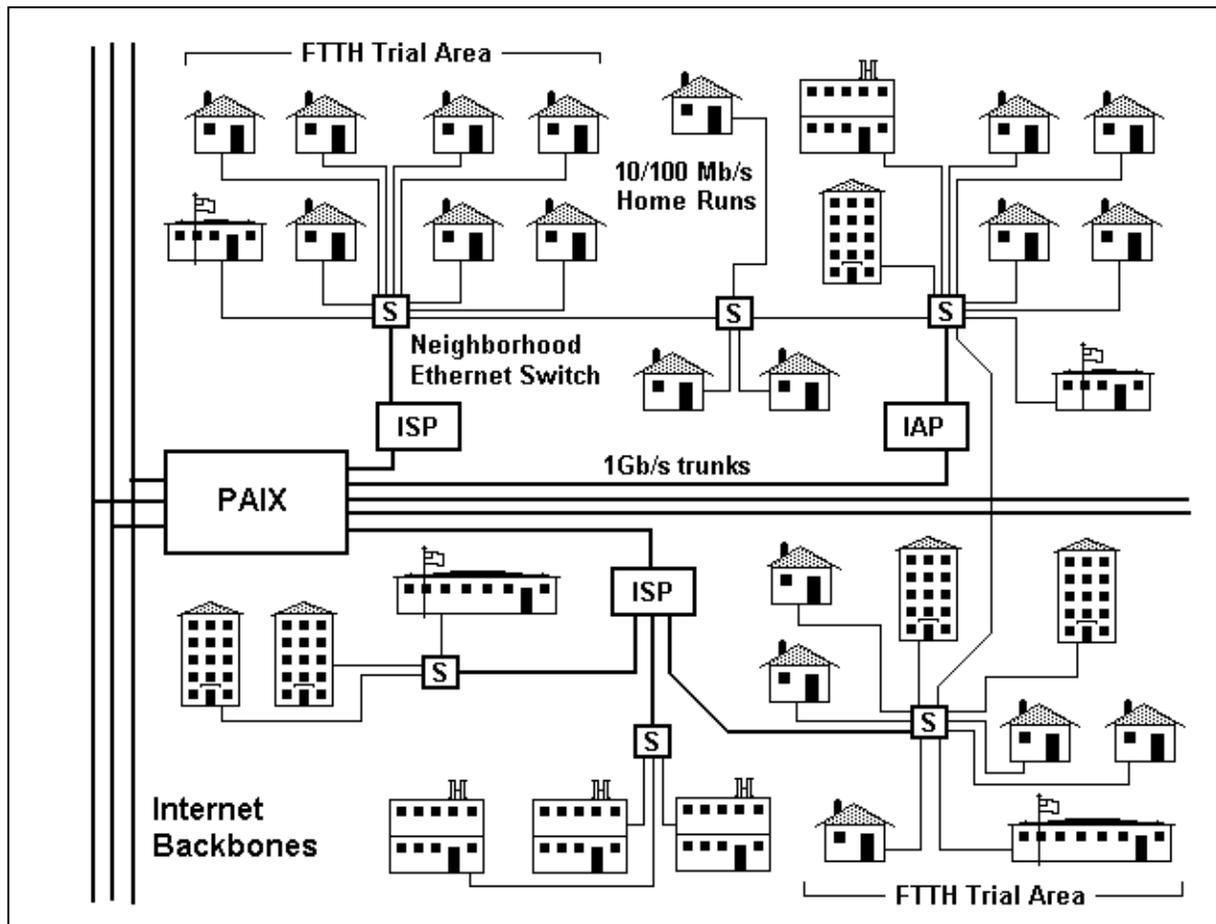


Palo Alto Fiber To The Home Trial



Contributions From:

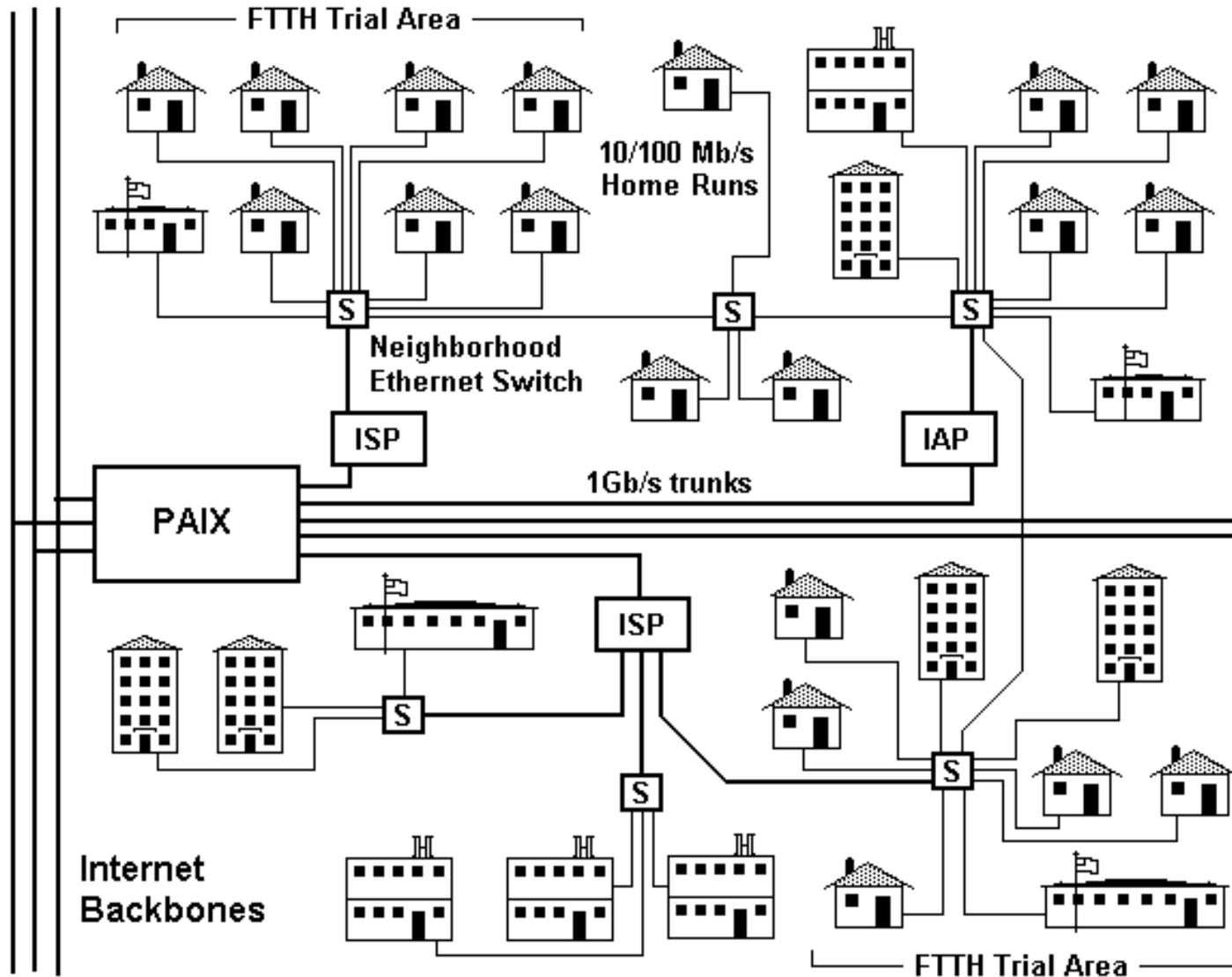
Peter M. Allen
Terry Andre
Keith Cooley
Margaret Cooley
Michael Eager
Rick Ferguson
David Harris
Warren Kallenbach
Marvin Lee
Ken Poulton
Frank Robles

The City of Palo Alto
Utilities Staff

Outline

- Goals
- Benefits
- System Description
- Cost Recovery
- Risks
- Summary

The Long-Term Goal: A City-Wide Palo Alto Fiber Network



Existing City Policy Objectives

- * *”Accelerated deployment of a broad range of advanced broadband telecommunications services to all of the citizens and businesses in Palo Alto”*
- * *”...an extension of the City’s long-standing policy of providing utilities infrastructure for the citizens and businesses of Palo Alto”*
- * *”...increased telecommunications choices for consumers”*
- * *”...minimizing disruption to the public rights of way”*
- * *”...diversify the Electric Utility’s revenue streams into a growth market and better position the Electric Utility for impending competition”*
- * *“...a valuable asset that could be sold”*
- * *”...limited financial risk exposure to the City”*

Source: City Manager’s Report on the Fiber Ring, August 5, 1996.
Unanimously approved by City Council

Palo Alto Fiber Network Objectives

- **Serve the community.**
 - Build the new roads of the Information Age
 - Enable better community communications.
 - Provide bandwidth to end the World Wide Wait.
 - Promote communication instead of commuting.
- **Minimize financial risk to our city.**
 - The customer pays for the system.
 - Safeguard our economy by building the new roads.
 - Prevent tax base attrition.
 - Avoid the ‘Invented here, Used elsewhere’ syndrome.
 - Work locally, compete globally.
- **Provide leadership, vision, and a legacy.**

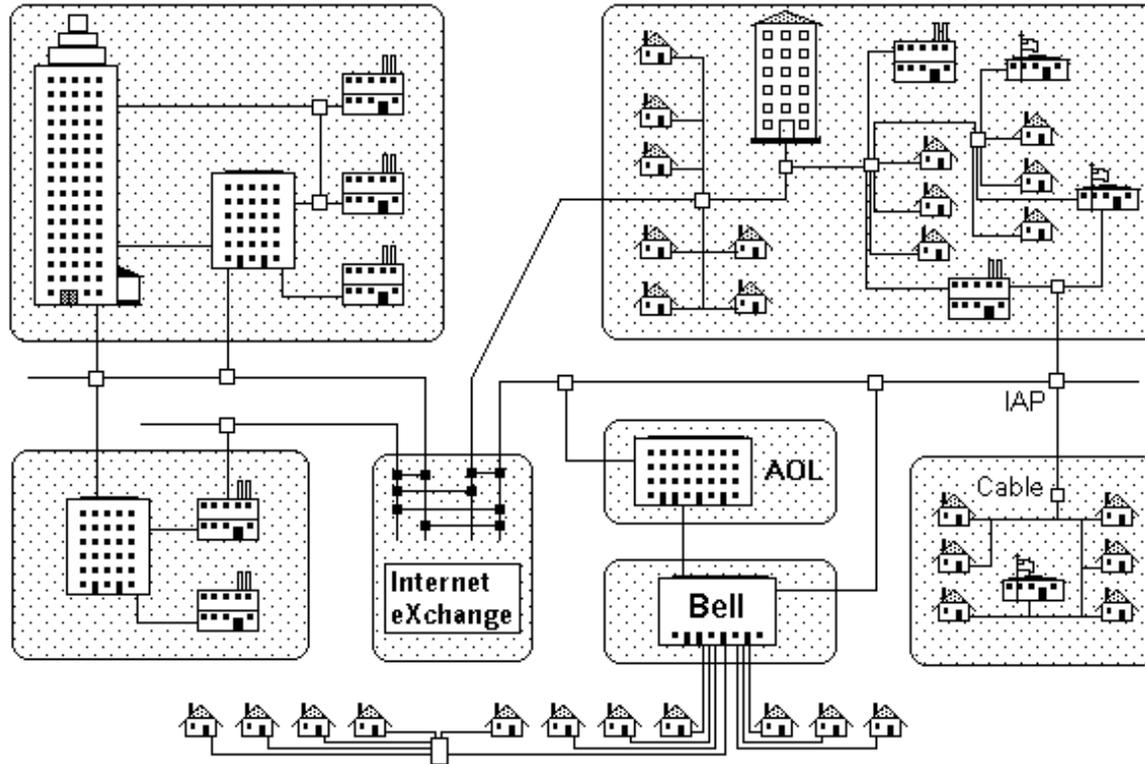
Residents' Contributions to the Utilities Department's FTTH project

- Initial idea for FTTH project in Community Center
- Publicity
- Increasing participation rates
- Reviews of and contributions to the FTTH proposal: technical, economic, organizational
- Wrote the Technical and Budgetary Report on the city's design

We have a wealth of local expertise assisting the city staff.

What is a Network?

A group of devices that can talk to each other within a policy boundary.



What is the Internet?

Networks that have agreed to communicate with other networks.

Revolutions of This Century

<ul style="list-style-type: none">• Industrial Age: Mechanical and Electrical.	<ul style="list-style-type: none">• Cars, trucks, airplanes, cinema, radio, TV.
<ul style="list-style-type: none">• Information Age.	<ul style="list-style-type: none">• Computers and the Internet.

Early in this century, cities with the best transportation infrastructure became centers of commerce.

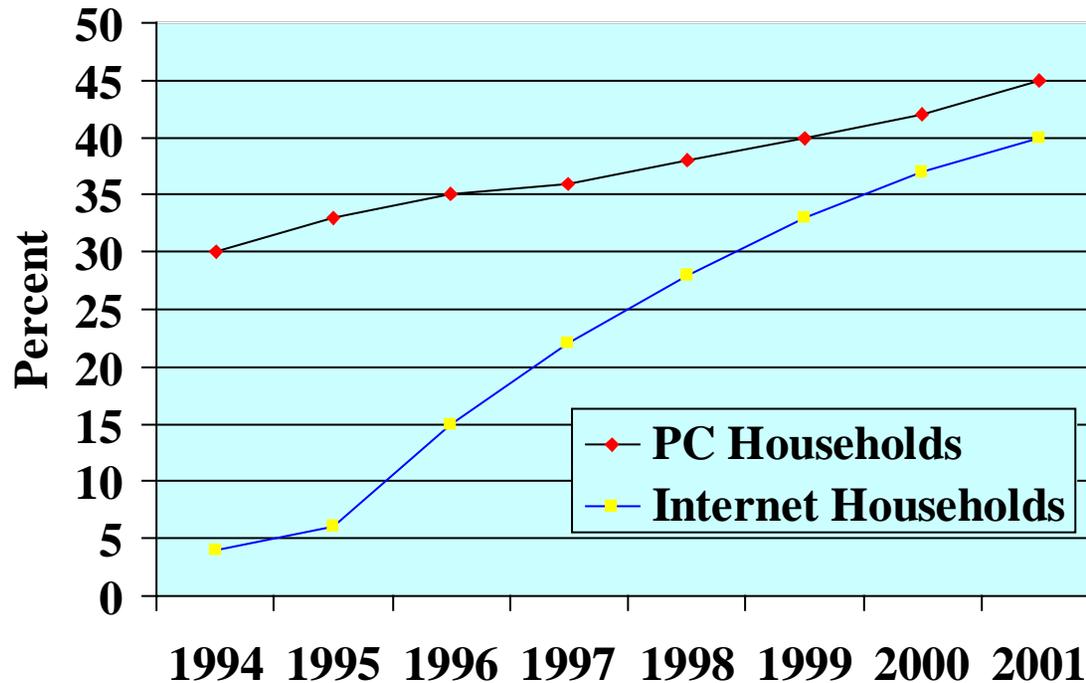
History is repeating itself with the Information Highway.

Beneficial Monopolies in the The Last Mile

Water, Gas, Electricity, Sewer, Telephone,
Cable TV, Fiber to the Home.

It never pays to duplicate Last Mile infrastructures.

Do Homes Really Use the Internet?



- * US home Internet use is approaching PC penetration.
- * 80% of Palo Alto homes have at least one computer.
- => 2/3 of Palo Alto homes (16,000) are connected to the Internet

- * Internet traffic doubles every six months!
- * Biggest Internet problem: Bandwidth in the Last Mile.

The 3 biggest Internet problems:

Bandwidth, Bandwidth, and Bandwidth

- Use is growing: New users and more frequent use.
- Richer content: graphics, sound, video, data bases.

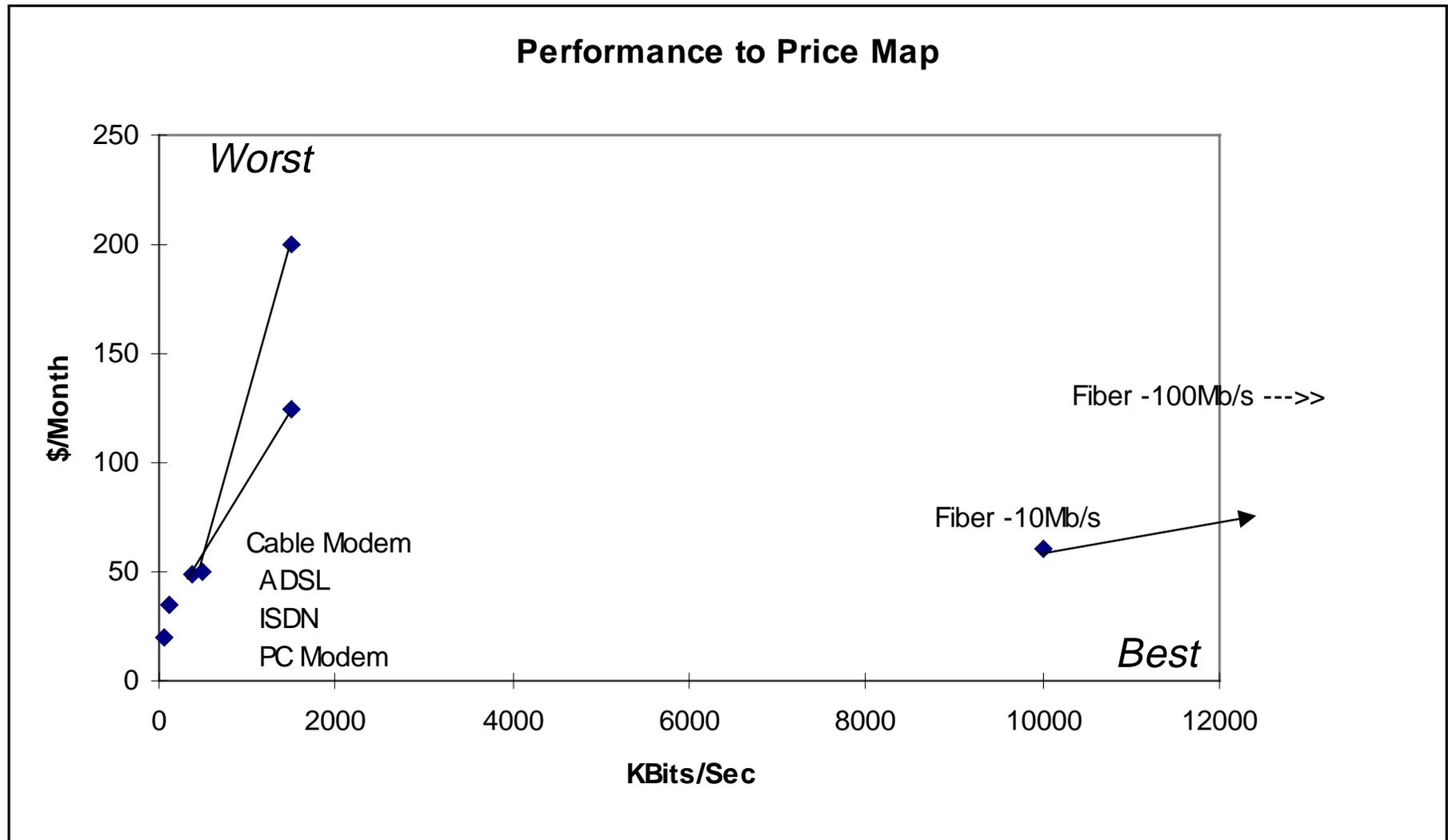
These trends create a push by producers and a pull from consumers for more bandwidth. The biggest bottleneck is in the Last Mile to the home.

Some Available Types of Data Services

Data Service Name or Acronym	Medium	Speed in Kbits/Second	\$Cost/month
Telephone Modem	Copper wire	56	20
ISDN - Pacific Bell	Copper wire	128	35
ADSL - Pacific Bell	Copper wire	384	49
ADSL - Covad	Copper wire	384	125
Cable Modem - CoOp Bronze	Copper cable	500	50
Cable Modem - CoOp Gold	Copper cable	1000	200
T1 - Pacific Bell	Copper cable	1500	1200
Fiber To The Home @10Mb/s	Fiber Optics	10000	60
Fiber To The Home @100Mb/s	Fiber Optics	100000	120

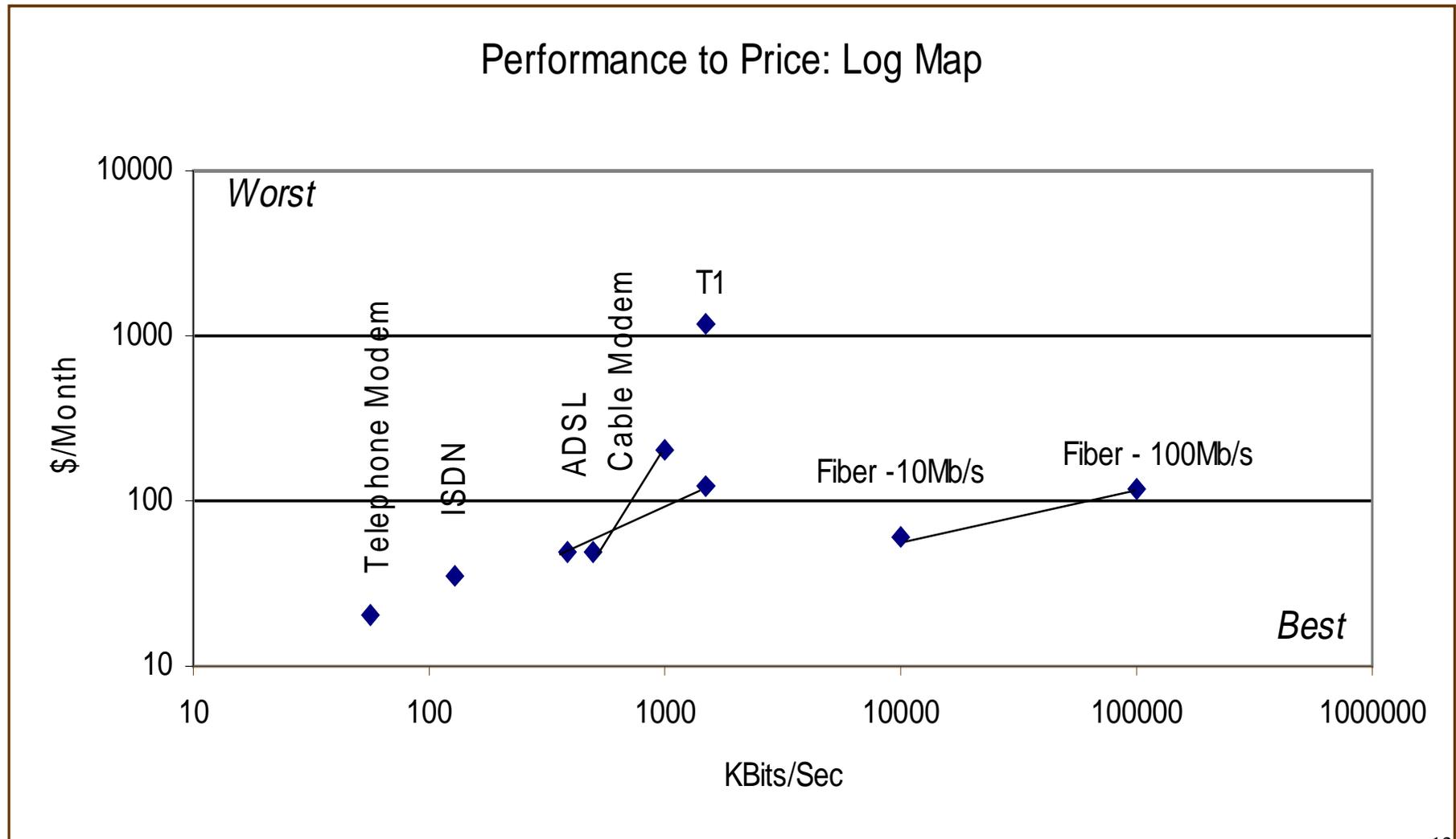
Is Fiber Optic Service a Good Value?

Yes! It is the ultimate in speed and value; It will not become obsolete; Fiber is secure; Fiber is unaffected by electric fields; Fiber does not radiate.



Is Fiber Optic Service a Good Value?

Yes! It is the ultimate in speed and value; it will not become obsolete. Fiber is secure; Fiber is unaffected by electric fields; Fiber does not radiate.



Why Ethernet?

- It's the standard - used in most offices in the world
 - 10 Mb/s is the least expensive kind of network now
 - Familiar to all ISPs
- It's easy to upgrade later
 - Many companies are creating new Ethernet products
 - 100 Mb/s will be cheap in 3 years, 1000 Mb/s in ~8 years
- It meets the whole spectrum of needs - now and into the future
 - 10 Mb/s provides enough speed for >90% of home uses
 - 100 Mb/s option can support virtually any use today
 - Room to grow as demand grows

What use is all that bandwidth?

Example: A music CD contains 660 Mbytes of data.

How long would it take to send this from Palo Alto to San Francisco?

Method	Transfer Time
56 Kilobits/second PC Modem	26.2 Hours
500 Kb/s Cable Modem	2.93 Hours
1.5 Mb/s Commercial T1 Service	59 Minutes
55 MPH Automobile	50 Minutes
10 Mb/s Fiber To The Home	8.8 Minutes
100 Mb/s Fiber Optic Service	53 Seconds

What will be the benefits of FTTH?

- **Better Communication**

- Within the community, between homes and employers, worldwide.
- Better *Quality* as well as *Quantity*
- Fast both directions - allows people to be providers, not just consumers.

- **New Ways to Work**

- Telecommuting, even for high-bandwidth tasks
- Internet-based businesses can be started in any home in the city
- Disabled or home-bound residents can work from home

- **New Services**

- Education/Research: live classes from anywhere, “Library to the Home”
- Medical: “Doctor to the Home”
- Entertainment: “Video Store to the Home”

- **Unparalleled Bandwidth and Value**

- Fiber costs are similar to medium-speed services at much higher speeds
- Fiber speeds are easily expandable by replacing inexpensive electronics
- No need to upgrade to another infrastructure

Who will benefit from FTTH?

An estimated 16,000 Palo Alto homes use the Internet today. Over 1000 want FTTH now as indicated by a one shot CPAU 'survey' via utility bill insert (8/98).

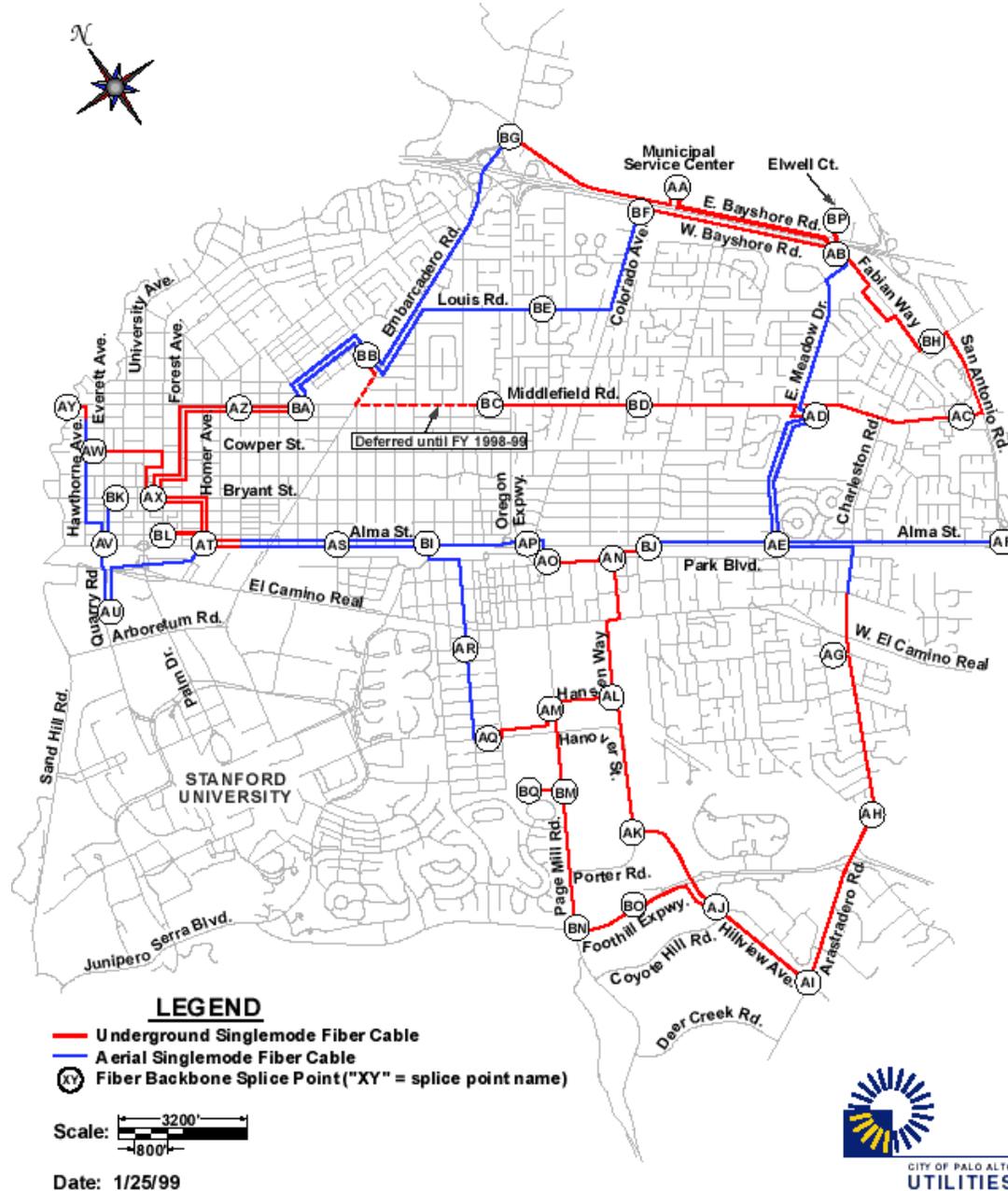
- **Homes, Schools, Libraries, and Businesses** will gain true high-speed Internet and community information access.
- **Every Palo Alto home** benefits from more choices and more competition simply because FTTH is available.
- The **City** increases revenue, commerce, and press coverage.
- **Our children** win. FTTH will grow as their information needs grow.

How does CPAU benefit from owning the FTTH system?

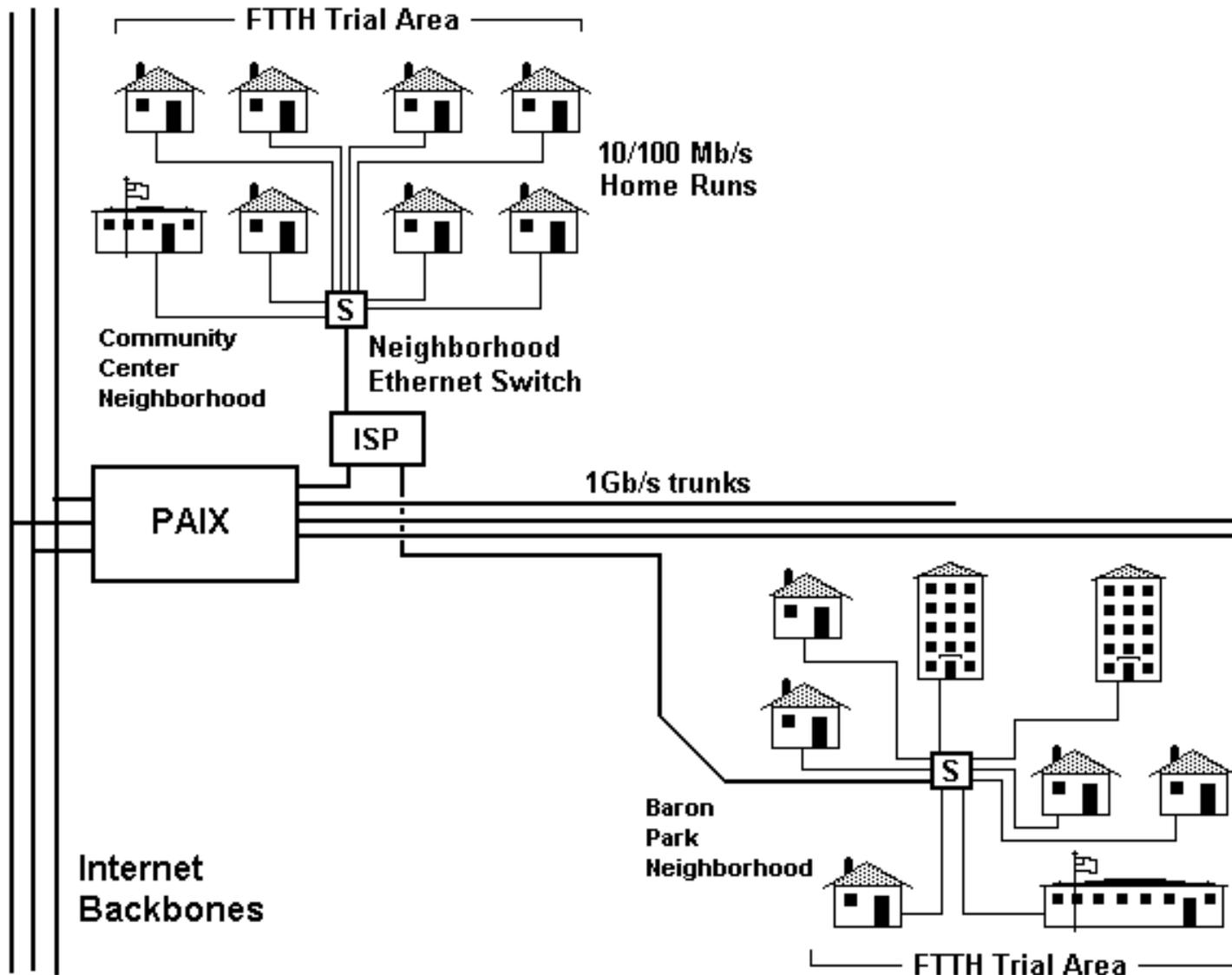
FTTH brings the city many of the same benefits as the Fiber Ring. Quoting from the Fiber Ring proposal approved by the City Council on February 26, 1996 (CMR:150:96):

- **Diversification** of the Electric Utility's revenue streams into a growth market.
- **Minimizing disruption** of public rights-of-way [underground conduits and telephone pole space].

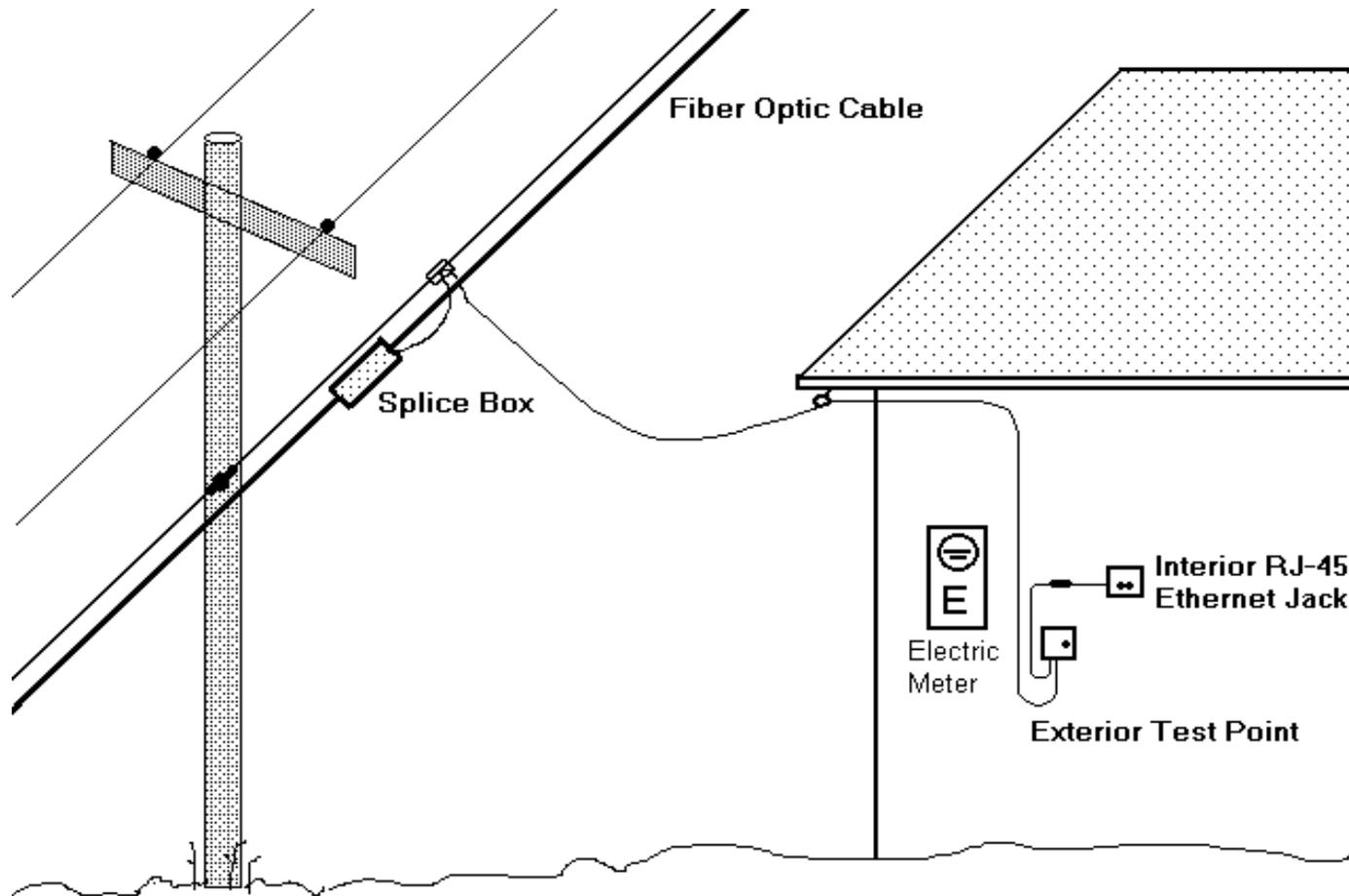
Existing Palo Alto Fiber Ring: Route Map



The Proposed Palo Alto Fiber Network Trial



Typical Pole to Home Wiring



Home installation is similar to cable modem but uses fiber.

What are the building blocks of a Network?

- **Customers**

- *Residential, Commercial, Academic, Civic, Special Interest*

- **Services**

- *e-Mail, Content, Web Hosting, e-Commerce, Education*

- **Internet Access**

- *Internet Access and Transport*

- **Network Operations**

- *Routing, Traffic Control, Security, Billing, Customer Support*

- **Infrastructure**

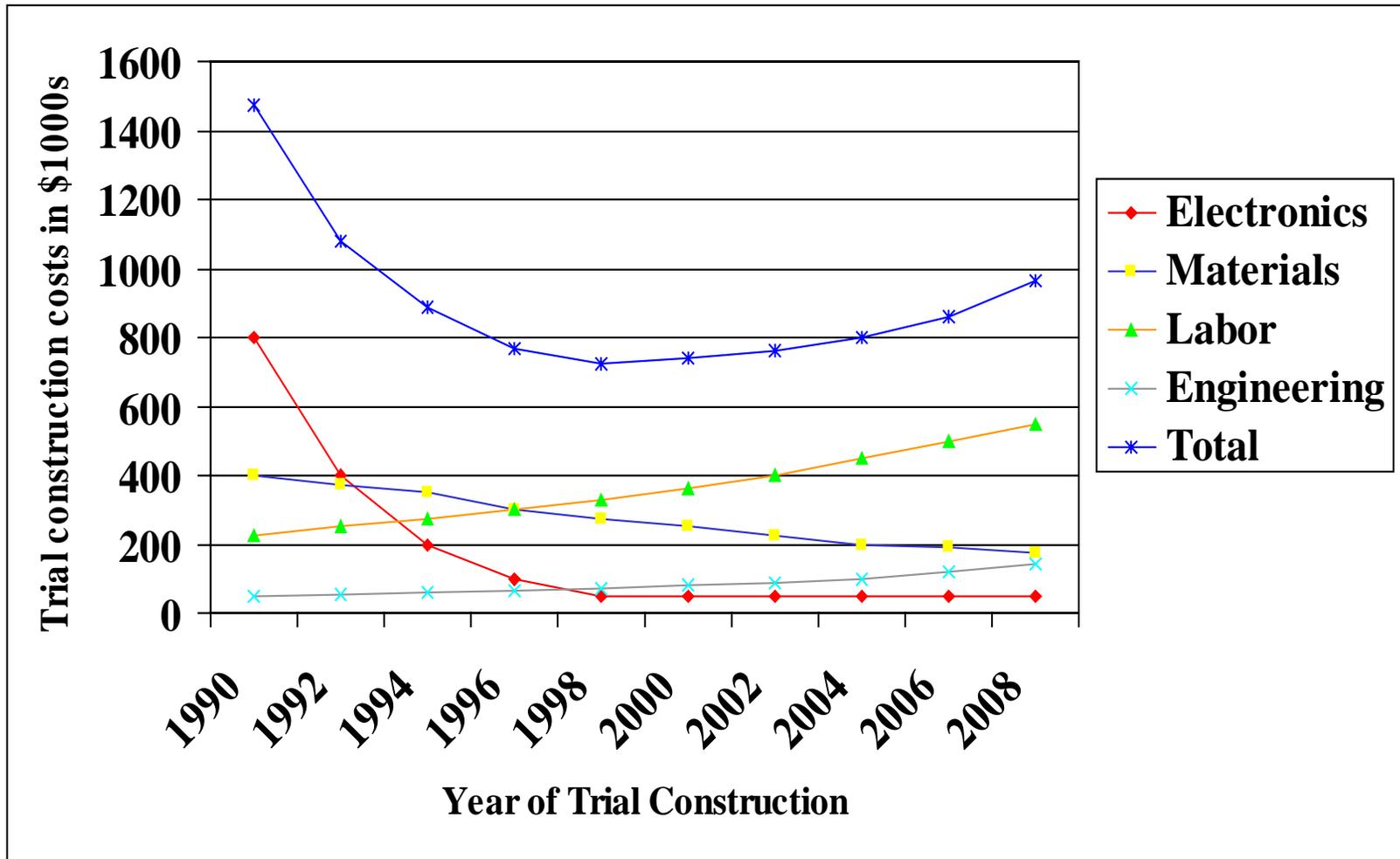
- *Wiring, Poles, Easements, Splices, Switching Equipment*

Who Does What?

<i>Trial</i>		<i>City-Wide</i>
160-800 homes	<ul style="list-style-type: none"> • Customers <ul style="list-style-type: none"> – <i>Residential, Commercial, Academic, etc</i> 	5000- 26,000 homes
Any ISP	<ul style="list-style-type: none"> • Services <ul style="list-style-type: none"> – <i>e-Mail, Content, Web Hosting, e-Commerce</i> 	Any ISP
Single IAP/ Network Operator	<ul style="list-style-type: none"> • Internet Access <ul style="list-style-type: none"> – <i>Internet Access and Transport</i> 	Competing IAPs
	<ul style="list-style-type: none"> • Network Operations <ul style="list-style-type: none"> – <i>Routing, Security, Billing, Traffic, Support</i> 	Network Operator
City	<ul style="list-style-type: none"> • Fiber Infrastructure <ul style="list-style-type: none"> – <i>Cables, Poles, Easements, Switch Sites</i> 	City

City can choose what tasks to assign to the Network Operator.
For the trial, use a single IAP/Network Operator to be cost-effective.

Cost of Construction vs. Year of Construction



The construction cost factors favor doing it right now.

Why Now?

- FTTH construction cost no longer dropping rapidly
 - Electronics now only 5% of system cost
- The market is ready
 - Telephone modems have reached the 56 Kb/s limit
 - Users starting to move to medium-speed (~1 Mb/s) services
- We have a window of opportunity
 - Cherry-picking of businesses and apartments has begun

Participation Rate

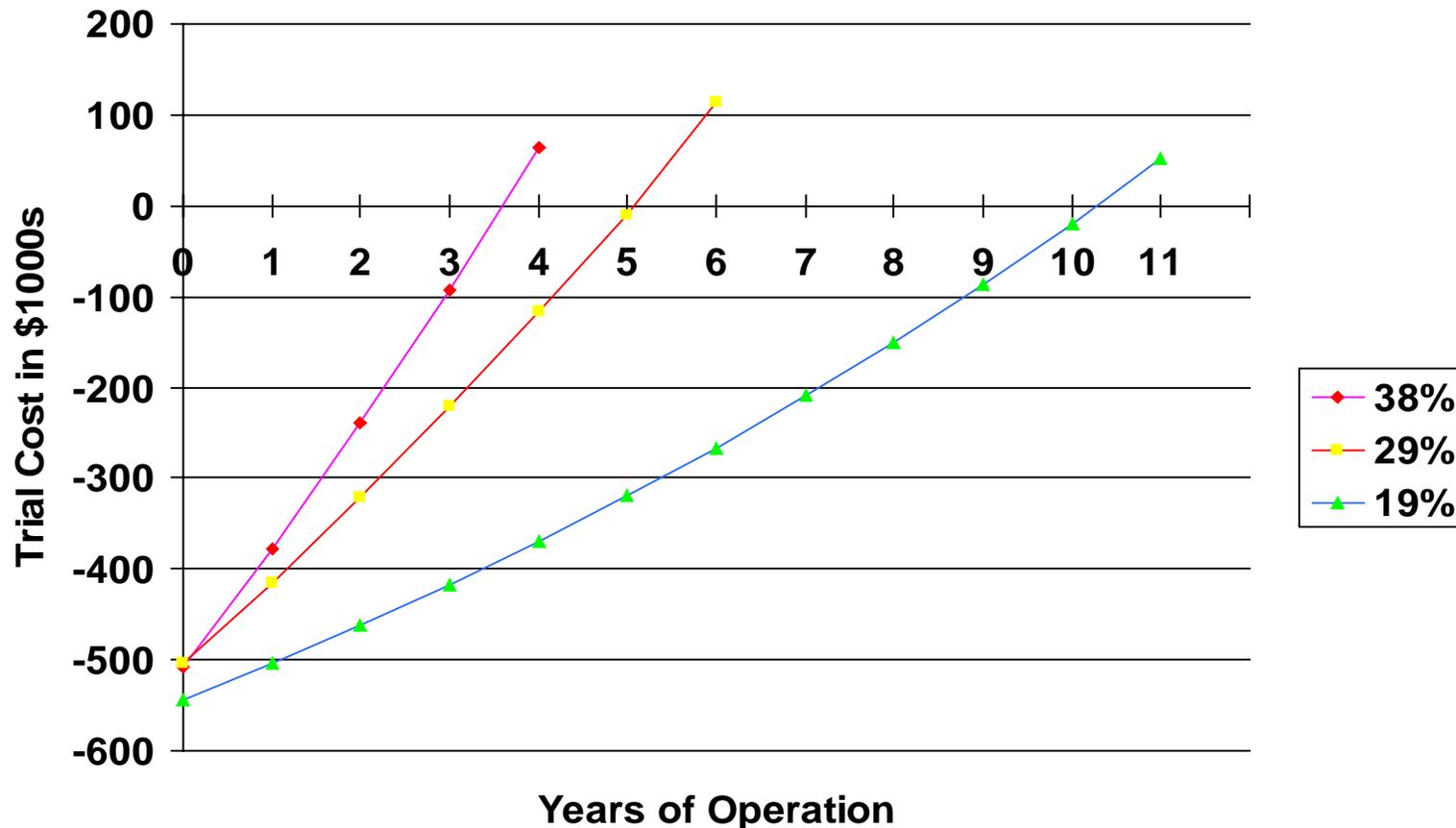
- The offer:
 - 10 Mb/s service
 - \$1200 install + \$10-35/month + unknown IAP charges
 - A first-in-the world service, not yet demonstrated
- The city's marketing:
 - A single utility-bill insert and a few ads
 - Yield: a 4% city-wide signup rate in just 4 weeks, (1% is considered a good return for blind mailings)
- The residents' marketing:
 - Flyers on doorsteps and word-of-mouth in 2 areas
 - Yield: a 19% signup rate in 2 weeks.

Participation is very likely to rise further once the system is demonstrated and marketed.

FTTH Trial Cost Recovery

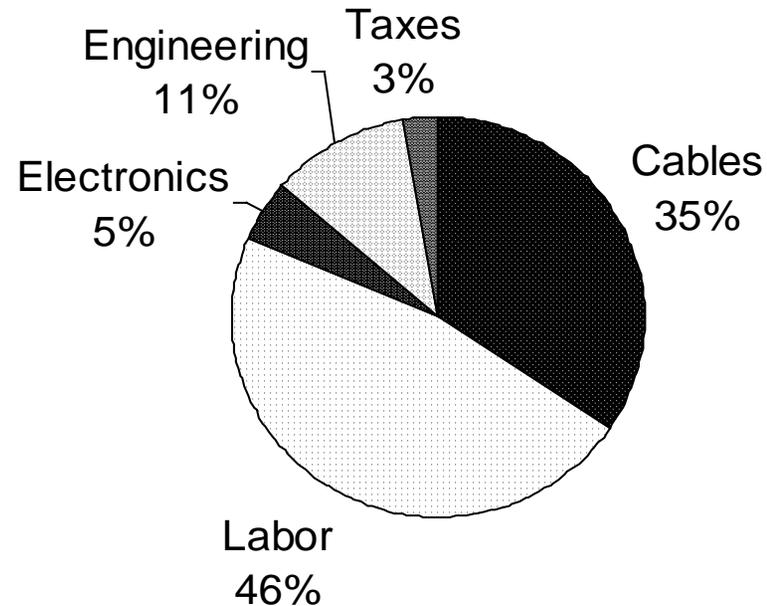
Based on Neighborhood % Participation Rates.

Installation Fee = \$1200 Monthly Subscription = \$40.



FTTH system is profitable in 4-10 years, depending on participation rate.

What are the construction costs of the FTTH Trial?



Projected fees: \$1200 installation, \$60/month
(including \$20/month to the ISP).

Construction cost is \$4,600 per home for 10 Mb/s service.

Total trial is \$753,000; \$218,000 paid by installation fees.

Didn't the City Manager's Report say FTTH takes too long to pay back?

December City Manager's Report: Cost recovery in 40 years

January Revision of City Manager's Report

– Construction cost estimate reduced by \$74,000 26 years

Option: Single-IAP Operation (City's numbers)

– Use IAP's equipment instead of building a central site 12 years

• Construction cost reduced by \$24,000

– IAP also operates network and provides customer support

• Operation costs reduced by \$16,000/year - speeds cost recovery

Additional Option: Increase fees slightly

– Increase from \$35 to \$40/month 10 years

This meets the 10-15 year recovery period advocated in the CMR.

Can we Reduce the Cost Recovery Period further?

Cost recovery period is much more sensitive to monthly revenue than to installation fees.

At 19% participation, \$40/month: 10 year payback

Ways to achieve 7 year payback:

- Increase user fees to \$50/month
- *Or* increase participation to 24%
- *Or* some of each: \$45/month at 21%

- ➔ *The cost recovery period can be reduced to the UAC-suggested 7-8 years with acceptably small changes.*
- ➔ *But further reduction would risk losing participants to lower-cost services.*

What is the Financial Risk to the City?

The city will invest 70% of the FTTH Trial cost: \$530,000.

- **Residents pay 30% of the cost up front.** Once connected, they will stay with the FTTH system because competing services are much slower for comparable monthly charges.
- **Cost recovery occurs in 10 years,** even with no new subscribers.
- Participation rate will likely increase once the system is demonstrated, thereby **reducing the payback period to as little as 3.6 years** if participation doubles.
- **No stranded costs:** The city could sell the FTTH system well below cost to recover its remaining investment (only 70% of the cost initially, less later).

The financial risk is minimal.

What Financial Obligations Are Appropriate?

- **No refund guarantees to residents**

- Once the system is up, it benefits both the users and the city to keep it running.
- The city could sell the trial system to a private operator if necessary.

- **No property liens to guarantee participation**

- The users will pay 30% of the system cost up front = 150% of the incremental per-user cost of connecting to the system.
- The city is gaining a valuable asset to secure the other 70%.
- The city should have a stake in the success of the trial.
- Requiring a 10-year lien will reduce participation and kill the trial.

***For a trial system, it makes no sense to
impose long-term obligations***

What is the Yearly Net Revenue?

Case	Investment	Net Revenue	Return
Trial, priced for 10-year payback:	\$530K	\$71K/year	13%
Scale up to a city-wide system:	\$18M	\$2.2M/year	12%
City-wide system, with 50% participation:	\$18M	\$6M/year	30%

Set the Fees to Reach the Desired Recovery Period

Payback period is most sensitive to monthly payment and participation rate.

- **Council chooses the payback period** (7-10 years).
 - Too short will increase risk of losing participants.
- Monthly rates are set to achieve the chosen payback period.
- Publicity to increase participation and **binding customer signups** proceed in parallel with design phase.

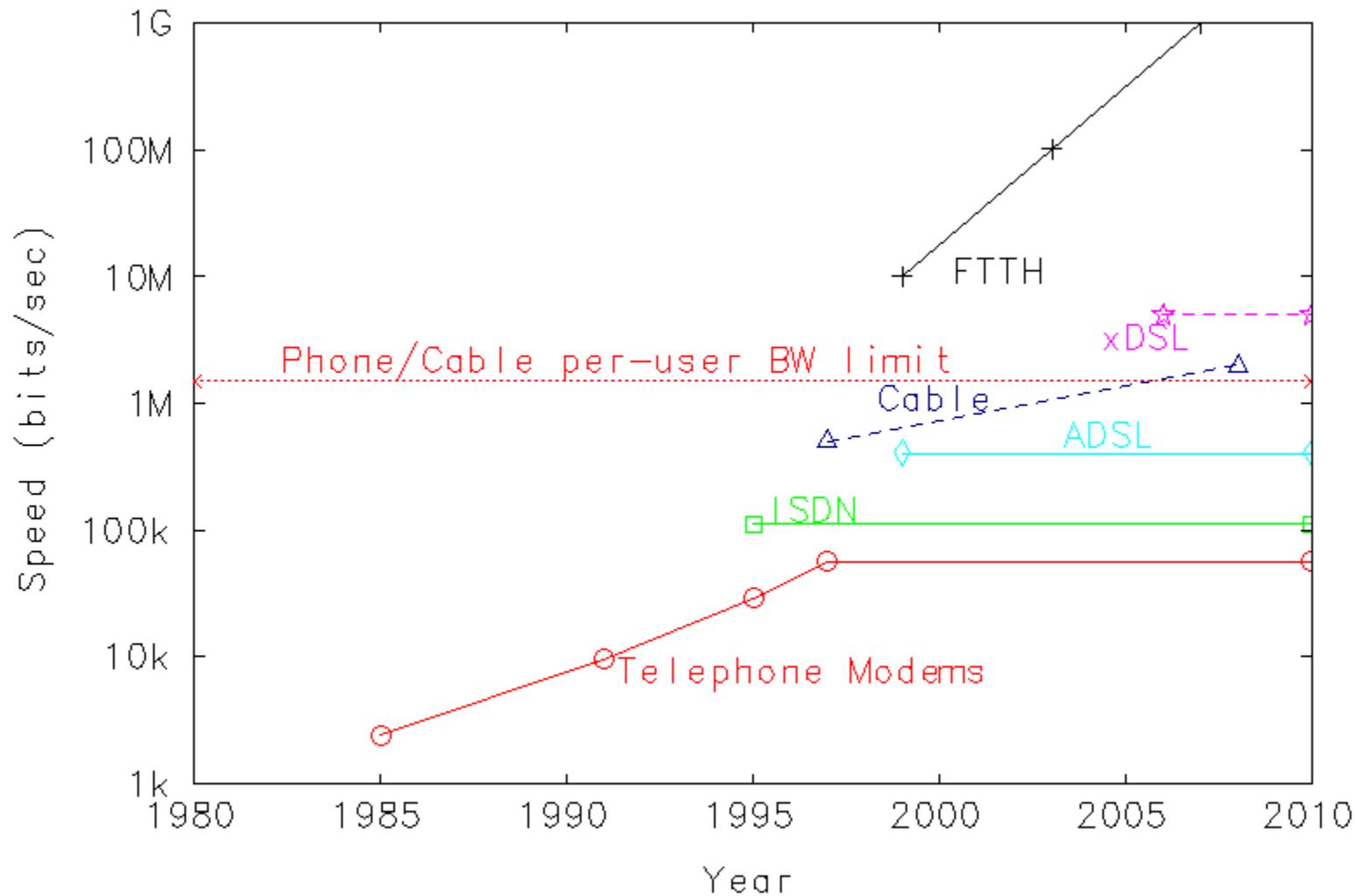
Customers can be signed up before construction money is spent.

What's the Competition for FTTH?

- Other Technologies: cable, DSL, wireless, satellite
 - FTTH has **10-100x more bandwidth** *per user* than competing technologies for the foreseeable future.
 - FTTH is **less expensive to upgrade** than other technologies.
 - FTTH monthly **fees are comparable** to other services.
- Competing FTTH systems
 - Like other Last Mile infrastructures, it is **uneconomic to build more** than one FTTH system in a given neighborhood.
 - The first builder effectively gains an **unregulated monopoly** on information delivery via fiber.

The biggest risk is in missing this opportunity.

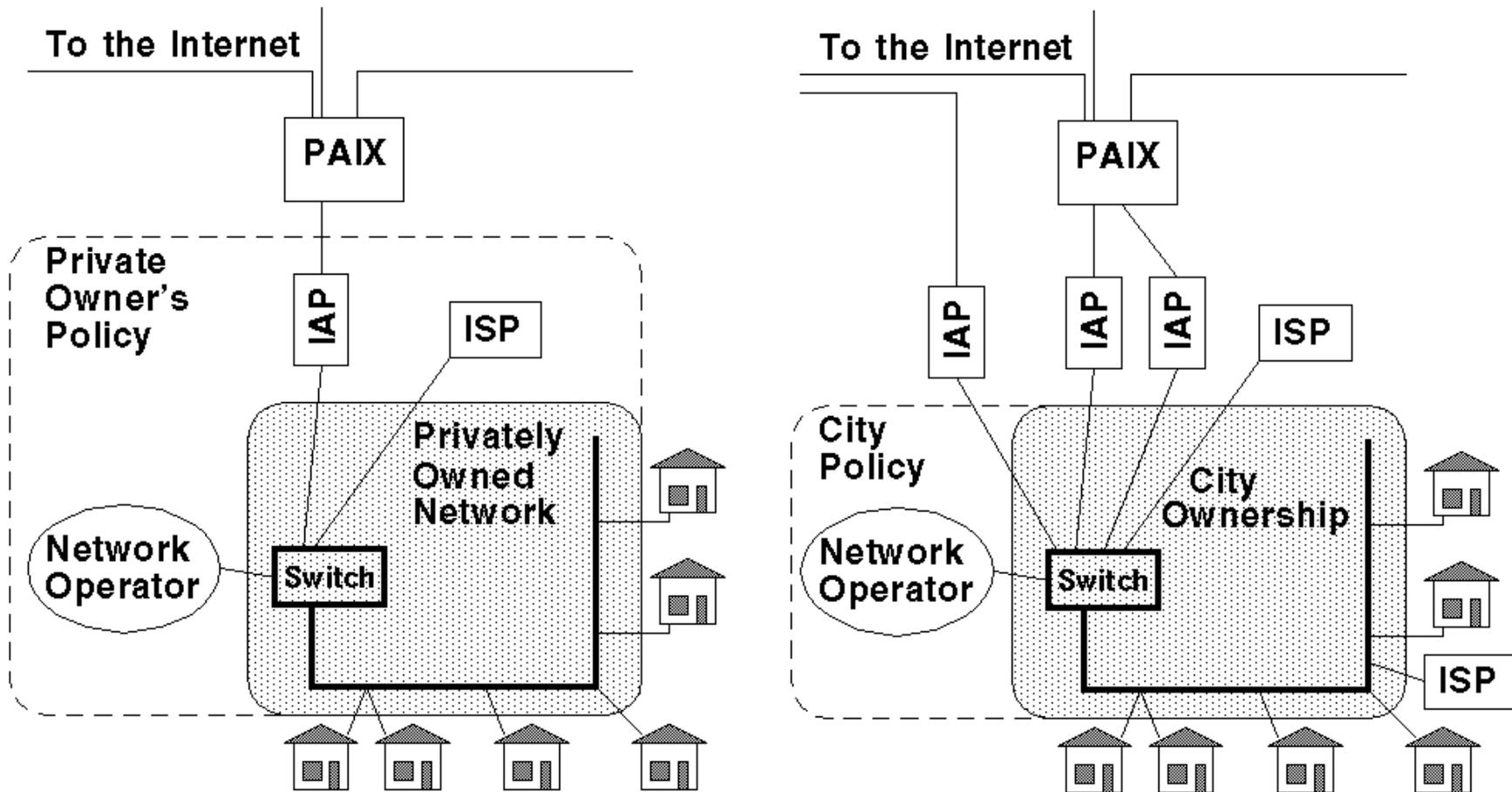
Consumer-Level Internet Access Technologies vs. Year



Any technology will need considerable new infrastructure investment to go much beyond 2 Mb/s per user.

City Ownership Enables Competition:

- multiple Access Providers
- multiple local Service Providers



Why should the **City** be involved in FTTH?

- Fulfill the City's telecom development policies:
 - **Accelerate deployment** to the residents.
 - Use the city's lower installation costs to **decrease costs** to the users.
 - Provide **additional means of revenue** for CPAU.
- **Enable competition**
 - Multiple IAPs
 - Local network services
 - Encouraged by 1996 Federal Telecom Act and State Policy.
- Use our **limited pole and conduit space** for a **long-lasting, expandable system**.
- **Focus on community benefit** first, profits second.
- Maintain Palo Alto's position of **technical leadership** in the world while building a **community legacy**.

Why Should the Trial Include Both Neighborhoods?

- Fairness
 - 2 areas chosen by staff because of local initiative -> high participation -> good economics
 - Avoid appearance of a North-South preference
- No public discussion of the best size for the trial
 - Telecom Advisory Panel discussed a 1% trial (full-size trial is 0.6%)
 - Utilities Advisory Commission discussed only the full-size trial
 - Policy and Services Committee never discussed trial size, but put the mid-sized trial into their motion
- Efficiency
 - Learning curve: installation process gets faster as you do more
 - Overhead spread more widely for a larger network -> faster cost recovery
- Diversity and size reduces risk
 - Larger numbers reduce statistical uncertainties
 - Construction: we should try underground, street poles and backyard poles
 - Homes: very old, very new and new development

= > A bigger trial predicts a city-wide system better

How Big are Other Telecom Trials?

• Sweden: IP Telephone trial	300 users
• Sydney: IP Telephone trial	250
• Netherlands: Lucent cable modem trial	1000
• West Indies: Lucent wireless trial	500
• London: Fujitsu ADSL trial	2000
• Boston: US West video-to-home-computer trial	180

*Even the full-size FTTH trial (160 homes) is a small trial.
69 homes is too small.*

Results of the Trial

- **Demonstrate** that FTTH is practical and pays for itself.
- **Refine** the construction and operational cost models .
- **Work out** operational details and user support.
- **Measure** user satisfaction.

- **Start bringing the benefits** of office-grade data networks to Palo Alto residents.
- **Increase awareness, demand and financial justification** for a city-wide FTTH system.
- **Reduce uncertainties and risks** of a city-wide FTTH system.

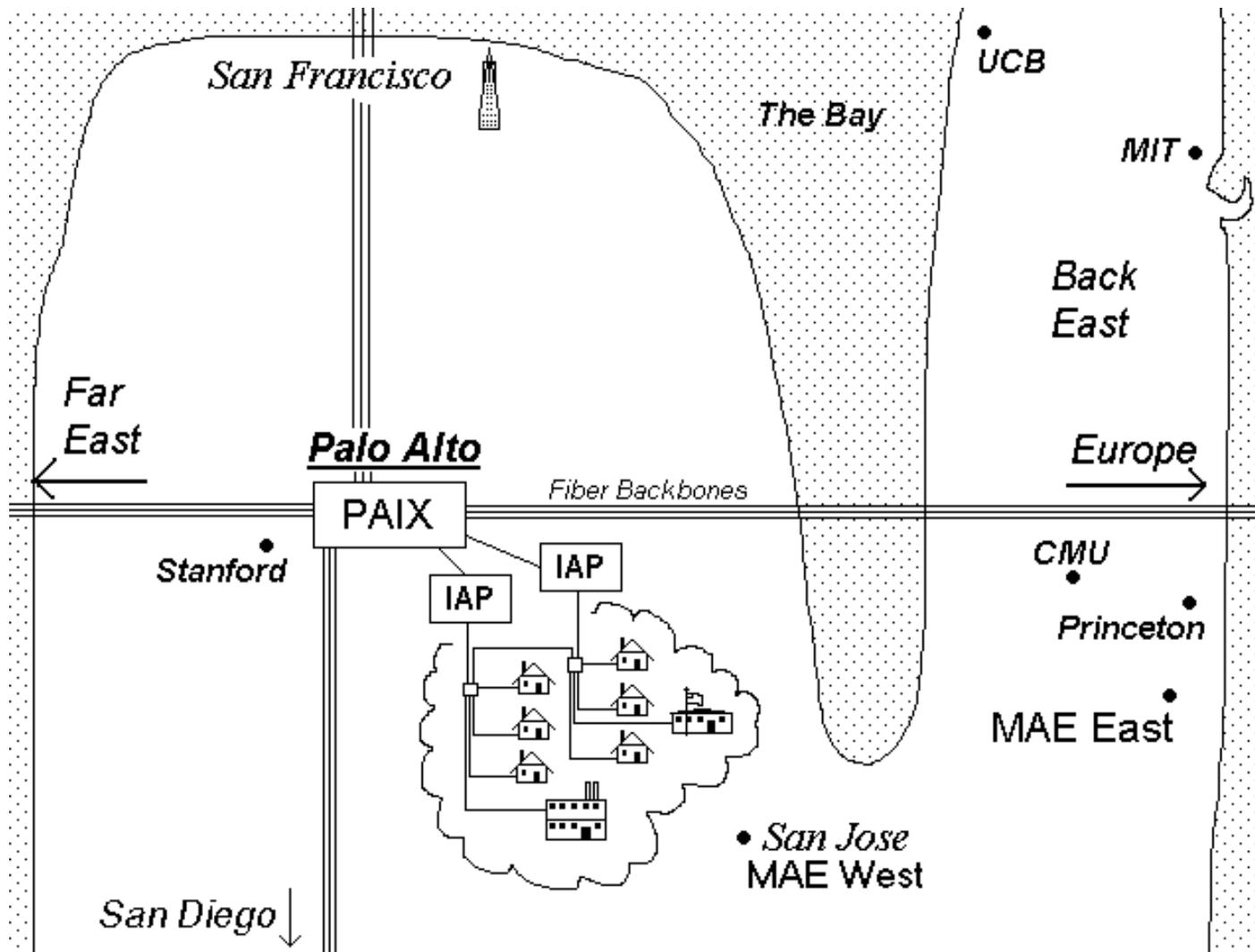
Palo Alto Fiber Network Phases

- Build the backbone (done!) \$2M
- FTTH Trial (the next step) \$0.5M
 - Refine cost estimates and design
 - Measure user satisfaction, participation rate
 - Make recommendations for a city-wide system
- City wide rollout \$26M
 - Market competition
 - New services
 - Revenue

Summary

- Fiber to the Home provides **unparalleled speed and value** to the residents.
- The proposed trial system is **technically feasible**.
- The **cost estimates are conservative** and the **revenue estimates are realistic**.
- The **financial risk to the City is manageable and reasonable**, coming well within the range of other comparable project investments by the City and by the Utilities.
- **City Ownership of the Trial is necessary** to demonstrate FTTH.
- **City Ownership of a city-wide system is not necessary, but provides unique benefits:**
 - Revenue diversification
 - Local control of a community resource
 - Reduced user costs
 - Increased competition.

Palo Alto and the World



Technology Leadership into the 21st Century

End

Supplementary Information Follows

Recommendations

- (1) **Approve a Budget** Amendment Ordinance of \$753,000 to fund trial implementation of a Fiber-to-the-Home (FTTH) network as described in *CMR:424:98*, modified to use a single Internet Access Provider as described in PA-FiberNet's *Technical and Budgetary Report*.
- (2) **Approve collection** of 25 to 35% of the construction cost from user installation fees and recovery of the balance over no more than 10 years via monthly user fees.
- (3) **Direct Staff** to select contractors for approval by Council by May 17, 1999; begin network operations by Sep 30, 1999; and report to the City Council by March 31, 2000 on the lessons learned, user satisfaction, participation rate, and recommendations on a city-wide FTTH system.

References

- Palo Alto Fiber Network site: **www.pa-fiber.net**
- Slide: “Do U.S. Homes Really Use the Internet?”
 - See **www.cyberdialogue.com/isg/timeline/forecast.html** for results of a FIND/SVP survey estimates and projections. This corresponds to the following government survey:
 - See **www.ntia.doc.gov/ntiahome/net2/charts.html** for details on the “The Digital Divide, NetII” survey released 7/28/98 by the National Telecommunications & Information Administration.
- Slide: “Is Fiber Optic Service a Good Value?” and “Available Types of Data Services”:
 - Snapshot from 12/98 of each listed service provider’s price structures.
- Slide: ”Palo Alto Fiber Backbone Route Map”
 - Source: City of Palo Alto Utilities
- Slide: “Typical Pole to Home Wiring”
 - Source: City of Palo Alto Utilities, Typical Aerial Installation
- Slide: ”Home Installation Costs of the FTTH Trial”
 - Source: City of Palo Alto Utilities, ‘Fiber To The Home Trial Cost Estimates’.
 - Analysis: Ken Poulton, ‘Palo Alto Fiber To The Home Trial Technical and Budgetary Report.’ (www.pa-fiber.net)
- Slide: “Cost of Construction vs. Year of Construction”
 - Source: City of Palo Alto Utilities, ‘Fiber To The Home Trial Cost Estimates.’
 - Analysis: Ken Poulton, ‘Palo Alto Fiber To The Home Trial Technical and Budgetary Report.’ (www.pa-fiber.net)
- Slide: “FTTH Trial Cost Recovery”
 - Ken Poulton, ‘Palo Alto Fiber To The Home Trial Technical and Budgetary Report.’ (pa-fiber.net)

More References

- Slide: “How Big Are Other Telecom Trials?”
 - <http://www.tagish.co.uk/ethosub/lit7/e236.htm>
 - http://www.idg.net/idg_frames/english/content.cgi?vc=docid_9-63300.html
 - <http://www.lucent.com/press/1297/971215.nsb.html>
 - <http://www.lucent.com/press/0598/980528.coa.html>
 - <http://www.westell.com/news.htm>
 - <http://www.zdnet.com/zdnn/content/inwo/0922/inwo0006.html>

Cost Recovery Scenarios

Costs and Revenues - Both Neighborhoods	City's cost recovery calculations			Ways to decrease cost recovery time further					
	Dec CMR	Revised CMF	Ed's single-IAP	\$40/mo	\$50/mo	29% Partic	Save \$55K	Save \$150K	Combo
Homes in Trial Area	836	836	836	836	836	836	836	836	836
Subscription rate	19%	19%	19%	19%	19%	29%	19%	19%	23%
Subscribers	160	160	160	160	160	242	160	160	192
100 Mb/s Subscribers	22	22	22	22	22	22	22	22	22
Monthly fee for 10 Mb/s	\$ 35	\$ 35	\$ 35	\$ 40	\$ 50	\$ 35	\$ 35	\$ 35	\$ 40
Installation Fees	\$ (218,400)	\$ (218,400)	\$ (218,400)	\$ (218,400)	\$ (218,400)	\$ (316,800)	\$ (218,400)	\$ (218,400)	\$ (256,800)
Design and Construction Cost	\$ 842,800	\$ 768,242	\$ 744,242	\$ 744,242	\$ 744,242	\$ 812,138	\$ 689,242	\$ 594,242	\$ 750,738
Construction Cost Recovery Requirement	\$ 624,400	\$ 549,842	\$ 525,842	\$ 525,842	\$ 525,842	\$ 495,338	\$ 470,842	\$ 375,842	\$ 493,938
Yearly Revenue from subscribers	\$ 76,440	\$ 76,440	\$ 76,440	\$ 87,360	\$ 109,200	\$ 110,880	\$ 76,440	\$ 76,440	\$ 102,720
Physical Maintenance	\$ (18,016)	\$ (16,422)	\$ (15,909)	\$ (15,909)	\$ (15,909)	\$ (17,360)	\$ (14,733)	\$ (12,703)	\$ (16,048)
Network operation and subscriber support	\$ (17,000)	\$ (17,000)	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -
Annual Net Revenue	\$ 41,424	\$ 43,018	\$ 60,531	\$ 71,451	\$ 93,291	\$ 93,520	\$ 61,707	\$ 63,737	\$ 86,672
Simple Cost Recovery Period (in years)	15.1	12.8	8.7	7.4	5.6	5.3	7.6	5.9	5.7
Cost Recovery Period at 6% (in years)	39.2	24.3	12.3	9.7	6.9	6.4	10.2	7.3	7.0
		25.0	12.6					Unrealistic	
Decrease in recovery period				2.6	5.4	5.9	2.1	5.0	5.3

Revised City Manager's Report:

25 years cost recovery

Single IAP model:

12 years

Monthly Fee changed from \$35 to \$40/month:

10 years

\$50/month:

7 years

-or- 27% participation (at \$35/month):

7 years

What about Fiber to the Apartment?

In December, a Palo Alto apartment building was directly connected to an ISP using the Fiber Ring. Does this mean private operators will do FTTH for us?

This is apples vs. oranges:

- single fiber run to one building vs. fiber per home
- shorter distances
- indoor electronics placement

Fiber to the apartment building costs much less to build than FTTH to single-family home so it will happen long before privately-funded FTTH.

What is the Universal Telecom Service Request For Proposal (UTSRFP)?

- **A passive approach** to residential service. It asks companies:
“Tell us what you’d like to build”.
- The city’s contribution (the Fiber Ring) **is less than 10%** of a city-wide residential system.
 - Little incentive for companies to do anything special in Palo Alto.
- Most or all of the proposals will be for **medium-speed services**; these already exist and can’t grow in the future the way fiber can.
- Any privately-owned system will:
 - **avoid competition**
 - **allow no city control** over network policies and services.

What can we expect from the UTSRFP?

The Universal Telecommunications Service Request For Proposal (UTSRFP) could gather several kinds of responses:

- **Wireless**
 - only low to medium effective speed (0.03-1 Mb/s) because it is shared among many users.
- Use **installed copper infrastructure** (telephone wires or cable)
 - only medium speed, competition is stifled the most
- **Hybrid fiber/copper** system
 - to approach high speeds cost approaches FTTH; expandability poor
- **Private FTTH** system (least likely)
 - risks are higher w/o a trial
 - creates a new, unregulated monopoly on high-bandwidth access

How can the UTSRFP fit with the FTTH Trial?

- Proceed with the FTTH Trial
 - Provides real-world cost, operations and participation data.
- In parallel, begin the decision process for a city-wide system:
 - Confirm that FTTH is the right choice for a city-wide system.
 - Decide what mix of public/private participation is best.
- Write a well-specified RFP to build the system that **Palo Alto** wants.

What Should Be in the UTSRFP?

- Clear technical specifications:
 - High *per-user* (not shared) bandwidth (10 Mb/s) available at the outset
 - Per-user choice of speeds
 - Inexpensive future upgrade path to 100 Mb/s, 1000 Mb/s
 - High speeds in both directions
- Operational policy requirements:
 - Real competition among Internet Access Providers
 - No exclusion of local Service Providers
 - Fees reflect costs rather than soaking high-bandwidth users
 - No content control

High Participation Density Streets Included in the
Fiber to the Home Analysis for the Barron Park Region

