure 1)⁵. In terms of their geographic distribution, Texas has 149, and Pennsylvania has 103, followed by New Jersey, New York, California, and Florida, each of which has 40 to 60 fiber optic communities (Figure 2). These States either have metropolises with population larger than a million, or have areas with rapid residential developments.



(Resource: Render Vanderslice & Associates, 2006)

[Figure 1. Increasing Number of Fiber Optic Communities]

2.2 Running Organizations

In order for fiber optics to be deployed and run, at least three different roles, i.e. constructing the infrastructure, owning/maintaining the infrastructure, and providing information services ⁷⁾, should be carried out. In some fiber optic communities, all three jobs are performed by one organization, while in others, each function is carried out by different organizations. As seen in such as members' directories of trades organizations, there are 5 primal categories of organizations shown below where each perform at least one of the above three functions in fiber optic communities. In A, B, and C, one organization often does all three jobs.

- A) RBOC (Regional Bell Operating Company): There are currently three in the States; Verizon, AT&T, and Qwest.
- B) ILEC (Incumbent Local Exchange Carrier): Local telephone companies which have been in place since before 1996 Telecommunication Act.
- C) CLEC (Competitive Local Exchange Carrier): Newer telephone companies started after 1996 as competitors. The word "Independent Telco" usually refers to both B) and C).
- D) Developer in conjunction with CLEC
- E) Public Organization: Municipalities, Public Utility Districts

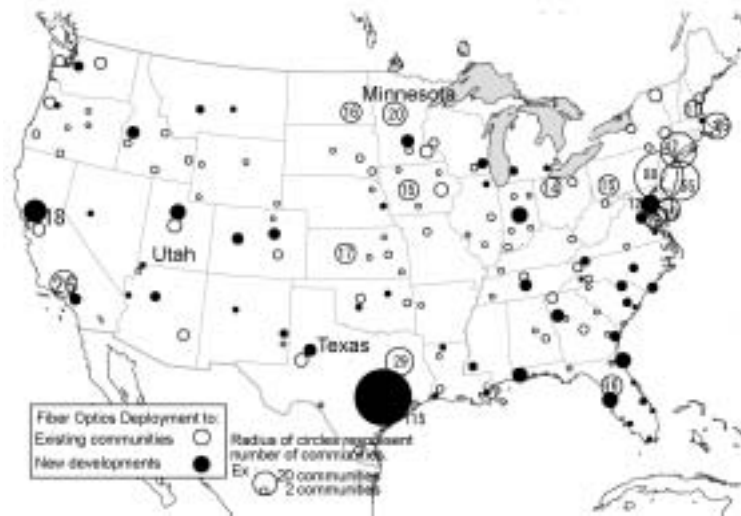
Figure 3 shows market shares of each category in the constructions of infrastructure and in the subscriptions to services. In both cases, RBOC(A) had the largest share followed by ILEC(B) and CLEC(C) in 2006. Yet recently, B) and C) have started to get involved new fiber optic projects whose number is expected to increase⁶⁾. The growth of D) should not be ignored either for the forecast. Among newly developed residential communities, the ones with fibers are increasing⁸⁾. It is expected that the number of houses in newly developed fiber optic communities by D) will become four-times-fold (89,600 units) in five years by 2009⁷⁾.

2.3 Relationship between Location and Running Organization

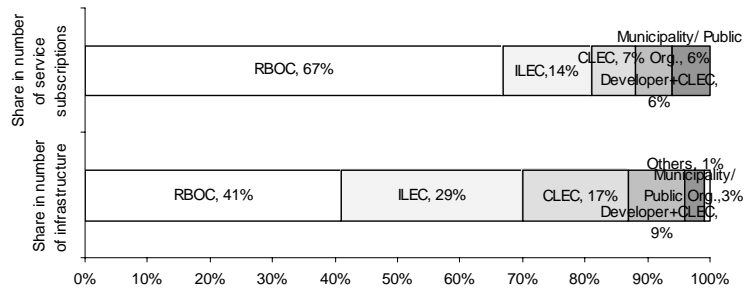
Figure 4 shows the geographical distribution of fiber optic communities by infrastructure providers, i.e. organizations own and maintain fibers. By comparing Figure 2 and 4, it is apparent that many of those by RBOC(A) are the existing communities to which fibers have introduced, and that they congregate in the metropolitan areas on North East coast where population density is high. All of fiber optic communities by D) (developers with CLEC) are new residential developments and are located often in areas where developments are abundant, such as outer suburbs of Texas, Florida, and California. Independent telcos (B&C) and public organizations (E) introduced fibers mainly to existing communities. They are often located in north-central, south-eastern, and north-western part of the United States, especially in the areas with low population density. Thus, authors identified three primary patterns among fiber optic communities in terms of their running organizations and geographical distributions.

- (1) Fiber deployments to existing communities in highly-densed metropolitan areas by RBOC

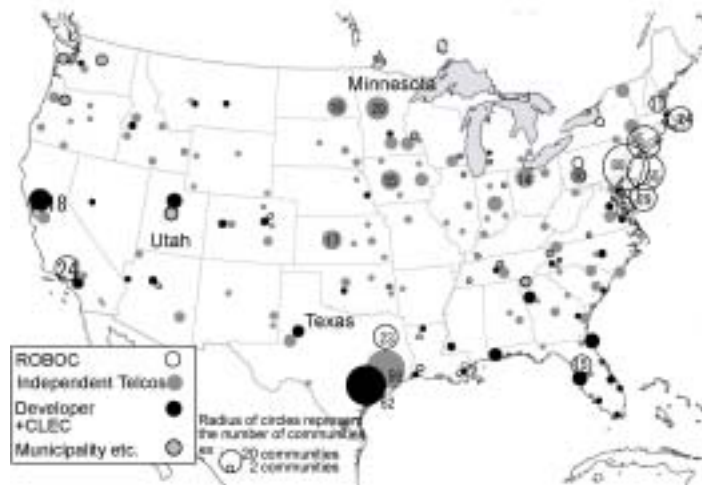
- (2) New residential developments armed by fiber optics which are introduced by developers in conjunction with CLECs
- (3) Fiber deployments to existing communities in low density areas, such as outer suburbs or rural areas, by independent telcos and public organizations.



(Analyzed & rendered by authors based on Render Vanderslice & Associates, 2006)
[Figure 2. Geographic Distribution of Fiber Optic Communities by New/Existing Status]



(Resource: Render Vanderslice & Associates, 2006)
[Figure 3. Market Share of Fiber Optic Communities by Running Organizations]



(Analyzed & rendered by authors based on Render Vanderslice & Associates, 2006)
[Figure 4. Geographic Distribution of Fiber Optic Communities by Running Organizations]

3. Selection of Case Study Areas

Among the above three patterns, (2) and (3) are chosen to be the subject for case studies. In pattern (1), the market for running organizations is nation-wide, and they give priority in deployment to metropolises where economic activities are already in full play. Therefore, authors assess that it is less likely in (1) than in others to find the strategic uses of fibers for the social and economic re-energization of the community, and decide to exclude (1) from case study subject. In case of (3), we choose to carry separate case studies for independent telcos and public organizations, because there are differences between them both in their nature as organizations and in the distribution of their fiber optic communities.

In sum, subjects of case studies are the following three types. In each type, the area with the largest number of fiber optic communities of corresponding pattern is selected as the study area⁹⁾(Table 1).

Type I: New residential developments armed with fiber optics which are introduced by developers in conjunction with CLECs (Texas Case Study)

Type II: Fiber deployments to existing communities in low density areas by public organizations (Utah Case Study)

Type III: Fiber deployments to existing communities in low density areas by independent telcos (Minnesota Case Study)

Studies were carried out in March 2008 in Texas, in April 2008 in Utah, and in June 2008 in Minnesota.

Fiber optics is urban infrastructure (hard system) just as electricity and water lines. Yet at the same time, it is a communication tool which requires proper application strategies (soft system run by people, not in computer) to be used for specific purposes. Therefore, in case studies, we cover following three topics for which multiple interviewees are selected in each study area. Please refer to the note for the list of interviewee¹⁰⁾.

- Methods for deploying fiber optics as infrastructure (hard system)
- Application strategies of fiber optics as communication tool (soft system) and their influence on the economy and life of the community
- Current and planned spatial condition of the community such as land use and housing plan

Organization Type	Metropolitan Area	Rural and Suburban Area	
		New development	Existing Communities
A			
B			Type
C			
D		Type I	
E			Type

Note) Light gray indicates that this combination is seen in small numbers.

[Table 1. Categorization of Fiber Optic Communities]

4. Type I: Texas (Developer + CLEC)

In Texas, there is concentration of fiber optic communities around three large cities; i.e. Dallas/Fort Worth, Houston, and San Antonio. Two residential developments in suburban Houston, Sienna Plantation and Telfair, are the subject of this particular study. Developers are Johnson Development for Sienna and Newland Communities for Telfair. CLEC is En-touch for both developments.

4.1 Background

The population is growing in southern and western parts of the United States. The growth rate is especially high in Texas, because it has large number of immigrants due to its proximity to the border with Mexico, and has been economically flourished by oil money. Accordingly, we see more residential developments and therefore higher market competition. It is necessary for developers to differentiate their own projects from others to survive it. Sienna and Telfair are not the exceptions, especially so because of possibly unfavorable conditions of the project, such as their sites standing below water level ¹¹⁾. Making “good communities” ¹²⁾ by taking advantage of fibers is one of their strategies for this differentiation.

4.2 Deployment Method of Fibers as Infrastructure

Developers of both projects are known for their Master Planned Communities ¹³⁾. In both cases, developers initiated the idea of community with fibers and created the basic plan, while En-touch, a CLEC, built, owns, and maintains fibers, and provides services on it ¹⁴⁾. Newland Communities of Telfair started to use intranet sites for community activities already back in 90’s. For them the existence of fiber optics in their communities signifies that the company is “at the head of curve” ¹⁵⁾ in residential development. At Sienna by Johnson Development, it is advertised in its sales brochure that residents receive the information on community activities through its own intranet site. It is fair to say that, in both communities, fiber optics is intentionally used as a tool to create a good community.

Every house already in place in both communities is connected to fibers. Subscription rates are very high in both being 95% at Sienna and 70 to 75% at Telfair. As for the operation of fibers, En-touch assigns company representatives for each community who help residents technically at start-up and respond to requests for maintenance.

4.3 Application Strategies of Fibers as Communication Tool

Each residential development has a staffed organization which supports community activities. At Sienna, it is a home owners association (HOA) with fifteen staff. At Telfair, a community foundation ¹⁶⁾ (CF) carries this role. These organizations cover wide range of community activities, including operating or supporting a nursery, kid’s sports programs, and sports/cultural/economic activities for adults/seniors. The intranet site ¹⁷⁾ for residents of each development is used either as part of or as a supporting tool for these community activities.

On intranet sites, schedules and plans for various programs are posted. Many residents groups such as Mother Club and Baseball Club, which started with the help from HOA or CF, have their own web sites either on or linked to the intranet site. Businesses of different sizes in the development also have chances to advertise or post messages on the intranet site. Sienna has larger number of work-at-home or small business than Telfair, and promotes their activities in town. A good example of this is Sienna Business Network which was organized by entrepreneurs and business owners with the help from HOA. In both residential developments, it is advertised at the time of home sales that telecommute and home-business¹⁸⁾ are possible there because of fibers.

4.4 Its Value and Issue as Fibers-for-Community Model

At Sienna and Telfair, in short, “good community” is regarded as an essential element for sales promotion, and fiber optics is actively used as a tool to create and maintain such condition. If fiber optics does not directly contribute to the creation of tight and active community, then its value as such a tool would become smaller. Therefore, HOA and CF, whose primal role is to support community, also promote residents’ use of fibers by presenting tangible examples of its use such as the ones on intranet sites. Since the running organizations of fiber optics also operates community programs other than fibers, the coordination between real and virtual programs started to appear as well. In addition, new economic activities which take advantage of fiber optics have begun to be seen within the residential developments.

Sienna and Telfair, new residential developments armed with fibers, were placed in a larger area where there has been no sufficient broadband infrastructure. Unless surrounding area can take advantage of this new infrastructure by extending it into the existing communities, new developments do not narrow the existing digital divide between this suburban area and metropolitan area. They will just create a new divide between the new and existing housings in the same geographical area. The similar could be said in the application strategies of fibers. Since HOA and CF were founded in a way to serve only within the boundary of the development, their promotion of the use of fibers and its possibly positive results on the community scarcely expand into the surrounding communities by nature. Yet, authors also came to know that En-touch has started to serve other new residential areas near Houston by expanding the backbone fibers which was built for Sienna. It should be observed if the attempt like this will go into the existing residential communities in the future.

4.5 Spatial Aspects of Fiber Optic Communities

1) Regional Condition and Site Plan

Both developments are significant in scale. When fully built, Sienna will have 15,000 housing units in 4,250 ha of land, and Telfair will have 3000 units in 971ha. Within each development, the areas occupied by other than houses, such as green areas, retail, commercial, and educational facilities, are large (Figure 5). For example, Sienna has 809 ha of green belt (19.0% of the development area, 28.5% of housing area), and Telfair has 121 ha of green area in total. In both, the land used for commercial and retail is about one third

of the total area. They started to develop housing areas first, and then slowly build office/retail sections to be accord with the growing population. In Sienna, there are a bank, a pharmacy, a gas stand, a grocery shop, and some restaurants. New office buildings are under construction there. Small offices of health, law, financial industries are expected tenants. Both developments have elementary, middle, and high schools. A community college is under construction in Sienna. Adjacent to Telfair, Sugarland Campus of University of Houston is being built.

2) Housing Plan

In both developments, houses are arranged into smaller sections. Especially in Sienna, twenty-three “villages” are allocated by having green belts in between. Each section in both developments is given its own design character. The standard lot size is different from section to section. Cul-de-sac arrangements are usual. These strategies for housing plan allowed them to provide various housing types in different price ranges. Each development also has a section with houses planned for the senior (active adults).

Housing prices also vary. They are from \$160K to \$1M at Sienna, and \$250K to \$1M at Telfair. Among them, more expensive houses have larger floor area, yet not proportionally larger lot size¹⁹⁾. In other words, even the larger houses are allocated in relatively higher density. Houses have 3 to 5 bedrooms and 2 to 3 car garages. In order to fit these functions of large volume in a lot with limited frontage, court-yard type floor plans where small yard is surrounded by rooms and garages are frequently employed. We see no other distinguishing characters in floor plans of those developments. They often offer floor plan options for game room, media room, and home office, to which broad band connections should be essential, however, there is no data available which shows how home buyers choice for these options are influenced by the existence of fibers.

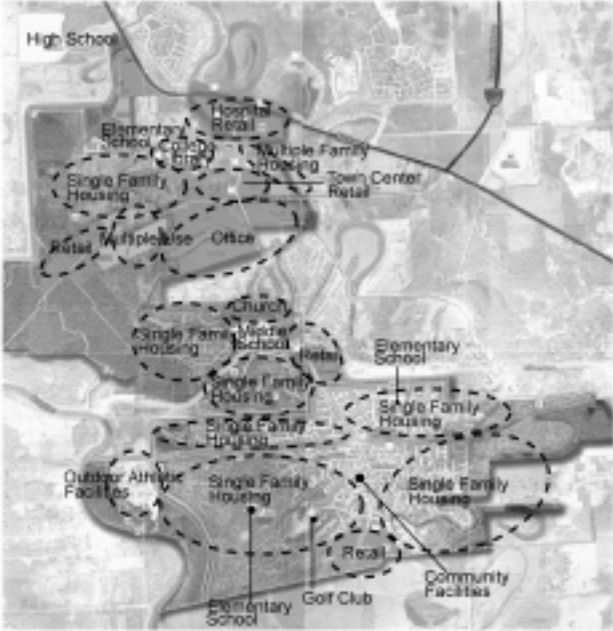
3) Analysis of Plans

It should be pointed out that spatial plans of two developments are unique in two aspects. First, they provide wide variety of housing types. Second, they are planned as areas with multiple functions, not as solely residential areas.

The wide variation of houses allows people with different income and of various ages to buy property there. It is also planned by envisioning future moves of residents within the same development. Already in Sienna, there are many examples of people moving within the development, and of older parents buying their houses to be close to the children’s families who live there. Multiple functions other than residential suggest that, in these developments, economic activities of different kinds are expected. In addition, a college/university in or adjacent to the development might not only stimulate economic activities but also trigger new social/economic programs in the community.

What these two aspects depict is a spatial image of residential neighborhood which might be able to support its stability and independence as a community. Fiber optics contributes to it by bestowing its residents extra amenities of life and alternatives of working at or closer

to home. The existence of fibers is also reflected upon spatial characteristics of the neighborhood to a certain extent such as options in residential floor plans. Offices and colleges are in the neighborhood which would be impossible to be out of cities, were there not fibers. Yet, by and large, designs of houses and site/land-use plan of communities are not distinctly different from the ones without fibers.



[Figure 5. Sienna Plantation Site Plan]

5. Type II: Utah (Public Organization)

There is largest number of Type II examples in Utah because of UTOPIA. UTOPIA is an only governmental organization in U.S. which was founded by multiple municipalities in order to introduce fiber optics to their communities. Sixteen member municipalities signed the inter-local agreement to form UTOPIA and send their representatives to operate it. UTOPIA owns and contracts the construction and maintenance of fiber optics. As for application strategies of fibers for social and economic benefits to the communities, it is individual city that plans them. Examples of Lindon and Brigham were chosen for this study. They have very different geographical and social backgrounds. In addition to the officials of UTOPIA and of two cities, research interviews were conducted with Packetfront, a private consulting company.

5.1 Background

State of Utah, its capital Salt Lake City having only 187,000 residents, does not have a metropolis. This fact kept the broadband expansion in the State behind. In smaller cities in Utah, like the member cities of UTOPIA, it is very unlikely that RBOCs provide the broadband service.

State of Utah is located on north-west of the States. In 19th century, members of the church of Jesus Christ Latter Day Saints (LDS or Mormons) moved in. And now, 71.6% of its residents are LDS members. On the west side of Rocky mountains, interstate highway 15 runs north-south along which most of towns are located. ICT-related companies are relocating from Silicone Valley, CA, to the area around north half of I-15, the center of which is Salt Lake City. This new area is called Silicon Slope. With the exception of Cedar, all member cities of UTOPIA are within this area. Heavy commuter traffics are serious issues there, due to the fact that there is only one major north-south highway. State Department of Transportation is planning commuter rails a part of which was already constructed.

5.2 Deployment Method of Fibers as Infrastructure

While the market-based infrastructure deployments were difficult, municipalities did individual efforts to solve the problem of lacking broadband. However, they were not successful in persuading RBOCs and their likes to introduce the broadband in their cities. Municipalities, then, came together to have a larger combined market. This orchestration became UTOPIA, a governmental organization. The number of member cities was 14 at the beginning, and then 16, which are larger than originally expected. This larger congregation became possible, because there was a strong leadership and because the joint enterprise would lessen the risk for each municipality. The combined population of member cities is 700,000 (150,000 households), while their average size of each is 20,000. The smallest is Perry with 2,383, and the largest is West Valley with population 108,896 (U. S. Census 2000).

UTOPIA's goal is to "provide the connection of large enough band-width for the future to every resident of member cities through Open Network." ²⁰⁾ In this, UTOPIA's roles are to contract the construction of fiber optics and to own, maintain, and operate it. The first phase construction cost was covered by the sales of bonds issued by a private bank and pledged by sales tax of member cities. PacketFront (then, DynamicCities) consults in effective management of constructing, maintaining, and operating fibers. Initially, it was also contracted the maintenance service of fibers.

Through UTOPIA's fiber optics, multiple private companies are providing services. This system is called "wholesale," because the owner of infrastructure does not provide communication services. The wholesale scheme was taken, partially because cities considered themselves not experts in providing direct services, yet also largely because the state legislature limited area of services which municipal governments are allowed to provide. This set limitation was the result of lobbying by RBOCs and cable companies. UTOPIA began construction in 2004 by starting in the areas where construction cost is less expensive.

As of 2008, 15 to 19 % of residential/business units within each member cities are connected by fibers, out of which 5 to 30 % are subscribing to the services through fibers. These numbers are much lower than forecasted. In addition, the loan amount from Federal government ²¹⁾ for the second phase construction turned out to be far lower than promised.

As a result, UTOPIA now faces the problem of securing the construction cost for the remaining areas. As of April 2008, UTOPIA was trying to refinance by increasing the pledge by cities, and to create the new marketing strategies to increase the subscription rate. One of them is to first locate tech leaders in each neighborhood by using interactive features of the organization web site, to ask them help gathering prospective subscribers, and when certain number of committed people is on the list, to construct fibers in the area.

5.3 Application Strategies of Fibers as Communication Tool

UTOPIA itself has not taken a leading role in promoting the application of fibers, due to the fact that it did or was forced to take the wholesale approach. Yet on the level of municipal governments, some application strategies have started to be seen in ways to resolve their chief motivations to join UTOPIA, such as the need for economic development or the improvement in quality of life. UTOPIA also has supported such efforts on municipality or user levels. For example, it helped Alpine School District²²⁾, in early stage of its construction, to obtain accesses to fiber optics with discounted service price, in exchange for the use of the underground of school properties in laying fibers down. Now schools are connected by virtual LAN, which has changed ways in which classes are delivered and in which teachers, students, and parents communicate each other.

As for the application of fiber optics for economic developments, two cities researched take apparently different stances.

Lindon City, population 11,000, is within the commuting sphere (47 km) of Salt Lake City. Its residents' median household income (\$65,000) is significantly higher than the state's median number (\$37,000); therefore, the city does not seem to consider its economic development an urgent issue. This fact, authors believe, is reflected on to its slow developments of application strategies of fibers. The only visible connection between fibers and other policies is to encourage home businesses.

Brigham City, population 18,000, is located farther away (87 km) from Salt Lake than Lindon is, and is not generally considered to be in a commutable area. Its residents' median income (\$49,000) is lower than that of Lindon. These brought the committed attitude of the municipality in using fiber optics for its economic development.

Brigham City once was an agriculture area known for its fruits. A chemical factory moving into the city in 1950's initiated the inflow of technology related companies over the years. The city still houses significant technology companies such as the one with NASA as its client. However, since these existing companies cannot solely provide enough high-income stable jobs, the city has been facing the problem of young people moving out to larger cities.

Meanwhile, one major company in Brigham moved out, due to its lack of bilateral information infrastructure. This triggered the city's efforts to provide sufficient information infrastructure to its businesses and residents. The state-of-the-art telecommunication system is incorporated in the city's future plan, Vision 2012. The city has tech expos to appeal the

existence and usefulness of fiber optics to companies and residents. The result of their efforts has already started to be visible; a technology company and a manufacturer decided to move in, another company decided not to move out, both of which because of the prospect that fiber optics are coming soon.

In the cities covered by UTOPIA, telecommuters and home businesses are seen and their numbers are increasing²³⁾. Brigham City also supports entrepreneurs by collaborating with private corporations.

The use of fibers for the better quality of life and communities is less visible here in UTOPIA cities than in Type I residential developments. The farthest authors observed so far are the over the web utility payment and facility reservation systems in Lindon and a plan to have a public broadcast channel in Brigham.

5.4 Values and Issues of Making Fiber Public Infrastructure

The system created by UTOPIA, in which small municipalities made a governmental organization to provide fiber optics as public infrastructure, indicates a possible model to expand broadband communication in the area whose market is too small for private enterprises. Authors value UTOPIA's perspective in which secure, stable, and large bandwidth connections are considered indispensable for their residents' lives and the local economy in the near future. Small cities lowered the risk of fiber deployment by increasing the prospective customers through the collaboration. Yet we also noticed cities might have been a little inexperienced to expect high subscription rates, in a way they do from other public infrastructure such as water and electricity.

UTOPIA, due to its wholesale style, is not designed to be positively involved with the application of ICT services for the active/tight community or for its economic development. This role is carried by each municipality. So far, the extents of this effort differ from city to city. However, when a certain city is aware of possibilities of fibers, as Brigham City is, then strategies for the application of fibers can be coordinated with other important municipal plans, such as a vision plan, land use plan, economic development projects, or plans for the local school district.

5.5 Spatial Aspects of UTOPIA Communities

The basic stances toward the coordination of fiber optics with their land use plans are very different between Lindon and Brigham, as they are in the case of above described economic developments.

1) Land Use Plan of Lindon City

Lindon City does not expect that, initiated or affected by fiber optics, a large change might occur in residents' ways of using spaces. Therefore, it does not plan to adjust its land use plan because of the change²⁴⁾.

As described above, residents' of the city have higher income and its existing industries are in good shape, from which it is assumed that the city does not feel pressing need for economic development.

Lindon was once an agricultural town. Over the years, it has been transformed into the suburban residential community of Salt Lake City. Yet its motto of "a little bit of country" is still reflected into its city planning, for example by permitting having horses and cows in residential zoning districts. Existing houses are in high quality. The newer ones are especially so with 280 square meters floor area in average. The minimum residential lot size which is set in municipal zoning ordinance is large being either 2,000 or 1,200 square meters. Existing residential areas, however, have been built out leaving little room for new developments.

Looking at the distribution of land use zoning of the city, the eastern part is residential, the western part industrial, and the area in-between is for commercial and retail. The deployment of fiber optics is completed in most of the residential and retail/commercial zones, as well as in the business park. The subscription rate in these areas is 28% which is highest among UTOPIA member cities.

In summary, Lindon has little residential area to be developed, and needs for economic developments are not urgent there as described in chapter 5.2. Therefore, fiber optics is introduced only into existing spatial fabrics of the city, and the use of fibers is now infiltrating into residents' lives within that spatial boundary. Their life styles might have changed because of fiber optics. However so far, this change either has not been large enough to create issues in the spatial aspects of housing/community, or the existing houses are spacious enough to absorb the impact of the change. These conditions underlie the above mentioned city's almost passive stance toward adjusting its land use because of fibers. As additional information, Lindon City ordains newly developed houses to have fiber optics ready wiring system.

2) Land Use and Housing Plans of Brigham City

Brigham City, as described above, is utilizing the existence of fiber optics for its economic development. Their land use plan has started to respond this effort by degrees.

As in chapter 5.3, Brigham has its reasons to be committed to its economic development. At the same time, the city has some large areas not yet to be developed. Its old town center is located some distance away toward east from the inter-state highway. Till recently, the area between the highway and town center has been undeveloped land. However, a new exit of the highway increased the potential value of this land. A development plan called West Forest Street Corridor is being created. In it, spaces for entrepreneur businesses, high-density housing for those who work there, some parks and shops are planned. Companies which the city would like to attract to this area are in the design and development industry, and fiber optics is necessary condition to induce them. Conduits for fiber optics are laid

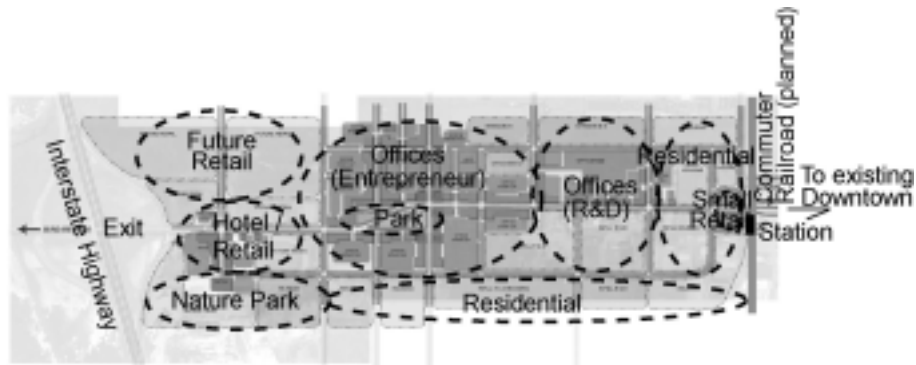
down by the city²⁵⁾ in 38% of municipal area including the new development area, yet no serviced has been started to be provided at the time of the research.

The minimum residential lot set by the ordinance here is smaller than in Lindon, being either 744 or 930 square meters depending on the zoning class. According to its General Plan²⁶⁾, the city will introduce “households per acre standard” in the place of conventional “minimum lot size standard” to accommodate various types of housings to which the young and retired generations will be attracted. The city also encourages home businesses in the residential areas. However, what it expects from this policy is not to increase the property tax income as found in the example of precedent studies⁸⁾, but to “increase its revenue through sales tax by attracting companies/shops and the class of people who buy their products and services into the city.”²⁷⁾

In short, the urgent need to sustain key industries and the outflow of younger generation has made it necessary and meaningful for Brigham City to position the deployment of fiber optics as a tool for its economic development. Its having some physical spaces appropriate for the new development also help its land use plan respond to fibers by incorporating spaces for new companies work with fibers and for their employees. Brigham City has also set the technical standards to accommodate fibers for the new houses and other developments.



[Figure 6. Brigham City Land Use Plan]



[Figure 7. West Forest Street Plan in Brigham City]

3) Analysis of Current Plans in Two Cities

As shown, two cities respond in very different ways to the idea of applying fiber optics as a communication tool for land-use/housing plans. This difference is largely due to the discrepancy between current conditions of their local economy. In the States, a plan for local economic development and one for land use are closely tied together. The term community development often means both in an integrated plan. Therefore, unless there is a demand for a certain economic development, there is little response required in a land use plan. Moreover, even when there is a demand for the former, the availability of lands to accommodate adequate development plans is another essential condition for both kinds of plans to really take advantage of fiber optics. In long term, in Lindon City, we expect the life style change caused by fiber optics to be responded by spaces in smaller scale, such as in housing plan. In Brigham City, we should see responses in larger scale of urban design.

6. Type III: Minnesota (Independent Telcos)

There are about 90 independent telephone companies in Minnesota, all of which are in rural areas²⁸. In rural areas all around the United States, there are about 300 telephone cooperatives and small private companies in roughly same number provide services as ILECs⁹. A telephone cooperative is a cooperation owned by its members who are also its customers. Telephone cooperatives provide telephone and information communication services, and some started to deploy fiber optics.

In Minnesota case study, with the help from Minnesota Telecommunication Association, four independent telcos were selected as research subjects. The choice was made based on the availability of fiber optics in a certain company's service area and its degree of effort to connect fiber optics to social and economic development of the communities. They are Consolidated Telecommunication Company (CTC) located in Brainerd, Park Region Mutual Telephone Company (Park Region hereafter) in Fergus Falls, Federated Telephone (Federated hereafter) in Chokio, and Paul Bunyan in Bemidji. All four telcos are telephone cooperatives.

6.1 Background

The state of Minnesota situates at north central part of the United States. It is known for its very cold climate. The western and northern part of the state where all four companies are

located is about three to five hours from the state capital, has vast lands, and is thinly populated. Its main industries have been agriculture and timber industry. In and around Brainerd, Fergus Fall, and Bemidji, there are many lakes which attract weekend house developments and support tourism in summer.

Each of these three cities has about the same population of 13,000. The cities are popular among the retired people who would like to enjoy cooler summer, and among those who are looking for a place to move into from metropolises. In spite of the distance from Minneapolis/St. Paul, their population is therefore growing. Only the city of Chokio (population 400), in which Federated has its head quarter, is more thinly populated than the other three. Its population density is 3.08 person/square kilometer.

In Minnesota, there are many kinds of cooperatives beside telephone ones. This is because of its historical backgrounds such as once having many immigrants from Scandinavian countries. The grange, the communal organization for farmers which started in 19th century, was also active in this state.

6.2 Deployment Method of Fibers as Infrastructure

Afore mentioned four telcos, as ILECs, had been providing telephone and dial-up connection services not inside but surrounding areas of regional core towns. While core towns had been struggling to have broadband connection due to their small population, four companies had demonstrated their interest toward broadband in their service areas by, for example, collaborating with a local technology company.

Three of them, CTC, Park Region, and Paul Bunyan, established CLECs in the core towns of their area, constructed fiber optic infrastructure, and started to provide information communication service. They, then, by using this infrastructure and market in core towns as a foundation, expanded their service to the surrounding communities which are their original service areas.

In the case of Federated, which is in more rural area than the rest, the opposite strategy was taken. "Rural fiber" was introduced, for the first time in the U.S., to its original service area, by using Federal loan. Based on this experience, Federated then expanded its service to the nearby core towns.

All four companies carry out three functions which are construction of fiber optics, owning and maintaining fiber optics, and providing services²⁹⁾. They started to provide services very early in 90's, and plan to complete the deployment in a couple of years following 2008 with exception in future service areas. Subscription rates of fiber optics differ in areas, and are between 30 to 100 %.

6.3 Application Strategies of Fibers as Communication Tool

All four companies actively applied fiber optics toward education. CTC and Park Region, especially, worked in partnership with local school districts not only in the application of fibers but also in the deployment. In the case of CTC, a school district paid for the construction and owns a part of fiber backbone. CTC gained the access to that backbone in exchange of providing its maintenance, and started to provide services to the communities through it. Park Region owns fiber backbone, yet its construction cost was beard by a school district, which was made possible by the local referendum.

Each telco links all local schools with the dedicated network which is also connected to the state government's network exclusive for the educational use. This enabled two-way communications between parents, schools, teachers, and students, and started to change the ways to operate schools and to teach. All the accounting and administrative procedures, as well as exchanges between parents and school/districts, are now carried out digitally. Home works and materials for classes are on the site that each teacher has. Sports matches between local schools are broadcasted live on the internet.

One of the schools in Park Region's area is run exclusively on line. Any child in the world can be admitted to that school. Bemidji State University, which is in the service area of Paul Bunyan, is at the forefront of on-line courses. The university has students in Canada taking its courses. Every time when schools or school districts presented these new needs to the companies, the companies responded well with technology.

Fiber optics is also used for economic developments of the local areas. By enhancing connection speed and providing LAN services, the companies help the municipalities in inducing new businesses into the area or preventing existing ones out from it. The achievements are apparent in the form of new business coming into the area by taking place of the old such as the lumber industry. Examples are a publication company in CTC's area, fortune-hundred ACS corporation in Park Region's, an Ethanol manufacturer in Federated's, and a DNA laboratory in Paul Bunyan's. These successes were brought in spite of the facts that communities are far from metropolis and are sparingly populated. Municipalities of Brainerd, Fergus Falls, and Bemidji, which are in lake districts, consider that new industry should be the ones that will not impact their natural landscape. This is the digital industry in the case of Bemidji, and high-tech bio-science industry for Fergus Falls.

Some of the important backgrounds of this successful inducement of new businesses are that all of four communities are rich in the nature, their labor costs are less expensive than in cities, and their residents' work ethic and education level are high³⁰. Fiber optics contributes to at least one of these factors: education. The complete information infrastructure in the area is also a big attraction for the businesses looking for their location.

We also found out through the interview with each company that work-at-home and home businesses are increasing in their areas. A wife, whose job moved to Minneapolis, can work at home with the broadband access, which enabled her husband to keep his farm in a town in Federated's area. In Park Region's area, a hospital provides at-home telecommunication service fee to some of its employees so that they could telework at home. The increasing

scale of modern farms is creating new demand to fiber optics in rural America as we found in Federated's area. This is because a large farming business requires both multiple bases within a farm and business transactions with overseas markets.

Fiber optics also serves for the medical purposes. A medical corporation whose head quarter is in Fergus Falls took advantage of fibers to connect its facilities and clinics with a dedicated network. This enabled its branch clinics in the very low density areas, often with population around 500, to have immediate accesses to medical records and tests results of the patients. The patients in those areas can now have medical services in more convenient way than before. This is also beneficial for the medical corporation. By being able to handle more patients in its branch clinics, it does not have to expand their downtown facilities which tended to become too crowded. In a CTC's fiber deployment plan for a new area, a hospital is going to be one of the owners of fiber back bones. It is expected that fibers will be used strategically for the medical uses.

6.4 The possibility of the Minnesota case as a model for the revitalization of rural areas

In these areas which are thinly populated and endowed with nature, if they would like to preserve their existing communities and economic activities, the industrial transformation from or the modernization of the agricultural and timber industries are critical issues to be addressed. There, supporting entrepreneurs, attracting new enterprises, enhancing the human resource development, and improving the quality of life are necessary to make the living in these areas attractive. The deployment of fiber optics was found to be a foundation to support these efforts.

Four companies appeared in this research have deployed fiber optic infrastructures by responding the demand from the community, i.e. the demands suggested by local school districts or by chamber of commerce. All four companies tried to minimize their business risk³¹⁾ by decreasing their initial cost or by making conservative forecasts of the needs toward fibers. Three out of four companies started deployment not in their existing service areas but in the core town of the region, which we observe as one of their efforts to evade risks. Each company responds to the needs from customers swiftly in flexible ways, which helps constant promotion for both the expansion of fiber infrastructure and the various uses of fibers.

In the researched part of Minnesota, fiber optics was deployed and its service is now provided, in spite of the area's low population density from which high economic returns are not usually expected. This success should be attributed to two factors. One is that four companies which run the infrastructure are community-based enterprises, in other words, the business of each company is directly connected with the local economy and its revitalization³²⁾. The second factor is that these companies are cooperatives which serve, to some extent, public purposes.

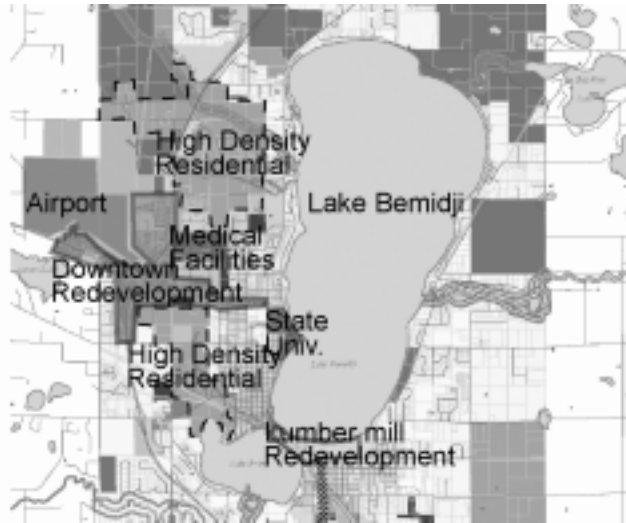
The facts we found here suggests that Type III presents a model for rural areas in expanding the deployment and use of fiber optics. Yet we also see two issues to be addressed. One is that the realization of this type is difficult unless a rural community has existing community-based enterprise such as telecom cooperatives. The other is that fiber deployment cannot achieve the community revitalization without some inherited or newly developed attraction of the area such as the rich nature or competent workforce.

6.5 Spatial Aspects of Fiber Optic Communities

In this chapter, we only discuss three communities near the lakes (Brainerd, Fergus Falls, and Bemidji) in which the existence of fibers is found to be reflected on to the spatial environment of the cities. The three communities share two general conditions, i.e. the increasing population brought by the inflow of wealthy retirees and the ongoing industrial transformation. These present some common land-use issues to the communities. For one, they need new housings of various types which can respond to the growth and changing structure of their population. City of Brainerd plans to double the area designated as residential zones and to differentiate the population density of downtown residential zones from surrounding ones¹⁰. In downtown where the designated density is higher, various housings are planned to be provided for the summer residents and for the lower income people. In Bemidji, apartments for rent and townhouses for the retirees are started to be seen, and the downtown population density has already increased. In Fergus Falls, there are new developments in the west and north parts of the city.

In these new housing developments, fiber optics has attracted home buyers to purchase their place there. In Fergus Falls, for example, we heard that some developers mentioned about the increased inquiries for newly built houses from those who wish to start working at home either as employees or as home-business owners. To the houses equipped with fiber optics, employees not only of the above mentioned new enterprises within the city boundary but also of those in surrounding cities will be attracted, because they could work at home. This means that the city will secure the new residents.

The other common land-use issue for three cities is to find the appropriate space for the new industries to come in. It was observed that the cities are responding to this problem through the revitalization of the central downtown and through the redevelopment of the areas used by old industries. Brainerd has the revitalization plan for the downtown which is now with many vacant lots. A business park is also under the way in the place where a paper mill was used to be. Bemidji started to preserve and revitalize its historic and government districts from as early as 80's. As a part of the redevelopment of the old lumber mill property by the lake, a new hotel was already built which goes with the ongoing plan for an event center, offices, shops, and housings. Plans for a business park and a research center goes simultaneously with the fiber deployment plan near the local airport and in the lot where a high school stood. In Fergus Falls, a part of the downtown residential zones will be designated as retail/business zones. What will happen with further fiber deployments are to invite a Chinese university to the old psychiatric institution site and to build a business park near the local airport.



[Figure 8. City of Bemidji Land Use Plan]



[Figure 9. Areas Planned to be Developed in Fergus Falls]

7. Conclusion

In this paper, after the increase of fiber optic communities in the United States was confirmed, three primary patterns among them were identified in terms of their running organizations and geographical distributions. They are:

- Pattern (1) Fiber deployments to existing communities in highly-densed metropolitan areas by RBOC
- Pattern (2) New residential developments armed by fiber optics which are introduced by developers in conjunction with CLECs
- Pattern (3) Fiber deployments to existing communities in low density areas, such as outer suburbs or rural areas, by independent telcos and public organizations.

3 types of running organization (Type I, II, and III) which represent pattern (2) and (3) were then chosen to be the research subjects for case studies in which their fiber deployment and running strategies as well as their spatial aspects were analyzed. The followings are the findings of and considerations to these case studies.

In Type I, developers, in conjunctions with CLECs, introduce fiber optics to new residential developments. There, the idea of “good communities” is a major attraction to promote home sales, and fiber optics is strategically used as a tool to materialize active communities. Efforts to create towns which do not completely depend upon the metropolis were also observed. The large variety of housings is provided, for example, and retail, business, and educational land use are planned within the development.

In Type II, small municipalities in suburban and rural areas collaborated in founding UTOPIA which provides fiber optic services. UTOPIA’s business is to deploy and maintain the infrastructure itself. Therefore, its direct contribution in taking advantage of fibers for the economic and social benefits of the local communities is limited. However, in certain municipalities, efforts to use fiber optics for the economic development and to coordinate it with land-use plan were observed.

In Type III, in thinly populated rural areas, cooperatives recognized the needs of the communities, built the sound deployment plans which respond to them, and are steadily expanding the infrastructure. They work with local school districts, chamber of commerce, or hospitals in trying new application of fiber optics, which could create future demands.

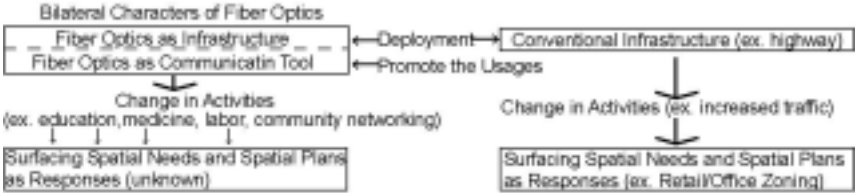
In summarizing the above findings, authors would like to point out the following four insights which relate to the fiber deployments and application of fiber optics.

1) In the United States where many public services are under the free competition, information infrastructure has started to be recognized not as a “convenient” tool but as an “essential” one. As seen in Type II and III, in the areas where their markets are small, organizations which are not solely profit pursuing, such as municipalities or cooperatives, have started to assume the role of building infrastructure. This shows that we are now in the era in which high-speed large capacity information infrastructure is considered to be vital for the local community and quality of life.

2) As a deployment strategy to rural and suburban areas where the market is small, Type III seems to be the soundest one because it is based on either already secured demand or relatively conservative forecast of it. Yet this may not make a general solution, since not all the rural/suburban communities have an organization which is community-based and has enough fund-raising ability. Therefore, Type II, the one by municipalities, can be an alternative solution in expanding the infrastructure. The issue in this case is the loose linkage between the deployment and use of fiber optics, yet if this is solved, there can be a new development of this type.

3) The key factor in successfully taking advantage of fiber optics for the economic and community development is the extent to which the running organization collaborates with its community and users. In Type I, the organizations which support the community activities are the ones which operate the usage of fibers. This system made virtual networks which also connected to the community activities that take place in the physical space. In Type III, running organizations work with local school districts, hospitals, municipalities, and businesses. Through these ties, fiber optics contributed to the education and successful invitation of new enterprises.

4) Fiber optics has a “hard” face as infrastructure and a “soft” one as a communication tool. Because of this bilateral character, the existence of fiber optics will be properly reflected to the spatial plan, only when it is physically deployed as infrastructure, its application is promoted, and the spatial needs evolved from its use are understood.



[Figure 10. Relationship between Fiber Optics and Our Spatial Environment]

In the cases of conventional infrastructure such as water/sewage or highway, as soon as they are built, houses and economic activities gather around them. Based on the experience, we know which activities will be brought into by these infrastructures, and therefore, could make proper plans for the land use and for related spatial environment. Fiber optics could bring about much more diverse activities. Further more, we do not yet know enough to make a logical forecast on what these activities require to physical environment. In the United States, broadband including fiber optics has just been expanded and recognized as a vital element of life. Authors observed that it has not reached to the stage in which people feel that their spatial environment should transform because of the new ways of life brought by fiber optics.

In the case studies of this research, too, the existence of fiber optics was not clearly reflected on to the housing or land use plans. However, as was found in Type II and III, municipalities have already recognized that the land use plan should incorporate the change of work and life evolved by fiber optics. The “recognitions” such as this, or needs for the different spatial environment have started to be observed.

In the future, when fiber optics expands into wider geographical areas and deeper into our lives, our new ways of life will have conflicts with the existing space around us, which will require the new spatial planning strategies.

Lastly, let us make a bold comparison. In the past decades in Japan, many public theaters/event-halls were built for “multi-purposes.” Yet since they provided these “hard”

and bare public infrastructures without clear directions how to use them, they ended up serving no purpose. The same could be said to fiber optic communities. Unless we foresee the kinds of its application and prepare the physical space for them, fiber optics would not enrich the local communities. It is therefore necessary to closely observe the developments of the use of fibers in our life and of the new spatial requirements brought by fibers.

Notes

- 1) Besides Fiber Optic Community, there are other names such as FTTH Community and Connected Community.
- 2) A fraction of this phenomenon was reported by some trade journals. One article suggests that these communities should be called “Fiber-connected Communities” in order to differentiate them from “Communities with Fiber”. (Moshia Zager, “Behind Numbers: Fiber Connected Communities and Communities with Fiber,” *Broadband Properties*, September 2007, Vol.7, No.10, pp.16-19)
- 3) States which are experiencing the decrease of providers are North Dakota, South Dakota, and Minnesota, which are on the west side of Great Lakes, as well as states in inland East coast such as West Virginia and Pennsylvania.
- 4) The presentation themes at the recent trade conference clearly show that those in fiber optic business are developing the products and services for e-learning, telework, and telemedicine, in addition to the application to the home itself such as home automation. (FTTH Conference, October 2007, Florida)
- 5) The number of houses which can be connected easily and cheaply to the fibers optics which has already been laid down to the point close to them (“home-passed”).
- 6) The number of homes which subscribe to the fiber optic services “Subscription” or “Home-connected”).
- 7) In the United States, three services including internet, phone, and video (TV) are often provided together by one provider. In this paper, providers of this kind are called as “information service providers” in order to differentiate them from Japanese service providers which usually only provide internet service.
- 8) This is especially so in the residential developments with more than 100 housing units. Among those completed in 2007, 25% have fiber optics. Among those would be constructed in 2008, 60% was expected to have fiber optics.
- 9) In Texas, there are 67 Type I fiber optic communities. Utah has 7 Type II fiber optic communities. There are 7 Type III fiber optic communities in Minnesota. (Number of communities which already had services provided as of 2006)

10) List of interviewed organizations

Texas	Minnesota
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The Johnson Development Corporation Sienna Plantation Residential Association, Inc. En-Touch Systems, Inc. Newland Communities Telfair Life	Minnesota Telecom Alliance Consolidated Telecommunications Company Park Region Mutual Telephone Company Fergus Falls Public Schools ISD #544 ACS
Utah UTOPIA head quarter (including representatives from Centerville, Layton, Midvale, Orem, Tremonton) PacketFront Brigham City Lindon City Alpine School District Broad Dog Technology	Fergus Falls Medical Group Fergus Falls Economic Improvement Commission Federated Telephone Paul Bunyan Telephone Joint Economic Development Commission

- 11) Both communities are located below sea level and more prone to floods than older communities on north and east side of Houston. In addition, Telfair is the redevelopment of the old prison site.
- 12) Since “good community” is a sales concept by the developer, the wording cannot have a clear definition. Yet sales brochures and the interview with the developer suggest that it means a tight connection among residents. In Telfair, for example, one of the catchphrases is “Connection Enhanced” which also implies the connection by fiber optics.
- 13) There is no scholarly definition for “master planned community.” Yet in general, it means a large suburban residential development which involves multiple builders and includes various recreation, education, and retail facilities.
- 14) The slight difference between them is that Sienna had a co-marketing agreement between the developer and En-touch from the start which Telfair did not have.
- 15) Based on statements from Newland Community’s staff
- 16) Council on Foundations defines community foundations as “nonprofit publicly supported organizations which carry out broad-based charitable interests for the benefits of residents of a defined geographic area.” At Telfair, at the time of a sale of new or existing house in the community, 0.25% of the sales price should go to the foundation.
- 17) Intranet often means an information network built within a certain organization such as a company or a school. Yet it could also refer to a web site to which only the users of that particular network can have accesses. In this study, latter is addresses as an “intranet site” to avoid confusion between the two.
- 18) On academic articles and statistics, words such as telecommute: employees work at home, telework: work from anywhere using ICT, work-at-home, and home business are clearly defined and differentiated. However, in everyday use including the interviews of this study, interviewees seldom differentiate them. In this paper therefore, author use only two wordings here, i.e. telecommute and home business. Both take place at homes. The former is used for the employees, the latter for small business owners.
- 19) For example, among houses on sales at Sienna Plantation at the time of studies, houses in the \$200 to 299 thousand range have floor area of 2,500 square feet in average, when their average

lot size is 9,000 square feet. For more expensive houses around \$350 thousand, average floor area is larger which is 4,200 square feet; however, their average lot size is not much bigger and stays around 10,000 square feet.

- 20) Based on the interviews at UTOPIA and at PacketFront
- 21) United States Department of Agriculture provides low interest rate loans for those who provide broadband infrastructure in rural areas.
- 22) In the system of public schools in the United States, a school district governs elementally, middle, and high schools within one or more municipality areas. It makes decisions on educational and administrative policies in the district, including the one for the use of information networks.
- 23) For example, two Lindon residents who are friends of a UTOPIA representative work at home for full time by using fiber optics. The service fees for fibers at their homes are paid by their employees.
- 24) Based on the statements from the planning staff of Lindon City: “(Because of fibers,) the life style of our residents will change. Yet it will not change (the form of) our city or make it necessary to change our land-use plan.”
- 25) UTOPIA reimburses the construction cost to the city.
- 26) A general plan in a municipality is a comprehensive plan which outranks other local plans such as economic development, land use, and housing plans.
- 27) According to the statements by the mayor of Brigham City
- 28) According to Minnesota Telecom Alliance
- 29) As an exception, some backbones within the area served by CTC are co-owned by multiple organizations including a school district and a local government.
- 30) Based on the interviews with ACS, Joint Economic Development Commission in Bemidji, and Minnesota Telecom Alliance.
- 31) An example of their effort is that, in some of the areas served by Paul Bunyan or CTC, fiber optics was not deployed to a door of each house at once. Instead, fiber-to-the-curb, which is a less expensive method, was temporarily employed to lower the cost.
- 32) According to Paul Bunyan Telephone

¹ Tony H. Grubestic & Allan T. Murray, “Waiting for Broadband: Local Competition and Spatial Distribution of the Advanced Telecommunication Services in the United States” *Growth and Change*, Vol.35, No.2 (Spring 2004), pp.139-165

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- ² Putnam, Robert D. *Bowling Alone: The Collapse and Revival of American Community*, Simon & Shulster, New York, 2000
- ³ “FTTF Customer Total Doubled in One Year”, *Broadband Properties*, April 2006, vol.25, No.4, data by Render, Vanderlice and Associates as of April 2006, pp.16-23
- ⁴ *Fiber-to-the-Council*, July 2007
- ⁵ Steven S. Ross, “Batting Almost a Thousand”, *Broadband Properties*, April 2006, vol. 25, No.4 data by Render, Vanderlice and Associates as of April 2006, pp. 16-38
- ⁶ Mosha Zager, “Behind Numbers: Fiber Connected Communities and Communities with Fiber,” *Broadband Properties*, September 2007, Vol7, No.10, pp.16-19
- ⁷ Research and Markets, “Community Outreach: Broadband in and Markets: Broadband Becoming the Common Component of Many Planned Community Projects” *Fiber optics weekly update*, July 1, 2005, Information Gatekeepers, Inc. Article retrieved from http://findarticles.com/p/articles/mi_m0NVN, on November 27, 2007
- ⁸ Yoko Kawai, “Work//Life Community by Telework – Possibility and Issue in Loma Linda Case,” *Journal of Green Building*, vol,3, No.2, Spring 2008, pp.128-139
- ⁹ National Telecommunication Cooperative Association, “NTCA 2007 Broadband/Internet Availability Survey Report”, September 2007
- ¹⁰ City of Brainerd, “Brainerd Comprehensive Plan 2004”,2004