Rationale, Specification, and Work Plan Proposal: The Dan River Area Advanced Network Infrastructure Project

The Opportunity

The premise underlying our activities exploiting advanced network and internet capabilities has been and continues to be that there is substantial competitive advantage for regions, communities, businesses and individuals in being near the leading edge of developments in this arena. As incredible as the first generation Internet ride has been, what is on the horizon in advanced network and communications capabilities may be even more significant. Just one example is the extraordinary potential change in the economics of access to advanced network services these technologies may enable.

The next generation of internet technology will enable the integration of telephone, television and advanced internet services. It will make visual communications and teleconferencing as easy and as economical as a telephone call. It will reduce the cost of communications to the point that most communications - audio, visual, eventually even virtual reality based communications - will have little sensitivity to distance or time. For instance, it is possible today to design and implement a communications network & a profitable, competitive business model that would eliminate “long distance” pricing of communications services anywhere in the state of Virginia.

Most important, an advanced communications system based on the next generation Internet will not be just a consumer network; it will be first and foremost, a producer network. The economies of this technology will make it possible for every individual, every connected home and business in every region and community to be a producer, a provider, of services in the network economy. Illustrated in Figure 1, these technologies are being implemented today in isolated environments as large-scale proof-of-concept projects - with some form of public involvement where risk is perceived to be high, or returns-on-investment ill-defined.

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1 This paper includes substantial extracts from work in progress by Erv Blythe, Andy Cohill, Jeff Crowder, John Krallman, Judy Lilly, Brenda Neidigh, and Jean Plymale.
The Economic Development Rationale for the Project

What are the implications of early access to these next generation technologies for our citizens and for regional competitiveness? Think about it in the context of the first (25 year) cycle in the development of the Internet.

Everything is being radically altered by the marriage of computer and communications technology. It is changing how we work, what we produce, how we socialize, how we play, perhaps even where we live. It is turning traditional businesses into low margin businesses - the advantages of being local are being destroyed thru easy access to network based, global competitors.

Premium returns are flowing to those leveraging advanced network and computer technology to do individualized marketing of customized products – to those utilizing the network economy, first to expand access to their products and services, then to add value thru one-to-one customization of those products and services. The highest returns are going to those who discover how to add value to common products and needs.

Every job is becoming dependent upon the life-long pursuit of technology literacy. According to a recent survey, 68% of all workers nationwide use computers in their jobs every day.

We are moving into an eLearning, eMedicine, eCommerce, eGovernment world. Anyone, any region, not comprehending this eWorld is in serious trouble. What regions dominate in the provision of Internet services and of technologies sustaining this first generation internet? It is those regions that were at the center of its birth and development (e. g. Washington, D. C. and its federal agencies, Silicon Valley and its research universities).

The good news is this. There are significant “first mover”, positioning advantages in this next cycle of the development of the Internet and advanced communications infrastructure.

The Internet Protocol and its new extensions, the latest fiber optic and optical technologies, and the gigabits-per-second potential of new wireless technologies, are together creating the potential for the emergence of an entirely new communications architecture and industry.

This new infrastructure will, must, allow every citizen the potential to become, not just a consumer, but also a producer and contributor of value added information and services to the national communications and information network fabric. This implies architecture and technology choices that do not prohibit very broad bandwidth (within this decade, billions of bits per second) access to and from every potential connection. It requires an entirely new array of "tools" and services that support people-to-people, people-machine, and machine-to-machine high bandwidth data couplings.
This new technology array may threaten business-as-usual for the traditional communications industry players (reference Figure 2), but eventually all that remain in business will have embraced it.

The Internet, and its next generation network promise, will prove to be the most transformational technology in history. Virginia Tech, in cooperation with individuals, communities, organizations, and regions that are invested in this idea, will work to create this 21st century environment - this primordial soup for future innovation and for future industries - out of which will come the next great companies, the next great regions, the dominant states and super-regions in the global economy.

The Definition and Rationale for the Multimedia Services Access Point Architecture

The Internet of today is a disruptive technology currently in its infancy. Most people still do not comprehend its extraordinary potential. What they see and experience is the Internet technology running over a communications infrastructure designed for entirely different forms of communications: the telephone system designed for narrow bandwidth voice communications, and the cable television system designed for one-way broadcast communications - in early 20th century parlance, we are running our internet applications over “muleways”, not "highways."

Just one example of this inefficiency in the way in which the first generation Internet in implemented is as follows. Figure 3 illustrates the “old” style of telecommunications services, in which each provider builds unnecessarily redundant facilities and provides end-to-end services without any consideration for exchanging data and services with competitors. This made sense in a regulated, monopoly telecommunications environment, in which only there was usually only one provider of each kind of service. It also made more sense before the Internet offered a way to carry multiple services (i.e. data, voice, and video) over a single cable and/or via a single service provider.

Figure 4 illustrates the “new” style of community telecommunications design, in which the community considers two key changes:

The deregulated telecommunications environment with multiple vendors in a community offering similar services, and the fact that the Internet is creating convergence of services, whereby it is possible to provide multiple services from multiple vendors over a single cable.

Multimedia Service Access Points (MSAP) and co-location facilities are key components of a Next Generation Internet architecture enabling efficient, cost effective delivery of last mile services within communities. Other features include the following:

(1) MSAP's will serve as community hubs that will provide exchange and access points.

(2) The MSAP will be a place where fiber, wireless, and copper-based network facilities meet.
(3) The MSAP will accommodate new economic models for ownership of last mile infrastructure. It will be equipped to house high-end network equipment, servers, and other electronic gear.

(4) Service providers and content providers of all types will have the opportunity to reach entire communities simply by extending their product to the MSAP. A variety of middle layer components can be located within the MSAP including, for example, directory services, replicated content servers, routing services, and other elements needed to deliver new multimedia services to the home and small office from multiple, competing providers.

(5) MSAPs will be deployed in a variety of ways designed to meet the specific requirements of the client community served. For example, an MSAP could be deployed within an information technology-enabled office park to provide service to tenants of the park. Or an MSAP might be deployed within a new planned residential community to deliver voice, data, and video services to the residents via a community owned, fiber optic network infrastructure.

As shown in Figure 5, functions of MSAPs include:

(1) Hub for new broadband infrastructure development at the community and corporate campus level.

(2) Exchange point for local service providers to peer reducing costs and increasing performance in a win-win-win scenario (keep local traffic local).

(3) Insertion point for multimedia services from multiple competing providers to reach subscribers over single broadband medium (fiber, wireless, other).

(4) Community, campus, or building point of presence for new middle layer components required to implement next generation Internet (directory services, caching, routing).

(5) Focal point for technical resources and management of community infrastructure.

(6) Aggregation point for low cost access to gigabit scale network services.

The starting point for a community-based telecommunications infrastructure can be an MSAP (Multimedia Services Access Point). The goal of an MSAP is to provide a central, broadband switching and network access point for all Internet, voice, and video traffic in a community. An MSAP has the potential to substantially reduce the traffic and cost of Internet feeds for all ISPs connected to the MSAP. Furthermore, the availability of a local broadband switch point can help spur the development of new local information services that require high bandwidth for short periods of time, like video on demand, multi-point gaming, and videoconferencing.
Multimedia Services Access Point Experiences in Blacksburg, Virginia

In Blacksburg, the MSAP has been developed by Virginia Tech as part of the BEV project. Because of the increasing traffic between the Virginia Tech (VT) campus network and local ISPs, Tech’s participation became very important. Packet losses of more than 50% had already been seen between one local apartment complex and Virginia Tech servers. Local Internet users were not aware of the relatively inefficient network routing, and tended to blame Tech servers and other local servers as being “slow”.

As more apartments and businesses in town become wired, a MSAP became the only cost-effective solution to the problem of efficiently routing packets around Blacksburg. The unofficial slogan of the Blacksburg MSAP planners became, “Keep Blacksburg packets in Blacksburg!”

The creation of an MSAP also offers the possibility of disaggregating local information services from Internet access. Currently, the worldwide Internet is used as the switching point for local Blacksburg traffic. This creates enormous inefficiencies, and limits the development of innovative local information services because of the requirement to purchase an expensive Internet feed (currently about $2500/month). The creation of the MSAP allows small local business entrepreneurs to market new information services and network systems to local customers without incurring the cost of a back-bone Internet feed.

Location of an MSAP must be done carefully to minimize the cost of circuits needed to connect local service providers (ISPs and others) from the service provider office to the MSAP. Downtown areas are often ideal because the availability of good telecommunications infrastructure. Furthermore, locating broadband access points in downtown areas can be an excellent way to revitalize Street areas that have lost retail businesses to Wal-Mart style shopping on the edges of communities. The combination of an MSAP and low cost fiber connections can be a powerful economic development advantage, pulling white collar businesses and high tech enterprises in from other areas.

A recent BEV survey of local businesses indicated that some businesses would consider relocating into the downtown area if inexpensive, directly connected Internet access was available. This may be particularly attractive in small and medium-sized towns that have suffered as traditional retail businesses leave the downtown area.

Again, referencing Figure 5, the functions provided by the MSAP include:

(1) Basic IP routing

(2) A broadband switch point for public and private fiber in the community

(3) A broadband switchpoint for high bandwidth wireless services like LMDS
(4) A public directory server to help local users find and access online resources in the
community, including individual users, businesses, Web sites, videoconference sites, and
video on demand services.

(5) The MSAP can also host caching servers to speed access time for popular Internet
services.

(6) The MSAP would have enough room to lease equipment space to service providers
like videoconference services and video on demand services. Hosting these services at
the MSAP can reduce costs for the service provider and reduce the cost of the service to
consumers.

(7) The MSAP would have very high bandwidth connections to the national Internet
backbone, which can reduce costs for local ISPs. A local ISP could purchase an Internet
feed via the MSAP rather than paying for a leased line to a distant Internet connection
point.

(8) The MSAP would also have a high bandwidth connection to the regional MNAP
(Multimedia Network Access Point), which is the regional equivalent of the MSAP.

The combination of community MSAPs linked to a regional MNAP effectively creates a
regional intranet where, in network terms, all services and users are equidistant in the
network. This is desirable to spur economic development because it lowers costs for both
service providers and service users (the equivalent of flat rate telephone use).

The MSAP in Blacksburg

In Blacksburg, a centrally located MSAP facility makes it economically feasible to
connect many downtown municipal facilities, including the Lyric Theatre, the Thomas-Conner house, the Police Department, the Five Chimneys building, and the Town Hall. A
preliminary engineering study conducted by the BEV for the Town showed that direct
costs for a downtown fiber project (where the Town supplied labor) would be about
$35,000. There are many other businesses in the down-town area that could also take
advantage of a local MSAP/fiber project, which would provide better services to
businesses and consumers while lowering the cost of service.

The Blacksburg MSAP project is managed on a cost recovery basis for all ongoing
expenses incurred by Virginia Tech and the BEV. The current Blacksburg MSAP has
eight T1 lines (fall, 2000) connected to it from various local and regional ISPs (Internet
Service Providers). Service began in the spring of 1999, and the performance
improvements were dramatic. For one ISP offering DSL (Digital Subscriber Line)
service, packet latency time between a subscriber’s home and the Virginia Tech campus
dropped by an order of magnitude, from 500 milliseconds to 50 milliseconds. The
The number of router hops involved dropped from 16 to 4. In this case, the MSAP performed exactly as planned. The DSL traffic, just to traverse a distance of a couple of miles between two points in Blacksburg, was being switched through MAE-East (the central IP routing center for the eastern half of the United States). Users have reported dramatic improvements in responsiveness when accessing local Web sites and information services.

This is a two year pilot project to stimulate the development of private investment in high speed networks in the town. At the end of the two year trial (summer, 2001), the partners will review the status of the effort. It seems clear at this time that the MSAP, to be most effective and most useful to the entire community, should be operated on a nonprofit, cost recovery basis and should be managed by a disinterested third party rather than by a for-profit company. Any for-profit company managing a community MSAP would have a tremendous competitive advantage (just as local telephone companies have today with local central offices), and there will be little incentive for other telecommunications providers in the community to use MSAP facilities if the fees accrue to the advantage of a direct competitor.

The Architecture of the Multimedia Services Access Point
The generic MSAP facility (see Figure 6 on the next page) will typically be located in a community-managed co-location facility. The co-location facility will typically be an enclosed area of at least 500 square feet designed to meet applicable standards such as Telcordia (formerly Bellcore) Distribution Components specifications and Network Equipment-Building Standards (NEBS). The facility will be designed to consider aspects of mechanical and structural protection, including: power systems, floor plans, fire protection and HVAC systems, raised floors, suspended ceilings, cable racking, and environmental threats.

Key components include:

1. Management -- management tools that allow remote monitoring and maintenance

2. Security -- security and access control protocols for both services and physical equipment like servers, routers, and hubs

3. Content -- local content may be provided, like directory services to help users find and access local resources like printers, email addresses, Web sites, fax services, etc.

4. Cache -- caching servers may be installed to improve performance for certain services (i.e. a Web page caching system).

Wireless services like LMDS and MMDS must be switched onto and through wired systems. The MSAP provides a convenient location for this.

Co-location space is available in the MSAP (typically industry standard 19” racks) for information service providers that want to reduce costs by gaining broadband access at a
central location. These services might include videoconference system, streaming video, and video on demand services that would be impractical to offer economically without a central broadband aggregation point.

The network architecture within an MSAP will include multi-service switch facilities designed to enable communication among subscribers and delivery of service from application service providers. The switch environment could, for example, support peering between locally connected Internet Service Providers and content providers.

The MSAP will be designed to support a variety of plug in services. For example, service providers will be able to plug in voice, Internet, entertainment, or other products for delivery to subscribers. Operators of the MSAP will be able to plug in common service components such as IP routing, caching, or middle-ware such as directory services as required. Design for the MSAP will include ample additional rack and floor space and environmental support to accommodate these plug-ins. The network architecture should easily adapt to delivery of new types of services and scale to meet increasing performance requirements.

MSAPs will be strategically located taking into account proximity to end users, service providers, existing and prospective fiber facilities, rights of way, line-of-sight for wireless communications, cost, serviceability, and other factors. The objective will be to reach all potential service subscribers with maximum performance at minimum cost. Subscribers may connect directly to the MSAP using fiber, wireless, or other broadband media or may be connected by a local incumbent or competitive service provider.

MSAPs will be served by at least one broadband service provider offering at a minimum high performance Internet access. It is expected that MSAPs will typically offer voice services in addition to Internet service. Ideally, MSAPs will offer distribution for voice, entertainment, education and other services provided by multiple, competing application service providers. The intent is to provide a common interface and exchange point to enable very rapid development of multimedia services delivery at minimum cost. As appropriate, MSAPs may be connected to the Internet2 and Next Generation Internet national infrastructures.

In summary, the minimal or critical architecture components of a Multimedia Services Access Point (reference Figure 7) include:

1. Central location in the community often helps downtown revitalization efforts.
2. Fiber circuits between MSAP and telephone company CO must be available.
3. Sufficient space for a rack of equipment to implement the MSAP.
4. Additional space is desirable for colocation opportunities for local ISPs.
(5) Downtown location is desirable to facilitate development of fiber networks in local commercial office space.

The initial architecture of the MSAP can consist of a simple 10 Mbit/s Ethernet backbone, collapsed into a fiber concentrator. As customer demand increases, the architecture can include a high capacity ATM switch. The ATM switch will allow traditional T1 and frame relay circuits to be connected to the MSAP, and provide the switching capacity to connect, switch, and/or route higher bandwidth connections like Fast Ethernet, Gigabit Ethernet, DS3 (45 megabits/second), OC3 (155 megabits/second), and OC12 (655 megabits/second) connections. These higher speed connections are necessary to provide efficient switching and routing of voice and video circuits.

A Business Startup Scenario

Rent and utilities represent an ongoing cost. It is necessary to identify an independent third party (community network or non-profit corporation) to guarantee all rent, utilities, phone line for out of band monitoring, and miscellaneous services related to providing the physical space for the MSAP (for this discussion, we will call it ‘MSAPCO’). The MSAP switch room should be at least 12’ x 12’ square and have adequate electrical power and heating/cooling to support several racks of electronic equipment (future expansion). This cost is estimated to be approximately $350/month, including utilities.

MSAPCO would be responsible for installing fiber cable, duct, and pedestals as needed to extend network services to and from the MSAP. MSAPCO would lease out use of fiber pairs to all interested parties, public and private, on a first come, first serve basis.

MSAPCO would provide all miscellaneous equipment needed to furnish the MSAP (equipment rack, surge protectors, power cords, modem for out of band monitoring, etc). Estimated cost is $1800.

MSAPCO would purchase (used equipment might be appropriate for a start up service) a fiber concentrator and related equipment for service connections in the MSAP during the two year pilot phase. There are many equipment options available, and it is beyond the scope of this paper to discuss them, but the equipment needed to provision an MSAP may range between a low of about $20,000 for a very low cost service using a collapsed Ethernet to $100,000 or more if multiport routers and/or ATM switching is needed.

Potential ongoing management and fees in a non-profit scenario relate to the following costs:

There will be an initial connection fee to cover the costs of installing customer connections to the MSAP.
Each MSAP customer will pay a monthly connection fee to cover all out of pocket expenses incurred by MSAPCO.

Each MSAP customer will cover the initial and ongoing costs of providing their circuit connection to the MSAP (i.e. T1 circuit, leased fiber pairs from MSAPCO, etc).

Customers will have several service options for connecting to the MSAP:

1. Direct 10BaseFL connection. Customers that lease fiber pairs from the local fiber utility, or who equipment located nearby may provide a 10BaseFL port for direct connection to the MSAP concentrator. This connection will be serviced at the base price.

2. A "full-service" WAN port. In this option, the MSAP provides the router port, CSU, etc, and manages one end of the connection. The cost of the equipment, long-term maintenance, and HR costs for management of the equipment are factored into the port fee charged to the customer.

3. A co-location agreement option. Customer locates in the MSAP facility all equipment necessary to deliver a 10BaseFL port to the MSAP concentrator. The co-location agreement specifies terms and conditions including, but not limited to, liability for loss or damage, timely access for service requirements, required out-of-band access facilities, etc. It will be necessary to factor into the fee such factors as power and HVAC requirements, long-term space considerations, etc, as well as the (marginal) cost of keeping someone on-call to provide physical access to the facility.

4. Customers not able to obtain a fiber feed to the MSAP immediately could purchase a frame relay connection to the MSAP. The MSAP could support numerous connections at a 256Kbps committed information rate (CIR) by using two T1 leased lines into the local telco frame relay cloud.

Each MSAP customer will independently negotiate routing agreements with other MSAP customers as needed. Connection to the MSAP and the MSAP service fee provides only for connection to a common packet switching point. Once the MSAP is operational, additional services might be provided by MSAPCO, including special connections and circuits as new technologies become affordable, like xDSL and ATM. Because ATM can carry voice, video, and data simultaneously, a MSAP with ATM switching capabilities would provide the base infrastructure to enable very high quality videoconference capabilities in the community–between schools, between government offices, and between business offices. Transport costs would be relatively low because all data remains in the local area community network. Local video on demand services would also become economically feasible, creating new competition and alternatives to traditional cable systems.

If a major backbone Internet provider could be brought in to the MSAP, all public and private Internet feeds could be serviced from the MSAP rather from remote POPs (Points
of Presence), resulting in dramatic reductions in the cost of Internet connectivity for local users.

If a local phone company or CLEC (Competitive Local Exchange Company) installed a voice switch in the MSAP, voice over IP switching capabilities could offer new alternatives to traditional circuit-based voice telephone systems.

**The Dan River Area Project**

The Future of the Piedmont Foundation (the Foundation), with close support from Virginia Tech, has applied for economic development funding from the Tobacco Indemnification and Community Revitalization Commission to create a regional, advanced network infrastructure serving the city of Danville and Pittsylvania County. The proposal described implementation of a Multimedia Services Access Point (MSAP) to function as the focal point for new fiber and wireless broadband infrastructure serving multiple constituents throughout the area. See Figure 8.

Anticipating funding for this effort, Virginia Tech proposes to establish a three-way project leadership and implementation team consisting of the Future of the Piedmont Foundation, Virginia Tech, and a to be determined local “Internet Services Provider.”

- The Foundation, or an entity it creates, will assume an ownership and oversight role to monitor progress of the work and to own certain assets that comprise the “community owned” components of the MSAP and infrastructure.
- A local “Internet Services Provider” will assume “prime contractor” role with responsibility to plan, implement, and manage the “local” components of the project with provisos.
- Virginia Tech will assume a consultative role assisting the prime contractor with planning, design, implementation, and other tasks and consulting and reporting to the Foundation, or an entity it creates, for oversight.

(We may try to expand roles in this project to include other players such as the municipal electric utility in Danville, the local electric coop covering most of Pittsylvania County and the local school networks. The reason for this is to incorporate their expertise, capital and right-of-way access to develop a longer-term infrastructure development project that will carry us far beyond the initial project. Long term, the provision of a very high-speed advanced network infrastructure will require the running of fiber to the home as well as to the office. Through these partners, we will encourage the deployment of fiber to key areas early in the project.)

It must be asserted that the vision for the Multimedia Services Access Point architecture consists of an open access model with some degree of community ownership and/or management. Normally, we would not consider a traditional service provider, such as a telephone company or an Internet service provider, to be an appropriate entity to control the resources of an MSAP. Nor do we believe there should be government ownership or
control of communications infrastructure. Rather, we believe a new type of business is needed whose return potential lies in provisioning of service provider neutral, value priced infrastructure. We’ve use the metaphor “DMZ” to describe this role.

However, the Danville project is unfolding very rapidly, time is short, business models are in the incubation stages, and there is a need to apply the best available resources to this project to ensure success. Through an open and competitive “Request for Proposals” process, we believe it is possible to structure an arrangement for one of the local Internet Services Providers to function in the DMZ role with appropriate oversight from the Foundation, or the entity it creates. Most important, there are professionals in the Dan River region who are dedicated to the improvement of network infrastructure in the region and who are innovative, are practiced at creating new business models, understand the potential for the open access model, have good technical resources, and see opportunity to evolve their own businesses in several complementary ways. We believe one or more of the local players in the Internet arena is in the best position to play a lead role for implementation to move this project to rapid success and to explore further opportunity.
The Proposed Development Plan
We propose to initiate an effort along the following outline of tasks:

Determine “Buy-in” and Modify Approach (Virginia Tech)
- Present concept to potential Prime Contractor(s) through a competitive Request for Proposals, and negotiate a mutually agreeable contract between that Contractor and either the Foundation, or its designated entity.
- Present concept to local electric utilities, ascertain their interest and modify as mutually agreeable.

Develop Agreements
- Virginia Tech as Contractor to Foundation, or the entity it creates
  - Provide technical consultation for deployment of infrastructure.
  - Provide consultation for oversight of other contractors.
  - Negotiate funding.
- Prime Contractor as Contractor to Foundation, or its entity
  - Provide project management for implementation of work as described in the proposal.
  - Build and manage infrastructure including MSAP and network components. May be accomplished through subcontracts with other providers. Maintain ability to implement related, for-profit enterprises including data center, data archival, and others.
  - Agree to facilitate open access model with equitable and reasonable costs (Cost Plus pricing) to any providers to deliver services over the infrastructure.
  - Negotiate funding.
  - Negotiate terms.

Establish Project Leaders and Teams (Prime Contractor and Virginia Tech)

Develop Project Plan (Prime Contractor and Virginia Tech)
- Identify and Enlist All Players (public utility, school system, partners, others)
  - Review feasibility of including local municipal utility, School districts and Adelphia in the project

- Develop Marketing and Cost Recovery Plan for Connections
  - Develop Network Infrastructure Development Plan
    - Review current infrastructure – cable, telephone, net services, municipally owned
    - Review community profile and determine where to start and how to roll out implementation
    - Research Available Systems
      - Search Sources of Information to Identify Vendors
      - Trade Shows
- Search Internet
- Trade Journals
  - Acquire System Information
- Determine Services to be Provided
  - Determine mix of wireless and wired access infrastructure to be developed and timing of implementation
  - Services Type
    - Internet Access
    - Intranet Access
    - Virtual Private Networks and Security Services
    - Telephony
    - Digital Video
    - System Management
    - Other
  - Market Analysis
    - Competitive Services Available
    - Services and Pricing Required
- Develop Business Cases for Selected Systems
  - Services Supported
  - Coverage Area
  - Subscribers Supported/System Unit and Scalability
  - System Cost/Subscriber for Various Configurations
    - Equipment
      - Wireless
      - Network
      - Fiber
      - Other
    - Space and Access
    - Network Services
    - Planning
    - Design
    - Installation
    - OA&M
    - Marketing
    - Billing
- Implement MSAP
- Implement Network Infrastructure Components
  - Deploy System(s)
    - Select Project Team
    - Specify Services which can be Provided
    - Target and Acquire Subscribers
    - Specify External Service Providers
    - Specify Operation, Administration, and Maintenance Plan
- Specify Quality Control Plan
- Specify Documentation Plan
- Perform Site Surveys
- Acquire Space and Access Rights
- Design Network
- Order Equipment
- Install Equipment
- Connect Services
- Test System
- Bill for Service
- Provide Customer Care

- Develop Ongoing Management Plan and Post-Funding Business Case
Figures 1 - 8:

- **Figure 1**: The Opportunity
  - IV Commodity
  - III Commercialization
  - II Large Scale Prototype
  - I Research and Development

- **Figure 2**: Next Generation of Internet Software
  - The Internet Protocol
    - Visual Communication
    - Death of Distance
    - A Producer Network

The Network Economy

Private: Low Risk, high/early ROI
& Public: High Risk, low/delayed ROI

DoD R&D, Universities, & Private Sector

NSFnet/VERnet

IP Switching, Broadband

DmWDM

Fiber to Home

Wireless

Next Gen IP

1990's

A New Industry

A New Competitive Space

1990's

DoD R&D,
Universities,
&Private Sector

Private:
Low Risk, high/early ROI
& Public:
High Risk, low/delayed ROI

A New Industry

A New Competitive Space

The Network Economy

- Visual Communication
- Death of Distance
- A Producer Network

Figure 2: Next Generation of Internet Software
Figure 3: Obsolete Twentieth Century telecommunications infrastructure

Figure 4: The Twentieth-first Century Community Telecommunications Architecture
Figure 5: Multimedia Service Access Point
A Community Resource

Figure 6: MSAP Service Model Description
Figure 7: MSAP Generic Architecture

Multimedia Service Access Point
Enclosure designed to meet standards for physical protection
with ample rack and floor space

Service Provider Plug-ins

Service Provider Plug-ins

Figure 8: 21st Century Infrastructure Program

Commercial ISPs
Network Services
Telephone Services
Education / Distance Learning Content
Management Services
Entertainment Services
E-Commerce
Multimedia Content

Multimedia Service Access Point (MSAP)

Education
Entertainment
Communication
E-Commerce
Distributed Multimedia Services Access Point (MSAP) for Danville and Pittsylvania County

**Distributed MSAP:** one or more local and/or regional backbone network access nodes interconnected with high-speed backhaul facilities to provide a virtual high capacity access point with high-speed Internet access.

**Design Guidelines:**
- provide reliable high-speed access to users
- minimize cost of infrastructure, operation and service
- use Ethernet and Internet Protocol switch-router infrastructure where possible
- scale MSAP functionality and capacity as needed
- use whatever network media is most cost effective (e.g., fiber optic, LMDS, unlicensed wireless, other)
- distribute MSAPs where cost effective facilities are available—perhaps trading service for space
- initial access methods include the use of LMDS for local backhaul with UNII band wireless
- feeding ISM band connections to end users
- fiber optic backhaul infrastructure should be obtained over time where cost effective to replace wireless that can then be redistributed to the edge of the network
- create redundant and/or mesh network topologies to maximize reliability
- support next generation Internet quality of service features and multicast where possible