

FTTP Architecture and Technical Issues

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Agenda

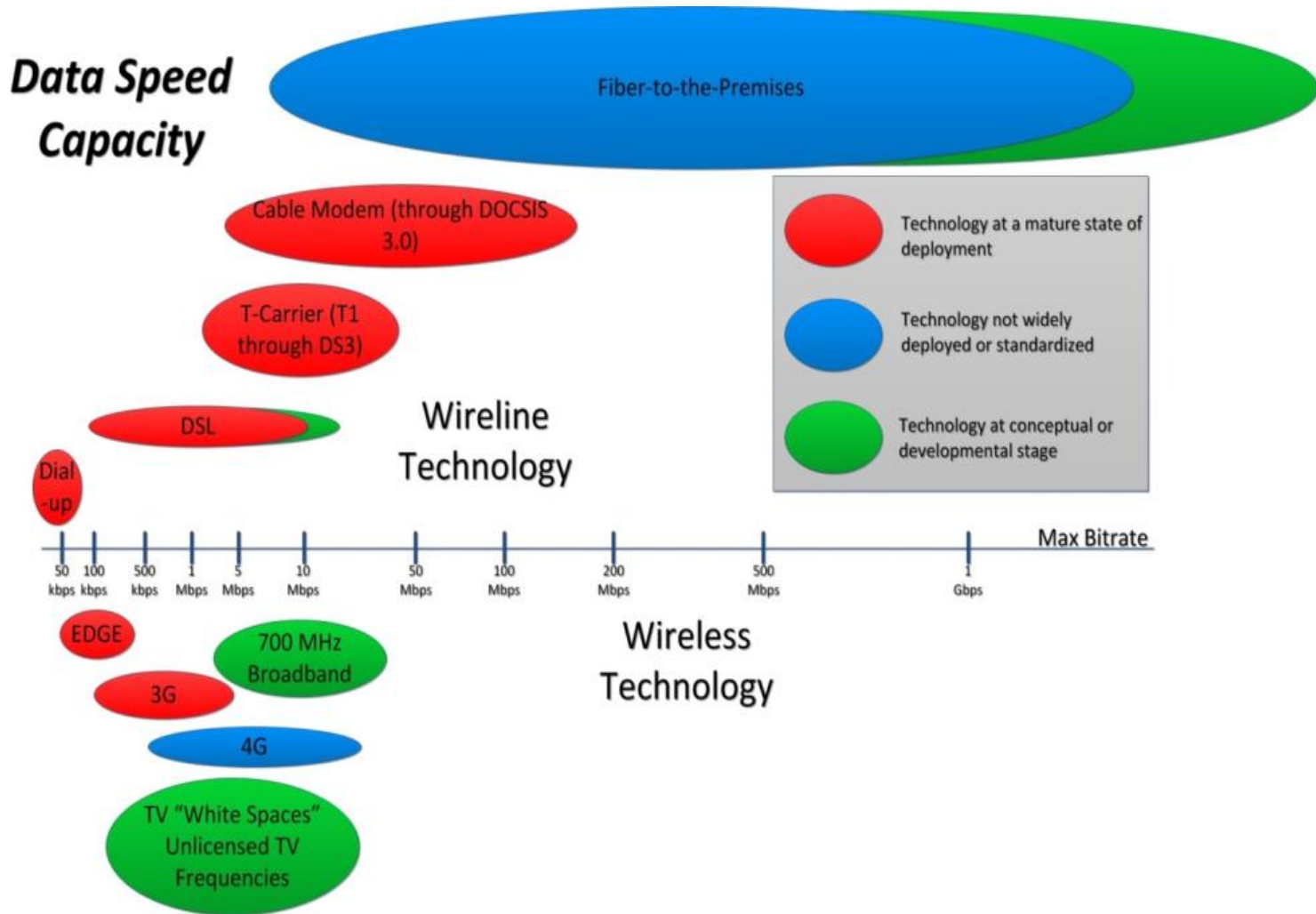
- ▶ FTTP Architecture
- ▶ Deployment
- ▶ Equipment
- ▶ Operation and Maintenance

FTTP Architecture

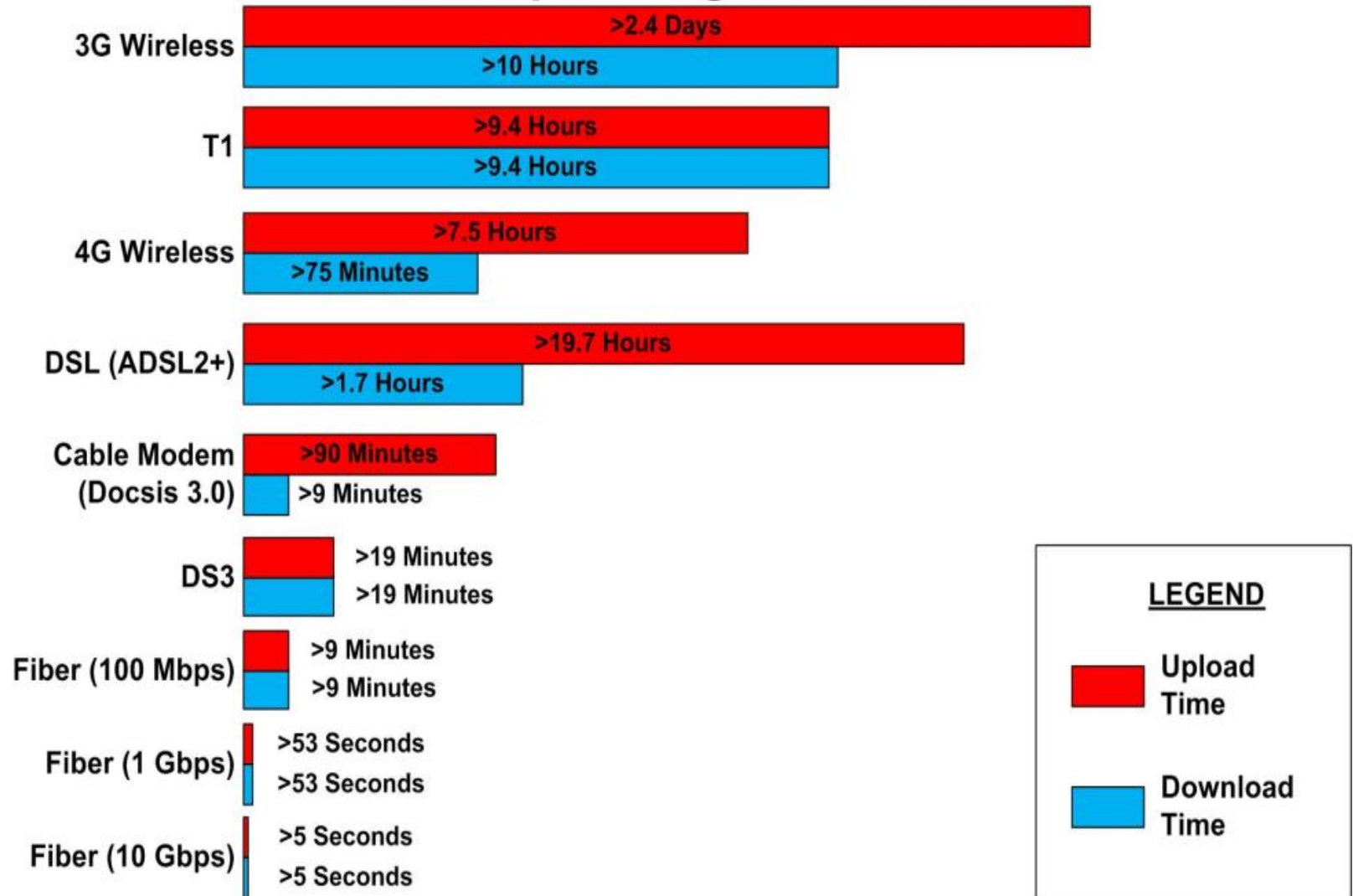
- ▶ Fiber-to-the-Premises (FTTP) more capable than previous communications technologies
 - Capacity to 1 Gbps and beyond
 - Can support any foreseeable residential and business needs
 - Can support cell site interconnection
 - Capacity scalable without new construction
 - Physically robust
 - Long lifetime
 - Electrically neutral (safety, interference)
 - Low maintenance (limited or no external electronics)
 - Voice, data, video
 - In greenfield- construction cost same as any other medium

Technologies and Speeds: *Fiber Ahead of All Others*

**Data Speed
Capacity**



Minimum Time Required for Downloading and Uploading a 5 GB File

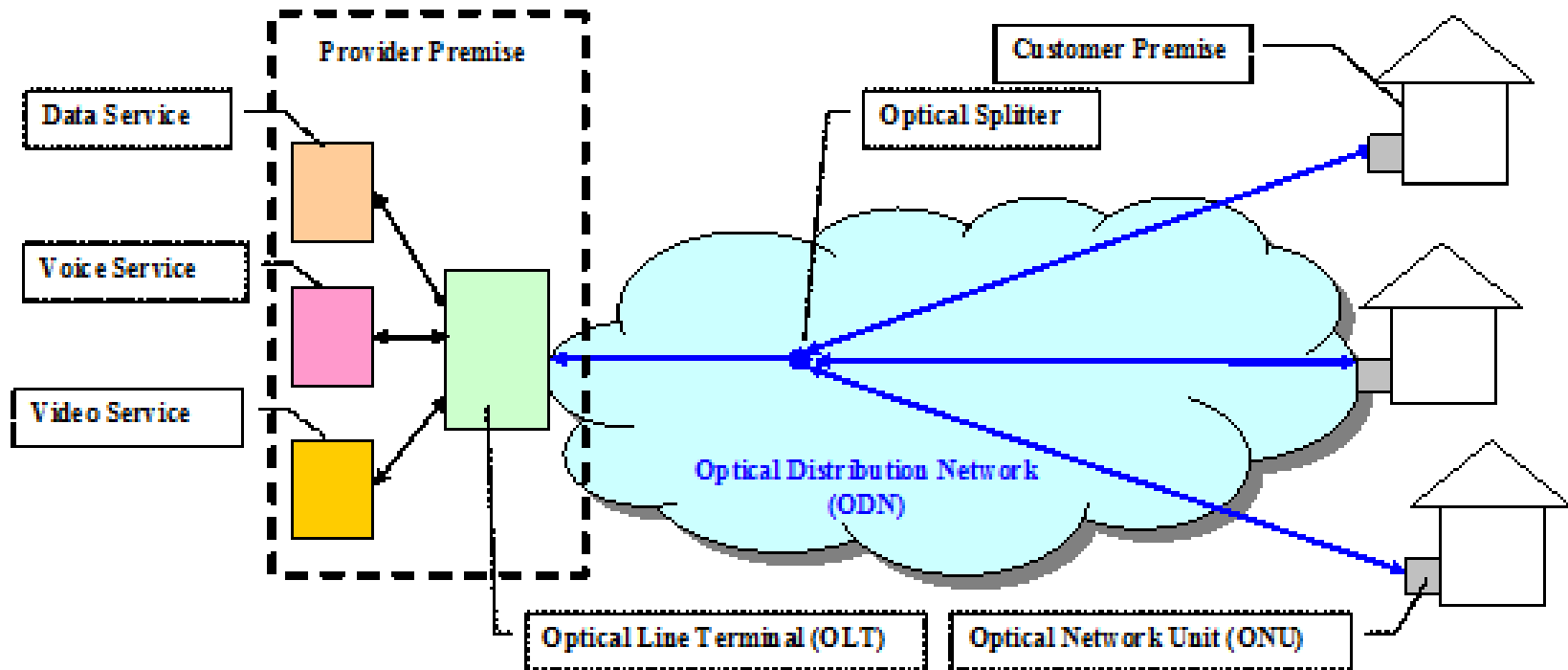


FTTP Architecture

- ▶ Passive Optical Network/Distributed Tap
- ▶ Active Ethernet

FTTP Architecture: Passive Optical Network/ Distributed Tap

PON Access Network

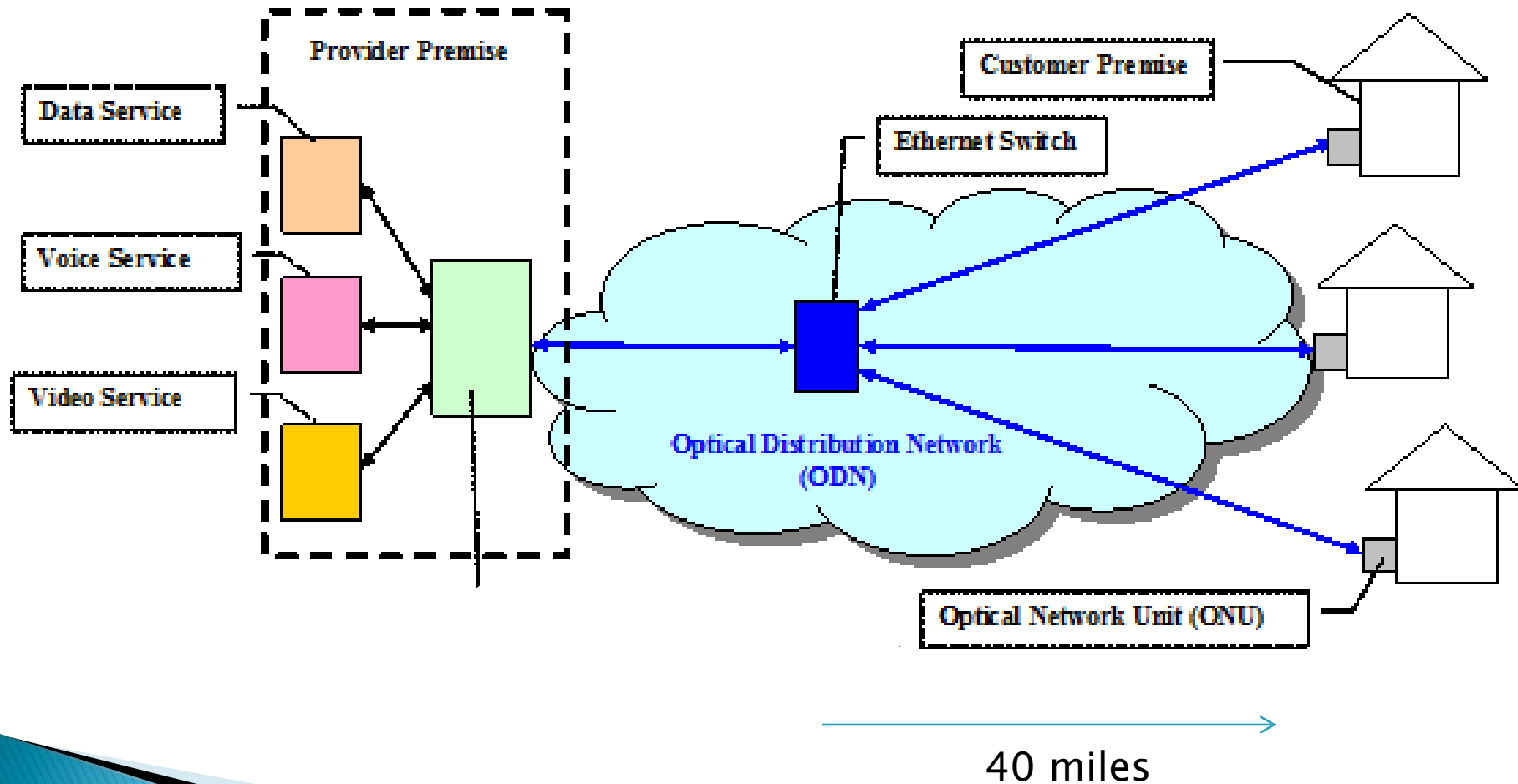


12.5 miles

Passive Optical Network/ Distributed Tap

- ▶ Fiber shared by multiple users from CO/substation to splitter near customer – reduces construction costs
- ▶ Individual fiber from splitter to customer premises
- ▶ Splitter is a passive, non-powered component
- ▶ Range of technologies
 - GPON/10GPON (timeslotting)
 - WDMPON (different wavelengths)
- ▶ Standard PON: 32– or 64–way symmetrical splitter
- ▶ Distributed tap is asymmetrical – drops off one customer at a time
- ▶ GPON: 2.4 Gbps/1.2 Gbps
- ▶ 10GPON: 10 Gbps/2.5 Gbps
- ▶ WDM-PON not standardized – faster speeds

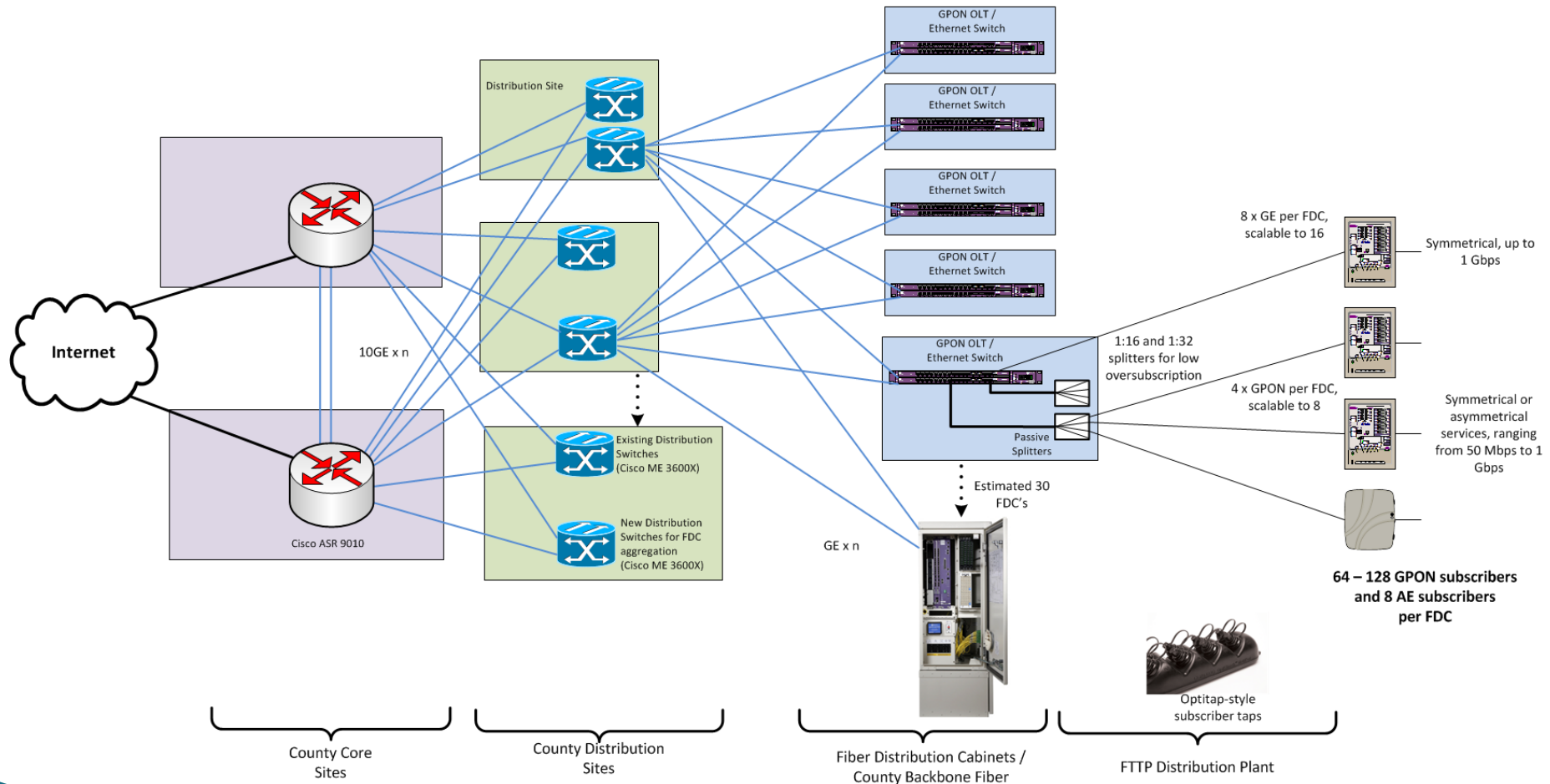
FTTP Architecture: Active Ethernet



Active Ethernet

- ▶ Dedicated fiber from CO/substation/cabinet to each customer
- ▶ Requires power at cabinet
- ▶ Higher capacity, longer range
- ▶ Typically greater cost per customer
- ▶ Possible to operate a hybrid network
 - Premium customers receive Active Ethernet
 - Others get PON

Example Hybrid PON/Active



Fiber Construction

- ▶ Aerial
- ▶ Underground

Option of In-House Construction

- ▶ Power utility line staff can construct fiber
 - Option to use “down time” from power crews
- ▶ Combination vendor instruction and internal training
- ▶ Can train in days
- ▶ Splicing and installation typically outsourced
- ▶ Hand-held splicing for small jobs

Aerial

- ▶ Labor + Materials: \$20,000 to \$50,000/mile
- ▶ Materials: \$10,000/mile
- ▶ Power utilities have option of placing fiber in power space
 - Guaranteed space available (make ready main impediment to most providers)
 - High-voltage-trained personnel must construct, install and maintain
 - Must use all-dielectric fiber (lower fiber count)

Underground

- ▶ Labor + Materials: \$25,000 to \$150,000/mile
- ▶ Typical technique: directional boring and HDPE duct
 - Depends on local labor rates and number/size of duct
 - \$50,000 to \$100,000 per mile is normal – depends on depth, rock, ROW considerations
- ▶ Lowest cost for plowing: \$30,000 to \$35,000/mile
- ▶ Highest for hand-dig where other utilities are located, locations where restoration is needed
- ▶ Materials: \$15,000 to \$20,000/mile
 - Fiber, conduit, handholes, manholes, cabinets, pedestals
- ▶ Some underground suburban and urban require construction on both sides of street

Fiber Deployment Considerations:

Fiber Count

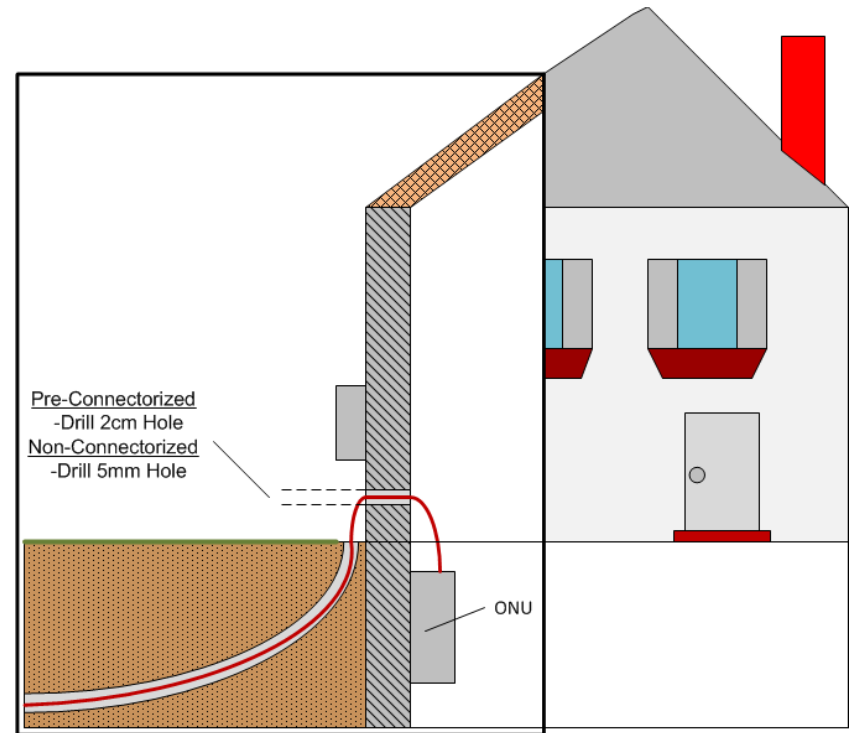
- ▶ PON enables lower count – typical approach to include 50% excess for spare capacity in distribution
- ▶ Recommend excess count in trunk and backbone
 - Future growth
 - Leasing
 - Wireless
- ▶ Overlash can enable fiber count increase for strand-mounted fiber, but **NOT** ADSS in power space
 - Requires replacement or new attachment

Fiber Deployment Considerations: Increased Fiber Count

- ▶ Incremental materials cost from 72 count to 144 count: \$2,000 per mile
- ▶ Incremental splicing cost about \$1,000 per mile

Premises Installation

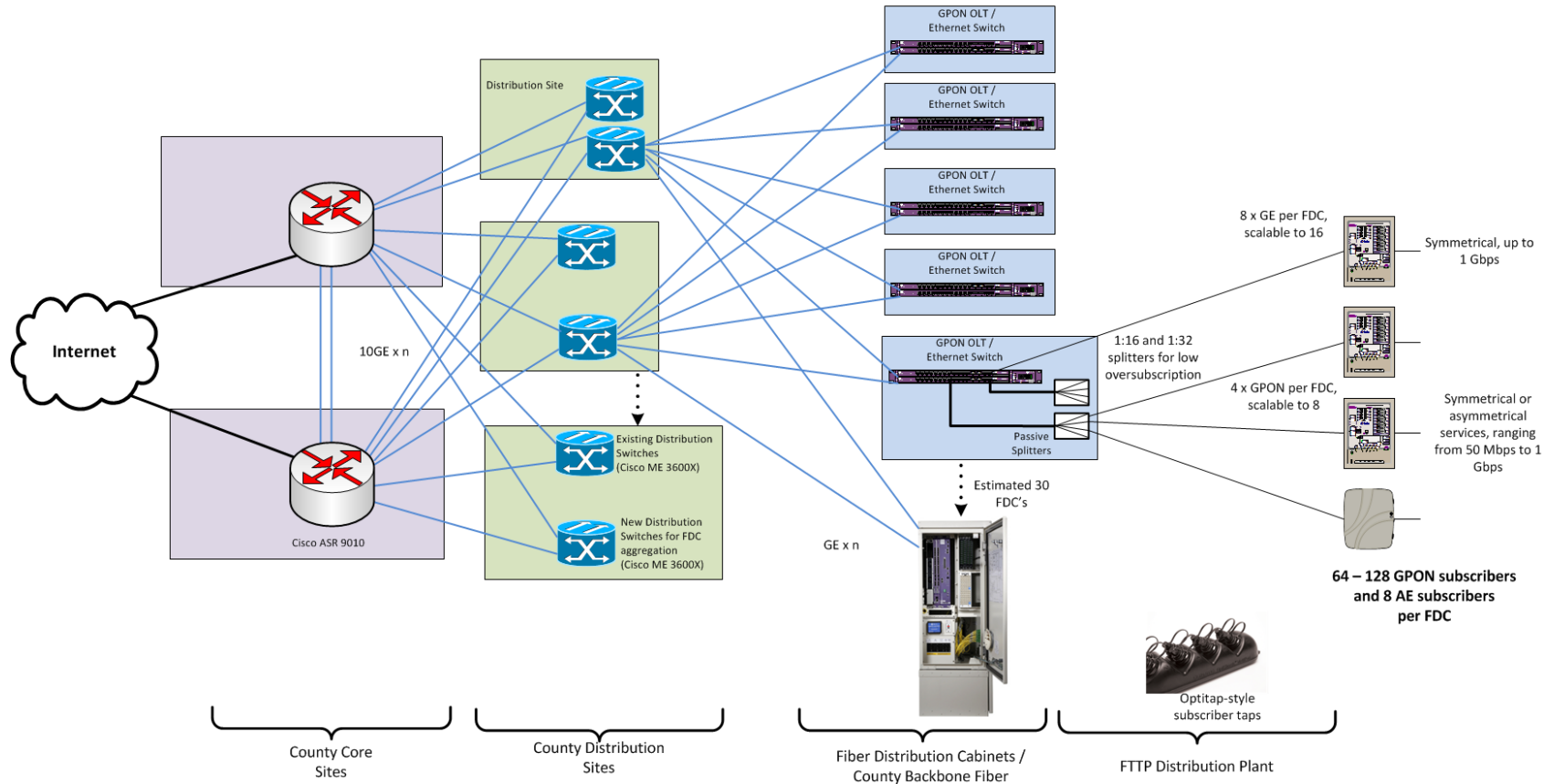
- ▶ Network demarcation indoors or outdoors near power meter
- ▶ Coaxial, Cat-5, Telco or WiFi on premises
- ▶ Pre-connectorized drops simplify installation
- ▶ Standardized processes critical



Equipment

Aggregate Capacity of Design Model

Downstream	10 Gbps	180 Gbps	200 Gbps	1,000 Gbps	Downstream
Upstream	10 Gbps	180 Gbps	200 Gbps	500 Gbps	Upstream



Central Office Equipment (Core)

- ▶ Main location (network operation center)
 - Robust facility with backup power, potentially co-located in building with power operations center
 - Systems
 - Servers
 - Core routers
 - Management and monitoring system
 - Billing
 - Backbone fiber connections
 - Outside Internet connection
 - Customer service
 - Warehouse
 - Vehicles

Central Office Equipment (Core)

- ▶ Costs depend on scale of network
- ▶ Smaller networks may outsource components or work cooperatively with other providers
 - Management and monitoring
 - Billing
 - Specialized technical staff
- ▶ Capital costs for 2,000 subscriber network (entry-level deployment):
 - Core routers, servers, systems: \$500,000
 - Facility costs: Up to \$1 million
 - Video headend: \$325,000

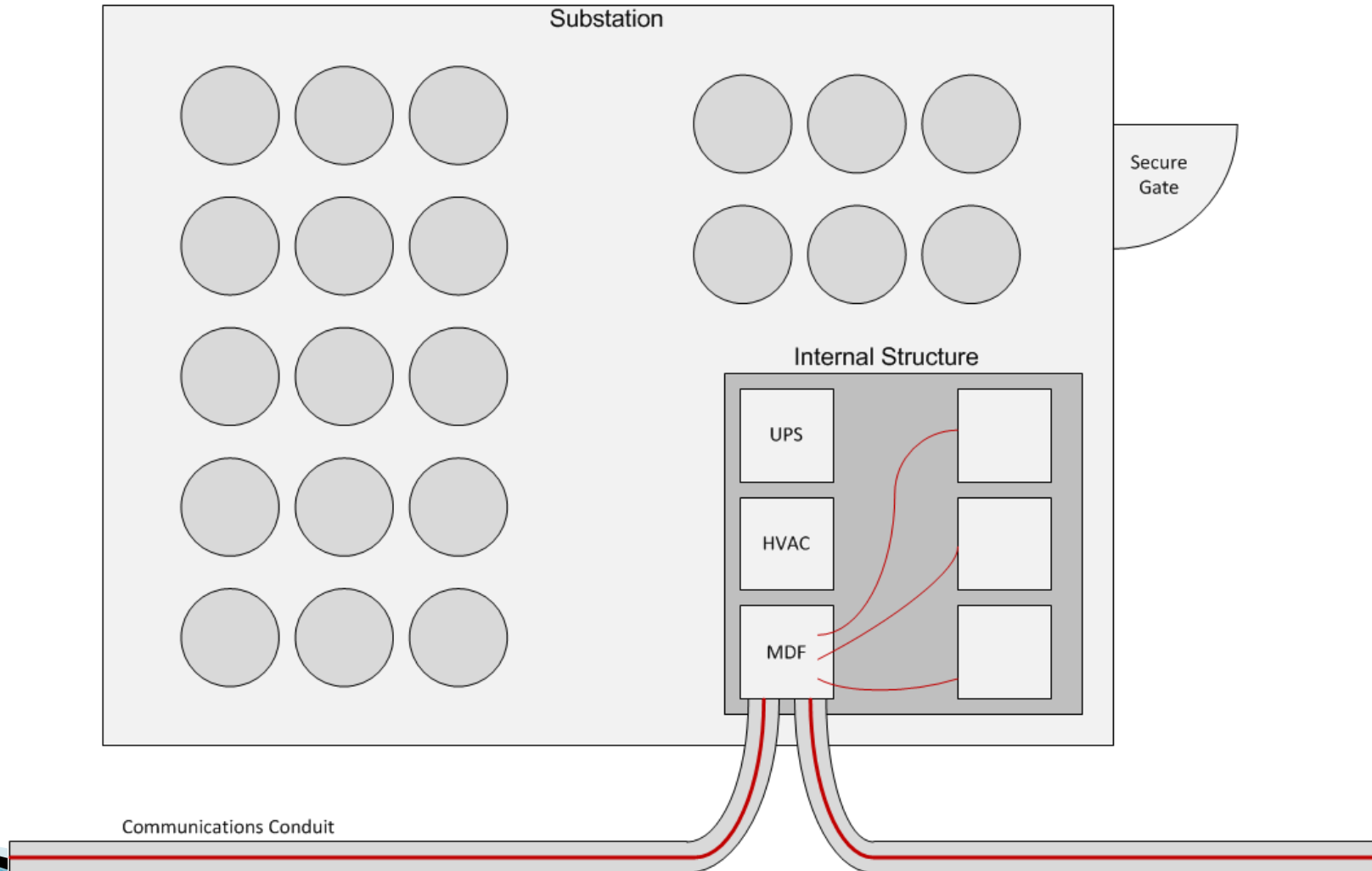
Distribution Equipment

- ▶ Intermediate hubs between core and premises
- ▶ 5 to 10 miles from customers
- ▶ May be in substations, huts or cabinets
 - \$200 to \$600 per activated customer for distribution electronics, depending on PON vs. Active Ethernet and service speed
 - \$10,000 to \$200,000 for each cabinet or hut, depending on PON vs. Active Ethernet and number of connected passings
- ▶ Includes:
 - Ethernet aggregation switching
 - Optical line terminal (originates PON or Active Ethernet network)
 - Backup power (batteries, generator ready)
 - Fiber terminations

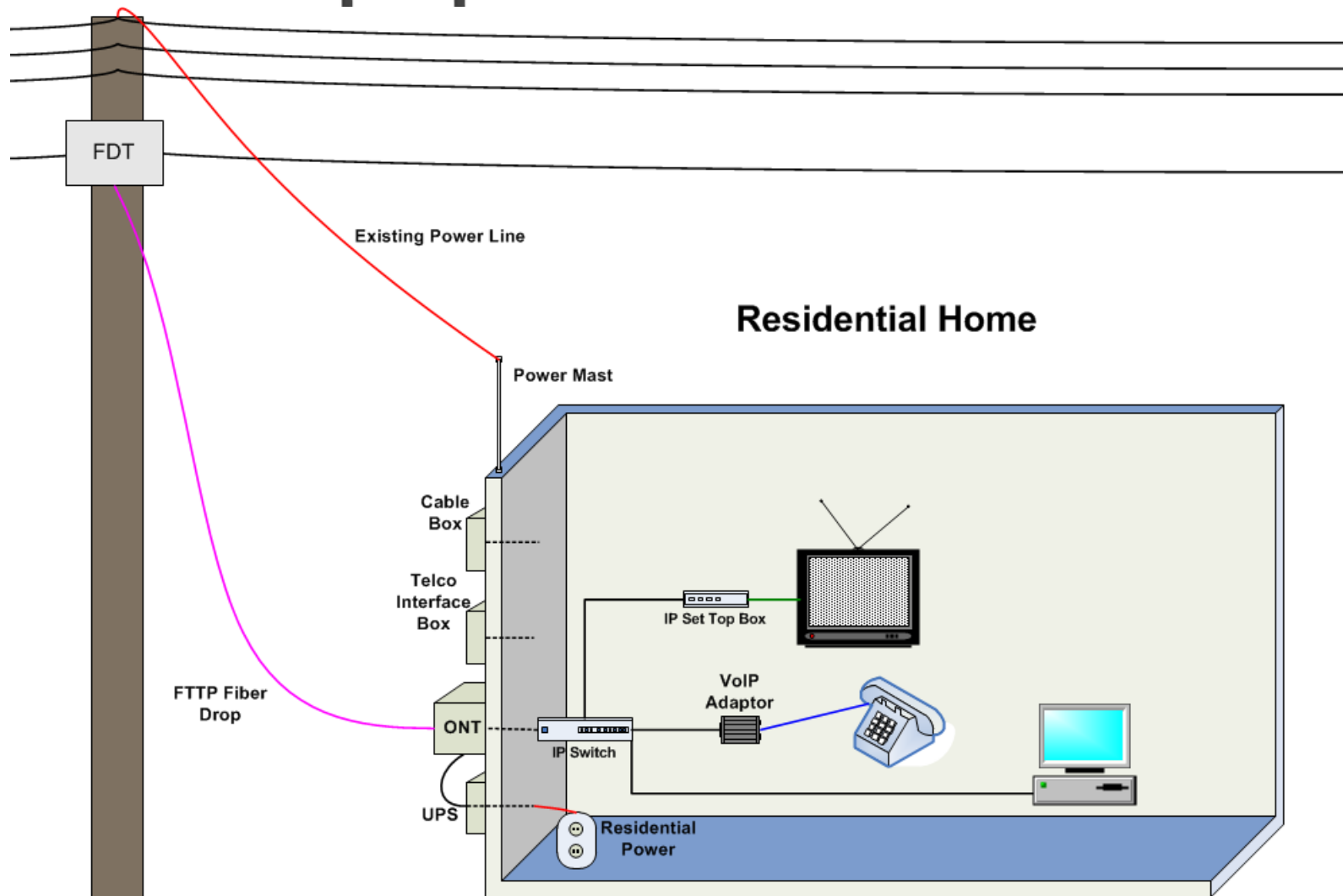
Distribution Equipment Cabinet



Distribution Equipment Substation



Premises Equipment



Premises Equipment

- ▶ Fiber connects to optical network terminal (ONT)
- ▶ ONT usually has UPS
- ▶ ONT connects over coax or Cat-5 /6 /7 to video set-top converter
- ▶ ONT usually connects to separate router for data service
- ▶ ONT connects to VoIP adaptor to connect to home voice line
- ▶ ONT may incorporate functions above
- ▶ Some providers may set up local WiFi
- ▶ Different approaches to using existing home cabling
- ▶ Premises equipment: \$300 to \$600

ONT and UPS



Maintenance and Operations

- ▶ Critical portion of sustainability model
- ▶ Advantages to power coop:
 - Cross-training of line crews
 - Central operation
 - Customer service
- ▶ Challenges:
 - Cost of specialized expertise
 - Lack of economy of scale

Staffing

- ▶ For a 5,000–subscriber Tennessee Valley system:
 - Business manager
 - Two Tier 2/3 NOC support
 - Sales/marketing representative (half-time)
 - Fiber plant supervisor
 - One CSR per 5,000 customers X number of shifts
 - 3 field staff
 - 3 to 4 installers (contractors)
- ▶ Labor cost will depend on local wages

Maintenance and Operations

Typical Yearly Costs

- ▶ Fiber maintenance: 2% of fiber construction cost
- ▶ Equipment maintenance/licensing: 10% to 20% of equipment cost per year
- ▶ Education and training: 4% of payroll
- ▶ Internet connection: \$5 to \$100 per Mbps per month, depending on bandwidth availability
- ▶ Wholesale voice: \$8.50 to \$15/month/customer (e.g., Momentum)
- ▶ Video programming: \$40+/month/customer

Other Costs and Considerations

- ▶ Test equipment: \$25,000
- ▶ Vehicles: \$50,000
- ▶ Equipment replacement
 - Electronics 7 years
- ▶ Pole attachment fees
- ▶ Insurance/Legal/Consulting/Marketing
 - \$40,000 to \$70,000 decreasing over time
- ▶ Debt service
- ▶ Utilities