



FTTP Pro Forma Phase 1 Analysis

for

The City of Hudson

April 2018

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1. Market Analysis – **Not Included (Phase II)**
 - Quantitative market research
 - Demand estimation
2. Product Strategy
 - Data and Voice services
 - Current and near-term multi-Gig offerings
3. Technology Strategy, Design, and Capital Budget
 - Reference architecture
 - Sample designs
4. Pro Forma Financial Analysis
 - Revenue, Opex, and Capex
 - Baseline 20 year pro forma results
5. Next Steps

Internet Product Strategy

INCUMBENT RESIDENTIAL INTERNET PRICING

	Download	Upload	Price	Technology
Spectrum	60M	5M	\$64.99	Cable Modem (DOCSIS 3.0)
	100M	10M	\$79.95	
	120M	10M	\$94.95	
	Affordable Internet: 30M	4M	\$14.99	
Windstream	3M – 100M*	-	\$39.99	DSL
	1G**		\$69.99	
	Website Quote: 20M		\$35.00 (12 months) \$45 - \$65 (> 12 months)	

Prices reflect subscription to Internet service at non-promotional rates. Windstream pricing per windstream.com and City staff knowledge. Spectrum pricing from 'Residential Broadband Services & Pricing' as of November 2017.

* DSL speed varies by CO distance **Not available in all areas.

RESIDENTIAL INTERNET PRICING

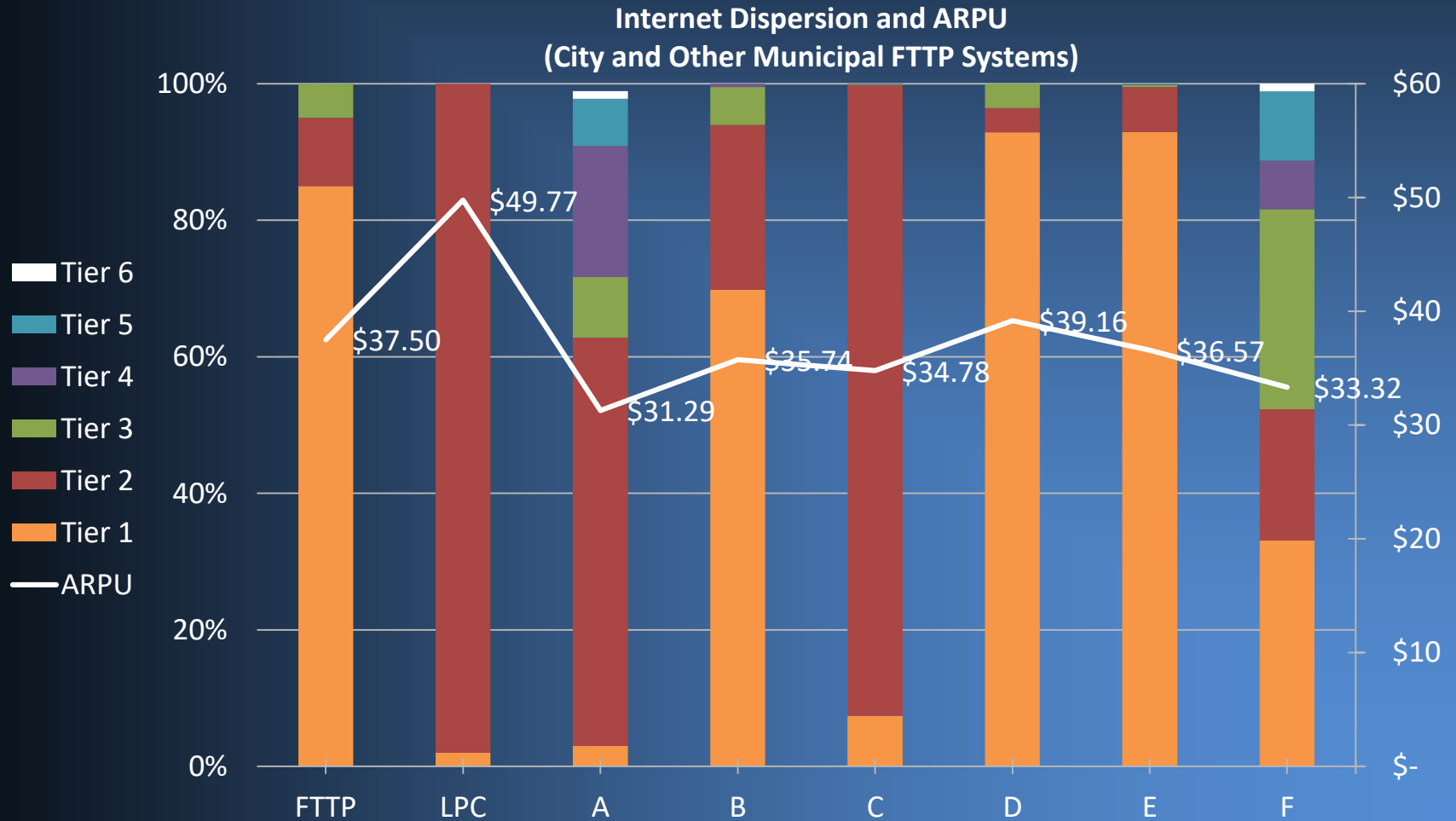
Internet Tier Download / Upload	Monthly Price	ONT Model(s) / Cost	Static IP Address
1G / 1G – Early Adopter*	\$30	844G / \$199	N/A
2G / 2G – Early Adopter*	\$50	ONT TBD/ \$385 est.	\$10
4G / 4G – Early Adopter*	\$70		
1G / 1G	\$40	844G / \$199	N/A
2G / 2G	\$70	ONT TBD/ \$385 est.	\$10
4G / 4G	\$100		

*Must sign up for service within 90 days of availability

Available 1Q2019

INTERNET DISPERSION & ARPU

The \$30 price point for Gig service, along with anticipated subscription to higher tiers, generates an initial ARPU of \$37....



1. Standard Internet Access

*** In Pro Forma**

- ◆ Shared capacity connection over GPON/XGS
 - ◆ Current: 100M, 250M and 500M tiers (\$120, \$240, and \$420 MRCs)
 - ◆ In Pro Forma: 100M, 250M, and 500M tiers (\$59, \$99, and \$249 MRCs)
 - ◆ Not in Pro Forma: 1G tier (\$399 MRC)

2. Business Dedicated Services*

- ◆ Dedicated direct fiber connection:
 - ◆ Current / In Pro Forma: 50M and 100M connections (\$800 and \$1,200 MRCs)
 - ◆ Not in Pro Forma: 500M and 1G connections (\$1,800 and \$2,700 MRCs)
- ◆ Contract agreement with SLA and term requirement
- ◆ Protected connection is optional

3. Point-to-Point (Transport Circuit): Dedicated pathway of defined capacity without access*

4. MAN: Customized access and transport solution for multi-site business or institution*

Voice Product Strategy



RESIDENTIAL VOICE SERVICES

With the below retail residential voice pricing, a net ARPU (retail less wholesale voice fees) will be \$28 per line at current CLEC market rates....

		Windstream	Spectrum	FTTP
Basic Service			\$27.49*	-
Packages	Voice Package with Features & Unlimited & LD	\$44.99	\$44.99 <i>\$29.99</i>	\$35.00
Access Lines	Additional Line	?	\$23.99**	\$30.00

* Taxes are additional. ** Limited to one line. *Orange* font indicates 12 month promotional rates.

With the below retail commercial voice pricing, a net ARPU (retail less wholesale voice fees) will be \$17 per line at current CLEC market rates....

Service	With Internet Rates	Without Internet Rates
Access Line, Features, & Unlimited LD	• Monthly: \$30.00 • 2 Year: \$26.00 • 3 Year: \$24.00	• Monthly: \$40.00 • 2 Year: \$36.00 • 3 Year: \$34.00
Digital SIP Trunk (per channel)	• 2 Year: \$25.00 • 3 Year: \$23.00	• 2 Year: \$30.00 • 3 Year: \$28.00
Hosted PBX (per seat)	Requires Internet and minimum 3 year term: • 1-5 Seats: \$25.00 • 6-24 Seats: \$23.00 • 25-49 Seats: \$22.00 • 50+ Seats: \$21.00	

Technology Analysis
Reference Architecture – Building Blocks

- ◆ **Provider Owned Premises Equipment**
 - Optical Network Terminal – indoor wall mount or desktop versions
 - Optional router capability (wireless or not)
- ◆ **Customer Owned Premises Equipment**
 - Router – may not be GigE capable
 - All end user computing devices
 - Standard telephones for telephone service
- ◆ **Inside Wire**
 - Phone services use the existing phone wiring
 - Data services delivered over new CAT6 cable or Wi-Fi

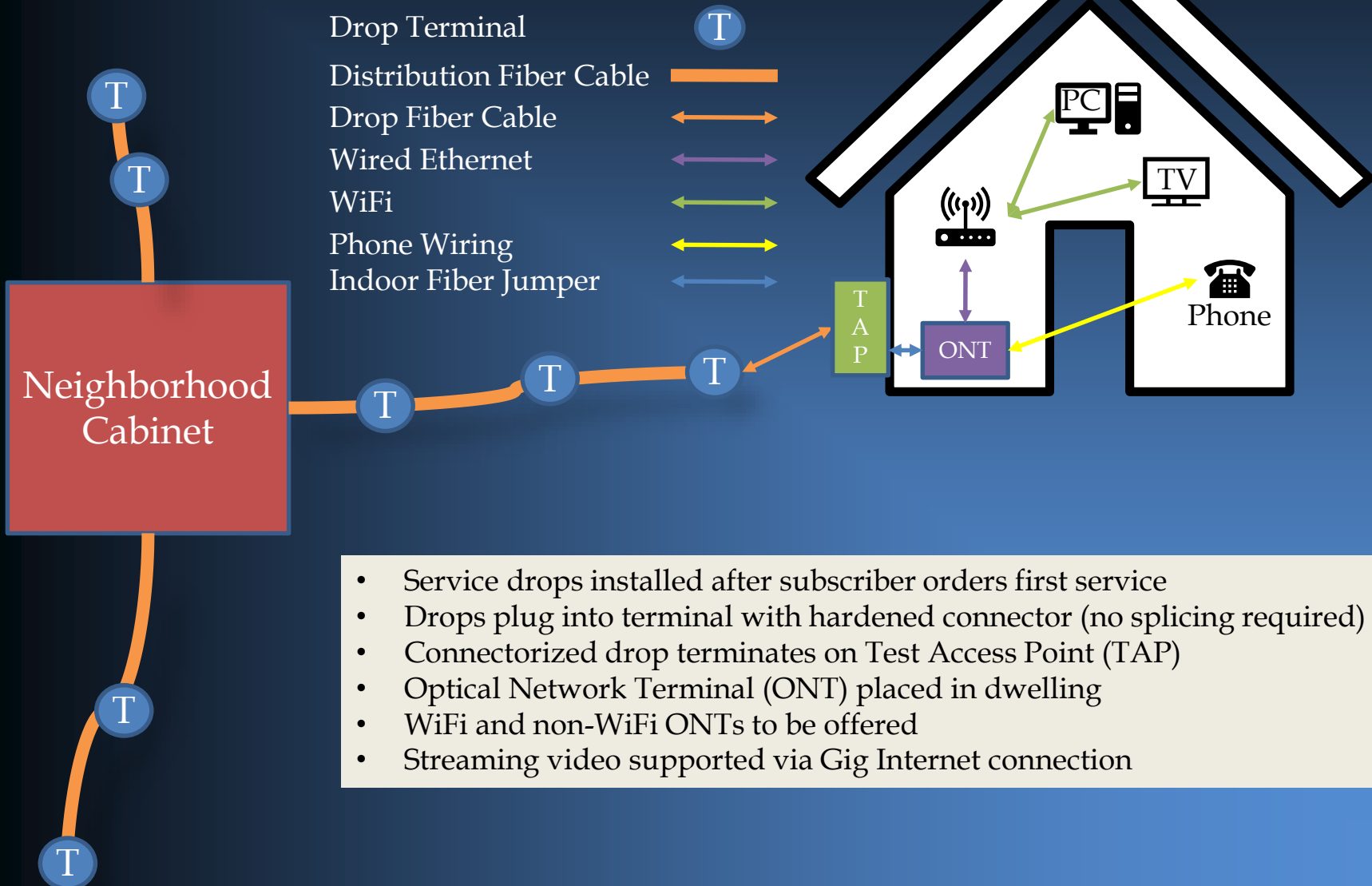
◆ Drop Terminal

- Drop terminals connect service drops to the distribution network
- One terminal serves between two and twelve passings
- Terminals allow for plug and play at the serving pedestal / pole
- Terminals spliced to the distribution network

◆ Service Drop and Test Access Point

- Drops only installed after subscriber orders service
- One fiber drop cable installed from terminal to each premises
- Fiber drop pushed or pulled in shallow drop conduit in underground
- Aerial drops are flat self support cable
- Drop fiber terminated in test access point (TAP) mounted on dwelling
- TAP provides demarcation between outside and inside fiber (bulkhead)

FTTP DISTRIBUTION NETWORK BUILDING BLOCKS



- Service drops installed after subscriber orders first service
- Drops plug into terminal with hardened connector (no splicing required)
- Connectorized drop terminates on Test Access Point (TAP)
- Optical Network Terminal (ONT) placed in dwelling
- WiFi and non-WiFi ONTs to be offered
- Streaming video supported via Gig Internet connection

- ◆ Distribution and feeder fiber
 - Distribution fiber connects network terminals to the feeder network
 - Feeder network connections can occur at a splice closure or cabinet
 - Distribution cables can range in size from 1 to 144 fibers
 - The size and type of cable is driven by the splitting approach
- ◆ Centralized split approach
 - 1x32 splitters aggregated in splitter cabinets
 - Dedicated fiber strands from network terminals to cabinets
 - Each cabinet typically fed with 12-24 feeder fibers
 - One cabinet for every 250 homes on average
- ◆ Distributed split approach
 - 1x4 and 1x8 splitters deployed in network terminals
 - 1x4 and 1x8 splitters also deployed upstream in closure or cabinet
 - Approach reduces fiber and splicing in distribution network by 87.5%
 - Outside plant savings used to fund additional OLT and splitter capacity
 - Networks typically designed and constructed to support 100% take rate

◆ Optical Line Terminals (OLTs)

- An OLT combines all digital content onto PON ports
- New Calix cards support 16 GPON ports per card
- Calix E9-2 chassis hold two line cards (one Rack Unit)
- Requires environmentally controlled space
- One chassis can serve up to 1,024 connected ONTs
- OLTs typically connect upstream via multiple 10G uplinks

◆ Feeder Network

- Feeder connects terminal based splitters to serving OLT ports
- Typically one feeder fiber per 32 passings (PON port)
- $\approx$ 265 feeder fibers would be required to service 8,500 passings
- Existing fiber network would be upgraded to provide FTTP feeder
- \$690,000 allocated to augment existing fiber infrastructure

◆ Core Network – Layer 3

- Core network safely routes traffic to and from the outside world
- Border Gateway Protocol (BGP) routers connect to the Internet
- BGP routers deployed in pairs
- Typically installed on backbone network in physically diverse locations
- Each router connects to at least two Internet backbone providers
- Business case includes capital to augment existing Layer 3 assets

◆ Outside World – Content

- Two physically diverse Internet backbone connections desired
- Phone traffic would also route over one or both Internet connections

Technology Analysis

Sample Designs

- ◆ 100% GPON standards based system
 - Relying on next generation standards to support future growth
 - Nx10G capabilities over time
- ◆ Distributed split architecture
 - 1x4 or 1x8 splitters located in drop terminals
 - Drop terminal serves as splice point for splitter input
 - One spare fiber terminated at each drop terminal for future
 - Splitter cabinets deployed for neighborhoods
 - Efficient use of fiber strands/splicing with future proofing included
- ◆ Design assumes the use of standard cable technology
 - Single jacket, single armor cable for aerial (com zone)
 - Single jacket all dielectric for underground

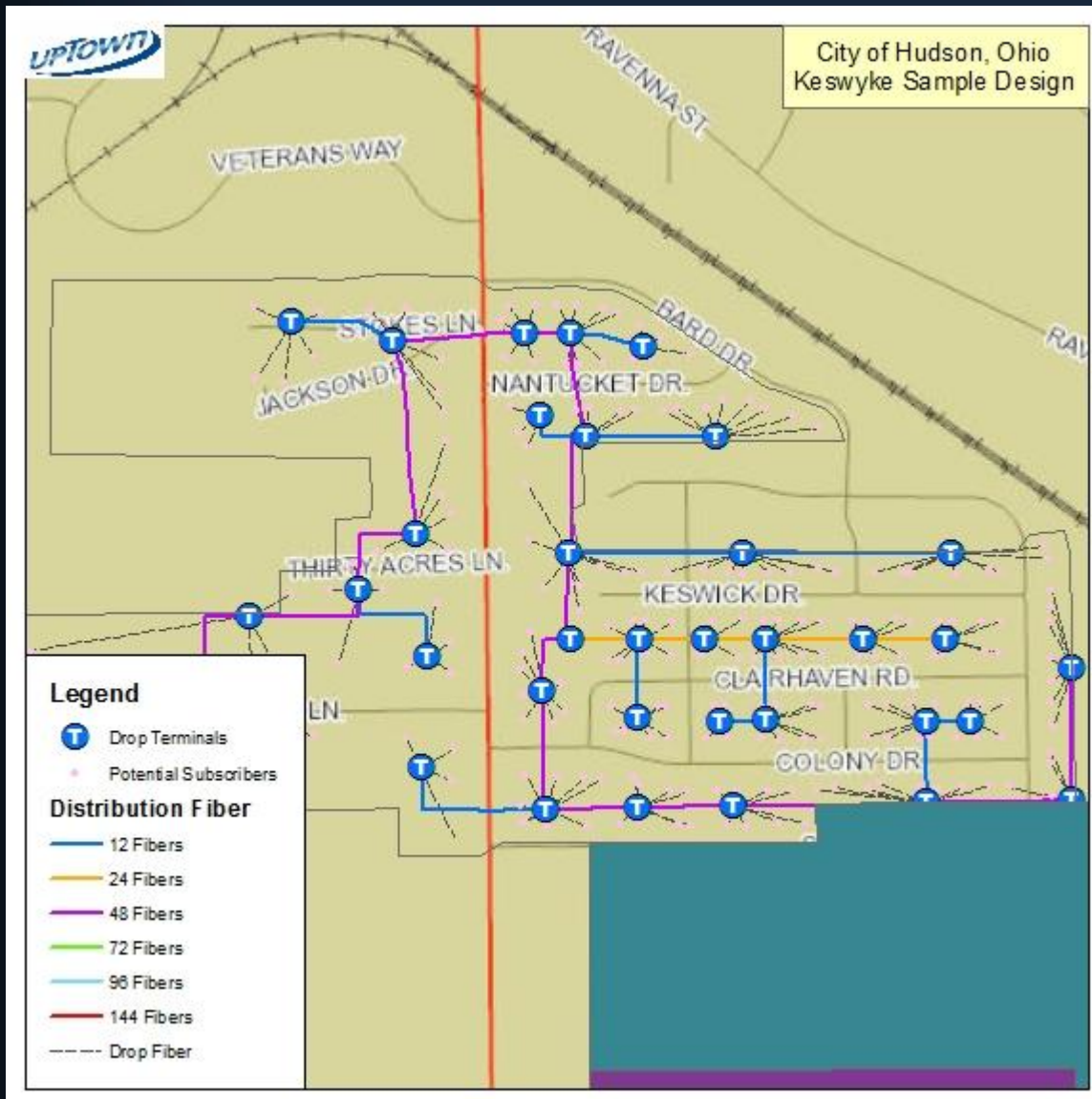
OUTSIDE PLANT COST ASSUMPTIONS

- ◆ New underground path creation and fiber placement
 - \$15.50 per foot composite for conduit and handhole placement
 - Assumes boring (2) 1.5 IN HDPE for drops and distribution
 - Per structure adder for handholes larger than 17x30
 - \$1.25 per foot labor to pull fiber into new conduit
- ◆ Aerial construction costs
 - \$2.80 per foot composite rate to install new messenger in com zone and lash each cable to strand in com zone
- ◆ Technical services
 - \$30 per fusion splice
 - \$400 closure prep for each drop terminal
- ◆ Material pricing assumptions
 - Fiber, terminal and structure pricing based on recent client bids
 - Pricing subject to change over time

SAMPLE DESIGN AREA OVERVIEW



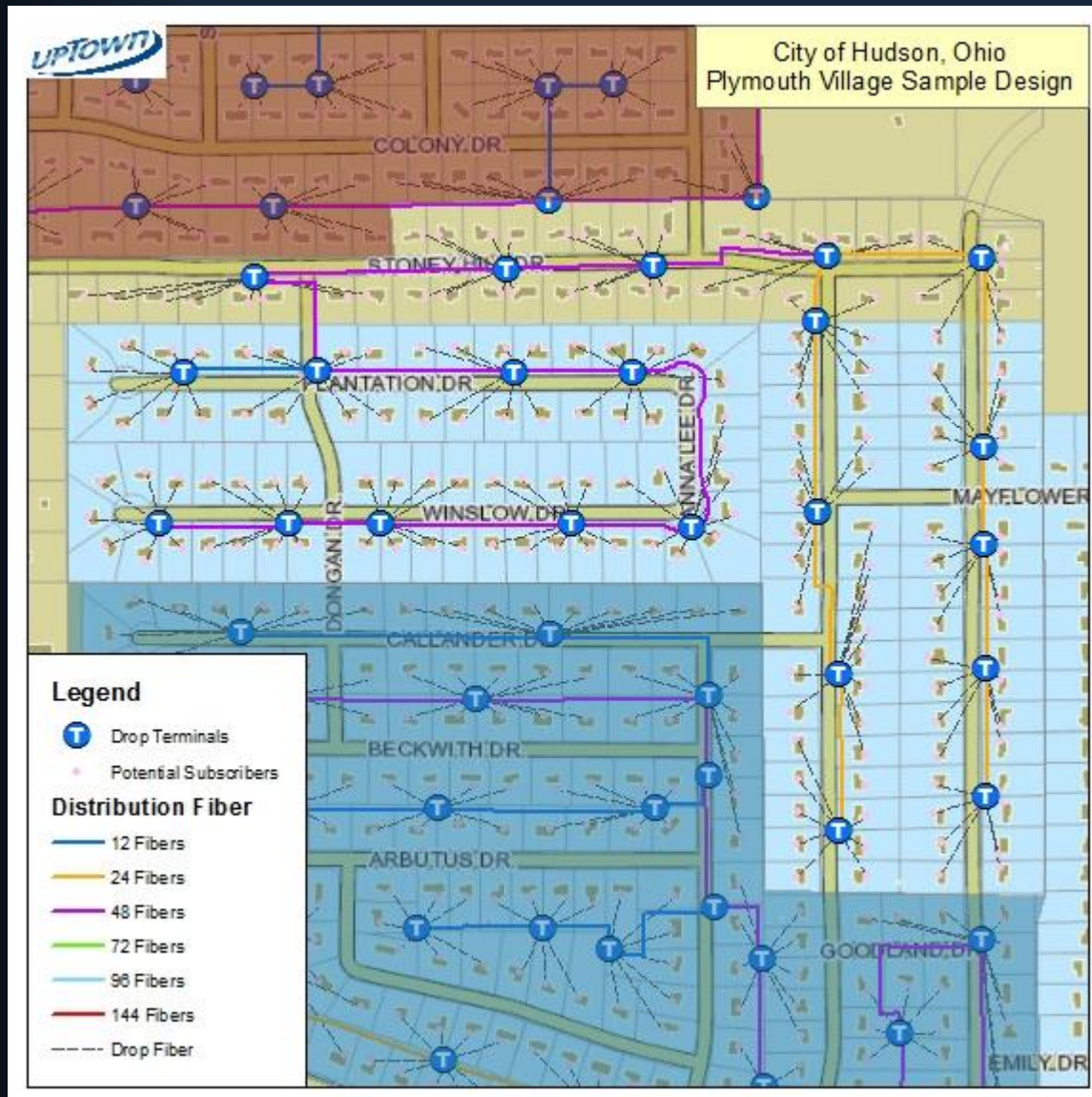
KESWYKE OVERHEAD SAMPLE DESIGN



Design Metric	Value
New Aerial Plant Miles	3.8
New Underground Plant Miles	-
% Aerial	100%
% UG	0%
Passings	216
Passings per Mile of Plant	56
Materials Cost per Passing	\$190
Labor Cost per Passing	\$348
Total Cost per Passing	\$537
Total Materials (no drops)	\$41,035
Total Labor (no drops)	\$75,062
Total Cost	\$116,097

* - Does not include engineering, fixed equipment, subscriber capital and installation costs.

PLYMOUTH VILLAGE UNDERGROUND SAMPLE DESIGN



Design Metric	Value
New Aerial Plant Miles	-
New Underground Plant Miles	2.7
% Aerial	0%
% UG	100%
Passings	179
Passings per Mile of Plant	66
Materials Cost per Passing	\$300
Labor Cost per Passing	\$1,501
Total Cost per Passing	\$1,801
Total Materials (no drops)	\$53,663
Total Labor (no drops)	\$268,635
Total Cost	\$322,298

* - Does not include engineering, fixed equipment, subscriber capital and installation costs.

HUDSON HOMES UNDERGROUND SAMPLE DESIGN



Design Metric	Value
New Aerial Plant Miles	-
New Underground Plant Miles	3.0
% Aerial	0%
% UG	100%
Passings	194
Passings per Mile of Plant	65
Materials Cost per Passing	\$314
Labor Cost per Passing	\$1,534
Total Cost per Passing	\$1,847
Total Materials (no drops)	\$60,886
Total Labor (no drops)	\$297,528
Total Cost	\$358,414

* - Does not include engineering, fixed equipment, subscriber capital and installation costs.

HUDSON PARK ESTATES UNDERGROUND SAMPLE DESIGN



Design Metric	Value
New Aerial Plant Miles	-
New Underground Plant Miles	6.0
% Aerial	0%
% UG	100%
Passings	367
Passings per Mile of Plant	61
Materials Cost per Passing	\$313
Labor Cost per Passing	\$1,615
Total Cost per Passing	\$1,928
Total Materials (no drops)	\$114,930
Total Labor (no drops)	\$592,554
Total Cost	\$707,483

* - Does not include engineering, fixed equipment, subscriber capital and installation costs.

SAMPLE DESIGN SUMMARY

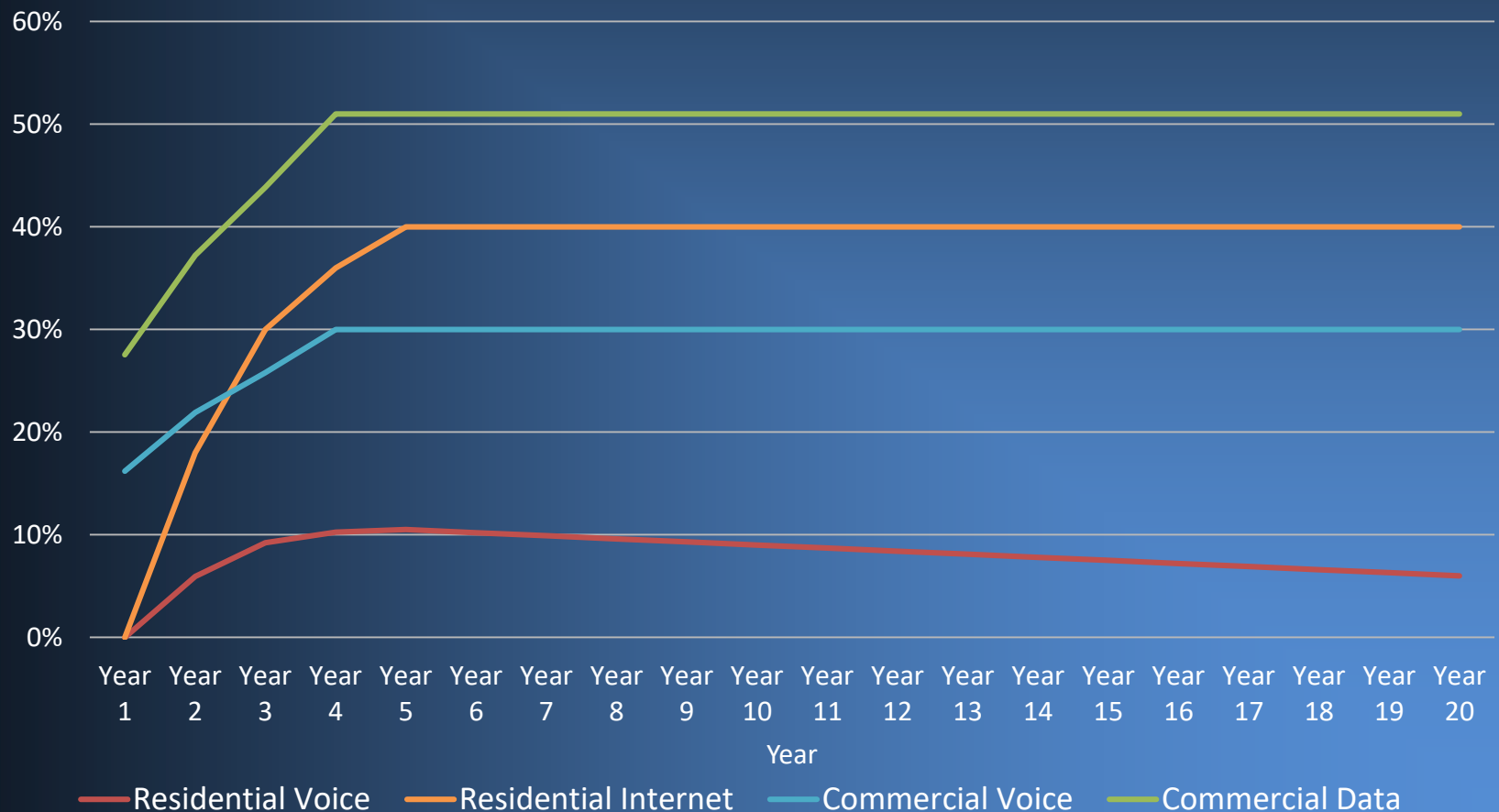
Sample Design Area	New OH Miles	New UG Miles	Passings	Passings per New Mile of Plant	Weight	Materials per Passing	Labor per Passing	Total per Passing
Keswyke Estates	3.8	-	216	56	29%	\$190	\$348	\$537
Plymouth Village	-	2.7	179	66	24%	\$300	\$1,501	\$1,801
Hudson Homes	-	3.0	194	65	24%	\$314	\$1,534	\$1,847
Hudson Park Estates	-	6.0	367	61	23%	\$313	\$1,615	\$1,928
Overall Weighted Average / Total			956	N/A	100%	\$275	\$1,206	\$1,481

- ❖ Weighting based on estimated number of passings in each category
- ❖ Total plant mileage estimated to be 99.2 miles based on housing density

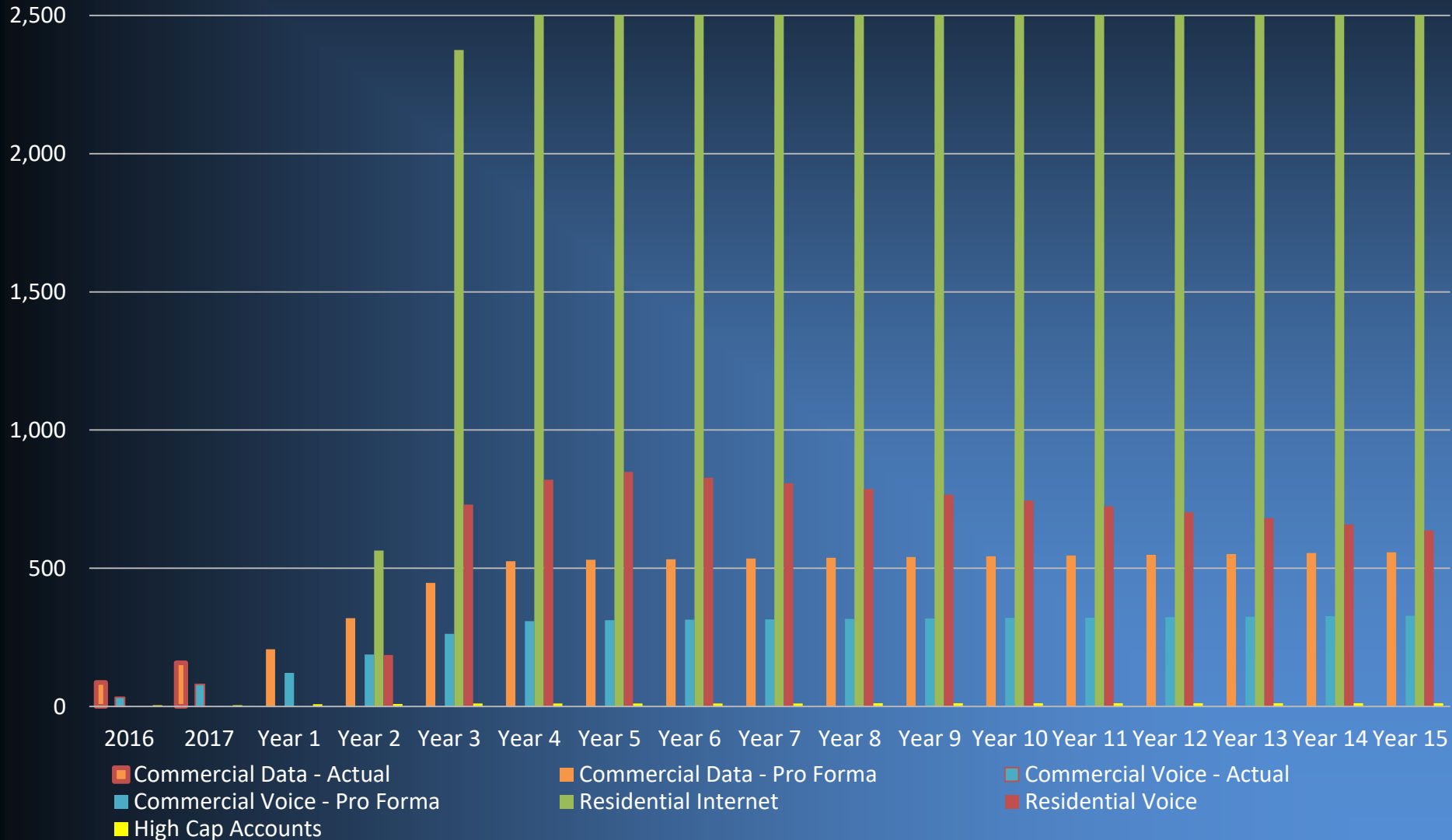
Revenue Forecast

- Pro forma take-rate projections are estimated in Phase 1 (prior to quantitative market research) and reflect ongoing wireless (voice) and OTT (video) substitution within the residential segment...

Service Penetration
(By Year Since Launch)

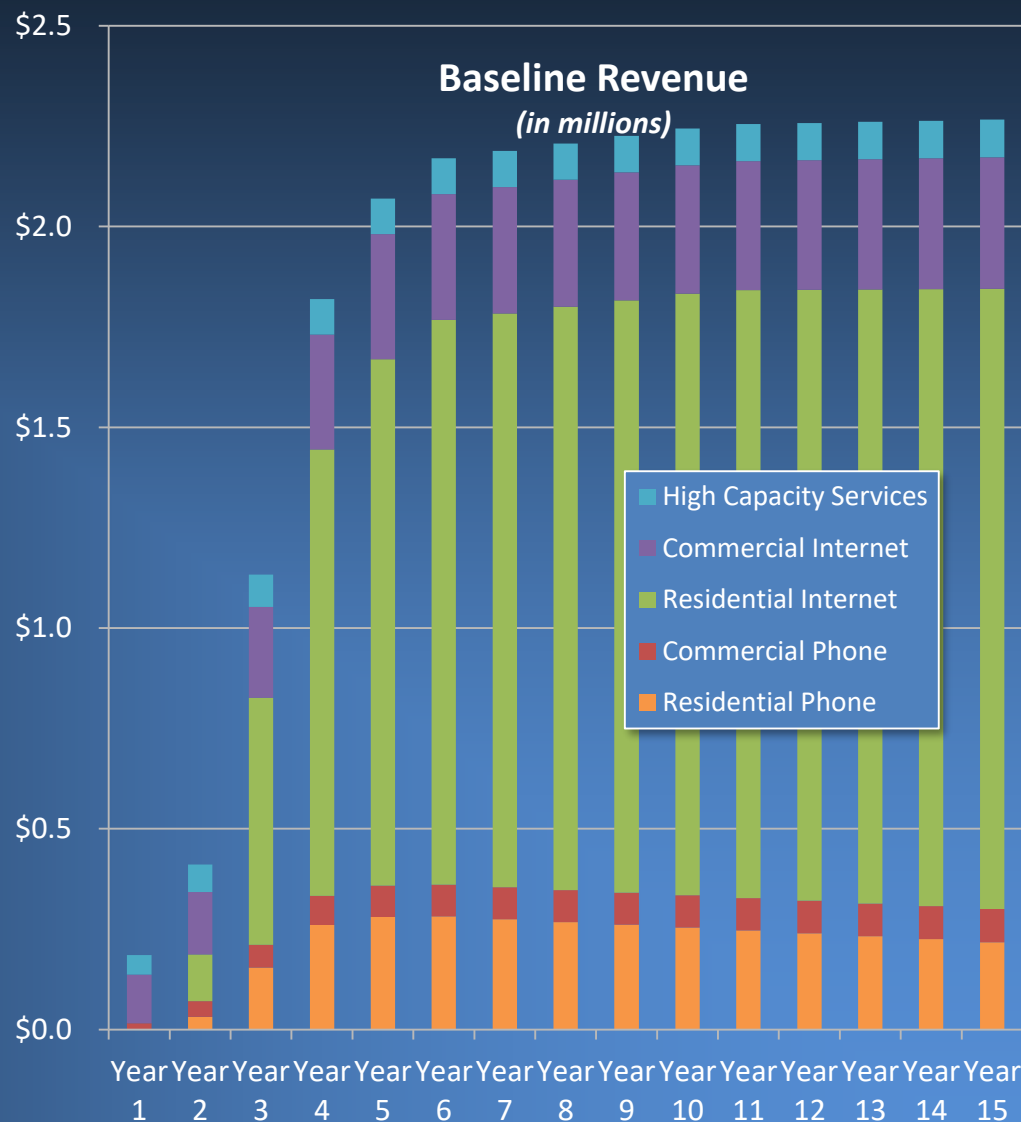


Subscribers by Service
(End of Period)



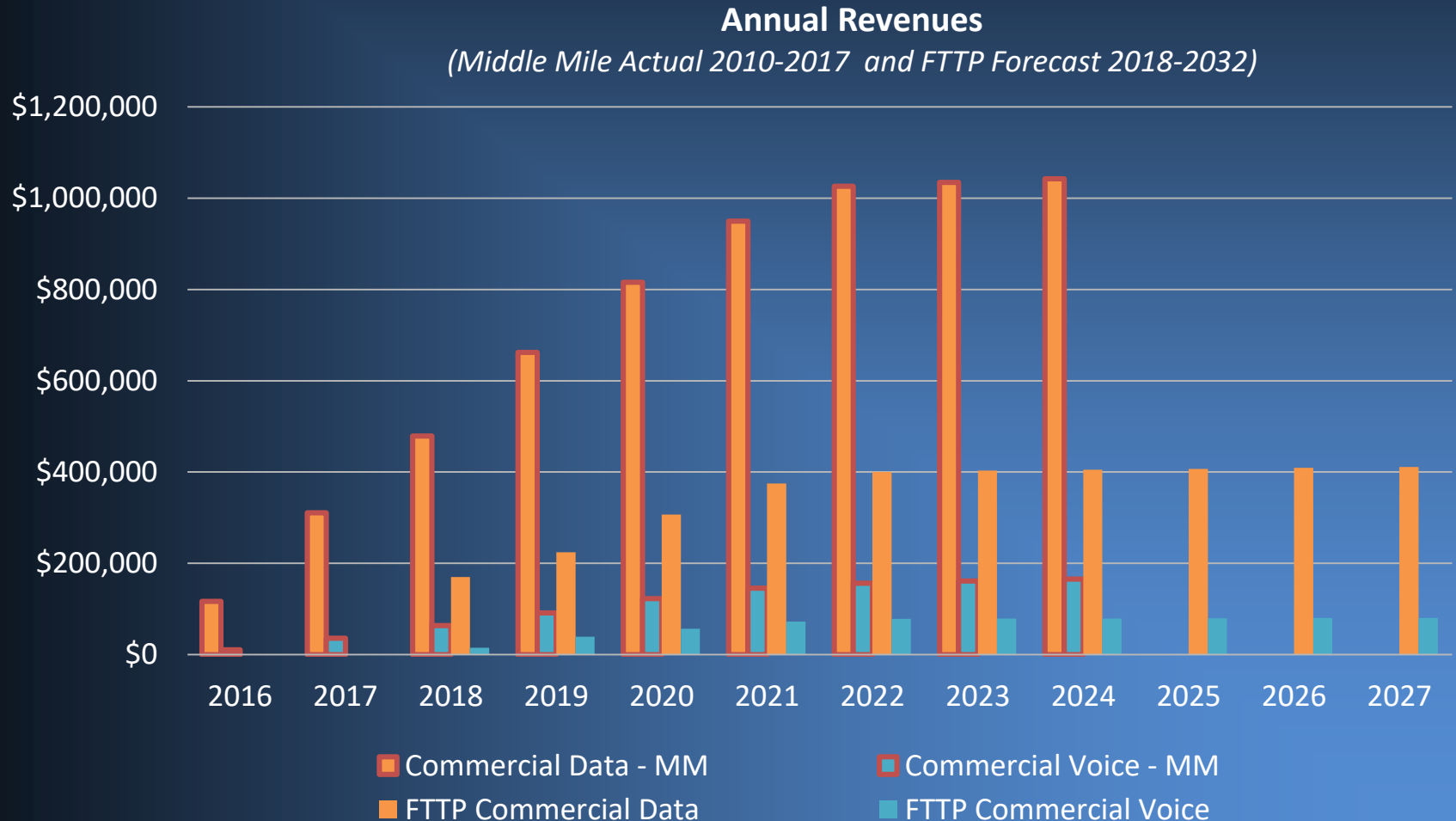
KEY INPUTS

- Premises
 - Residential: 7,761
 - Commercial: 650
 - Household Growth: 1.0%
 - Commercial Growth: 1.0%
 - % Complex: 2.5% of commercial
- Year 5 Penetration
 - Internet: 40%
 - Voice (eroded): 10.5%
- Residential Internet
 - 1Gbps Tier: \$30
 - 2Gbps Tier: \$50
 - 4Gbps Tier: \$70
 - WiFi: Included
- Commercial Internet
 - 100Mbps Tier: \$59
 - 250Mbps Tier: \$99
 - 500Mbps Tier: \$249
 - 1Gbps Tier: \$399
 - WiFi: Included
- Voice
 - Residential: \$28 net wholesale
 - Commercial: \$17 net per line
- Install Fees
 - Residential: \$0
 - Commercial: \$0



MM & FTTP FORECASTED COMMERCIAL REVENUE

The FTTP system forecasted revenues conservatively reflect the growth opportunity to all commercial premises that FTTP affords...

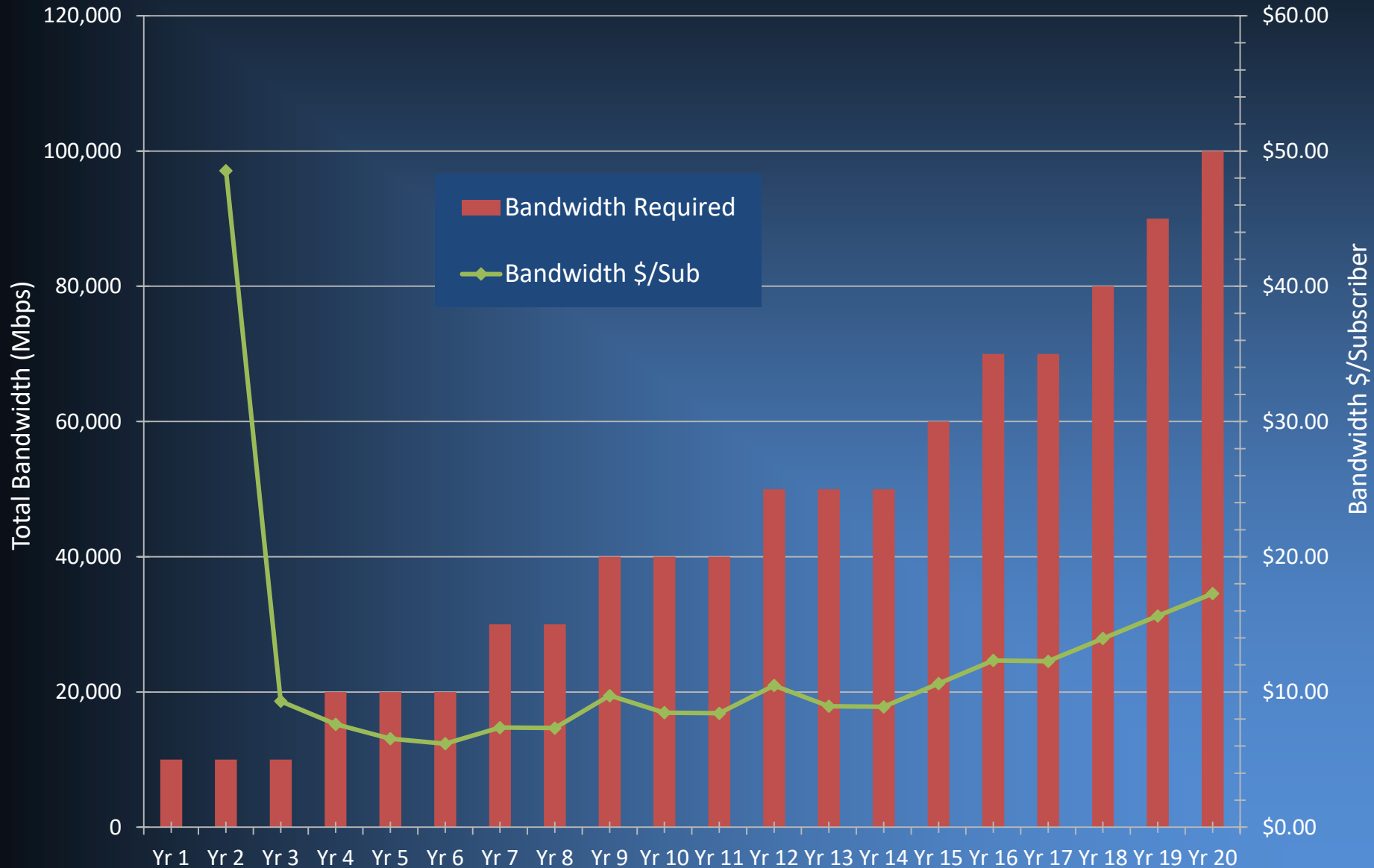


Operating Budget

BANDWIDTH SOURCING & USAGE INPUTS

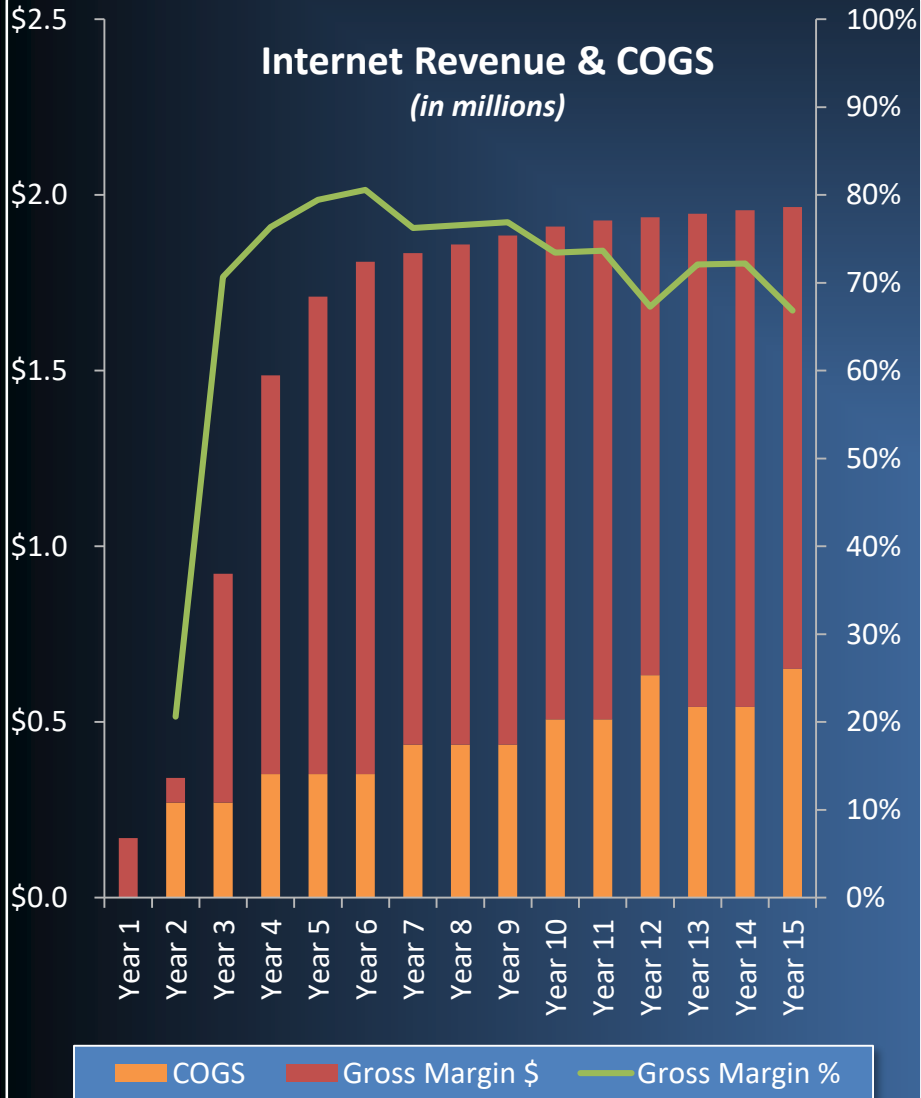
Delivered Bandwidth		Crown Castle 2G circuit directly to Hudson Headend at \$3,200 MRC	<i>\$1.60/Mbps</i>
Direct Access Configuration	Transport	Windstream 1G transport circuit at \$1,710 MRC	<i>\$1.71/Mbps</i>
	Access	Cogent 1G bandwidth at Cleveland POP for \$900 MRC	<i>\$0.90/Mbps</i>
	Other Fees	X-Connect: \$300 MRC per circuit x 1 = \$300 MRC IP Addresses: \$0 (ARIN /22 and Lighttower /24 one-time fee)	
Bandwidth Usage Per Subscriber		Residential: 2M in Year 1 growing at 25%/year reducing to 10% by Year 10 Commercial: 1M in Year 1 growing at flat 10%/year High Capacity: 500K in Year 1 growing at flat 10%/year	

BANDWIDTH FORECAST

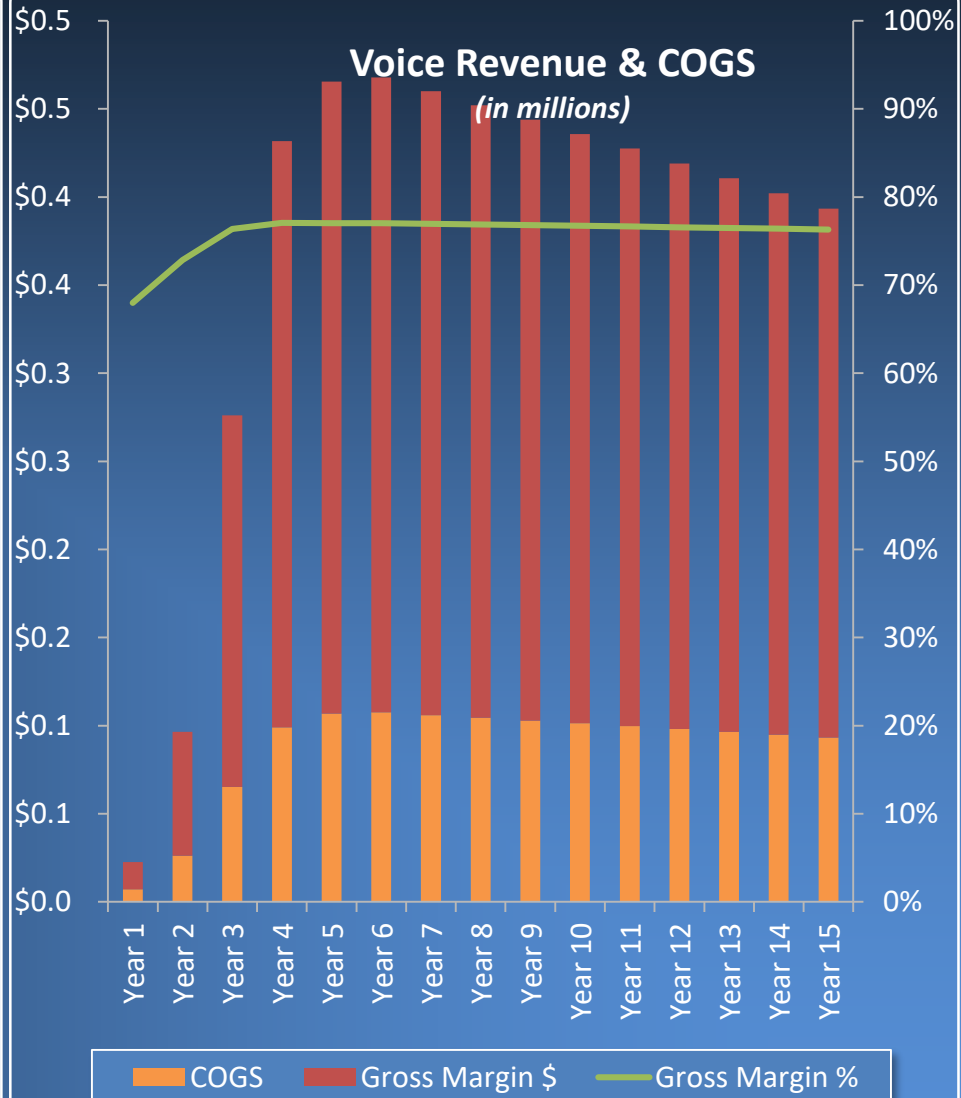


BASELINE COGS & GROSS MARGIN

Internet Revenue & COGS
(in millions)



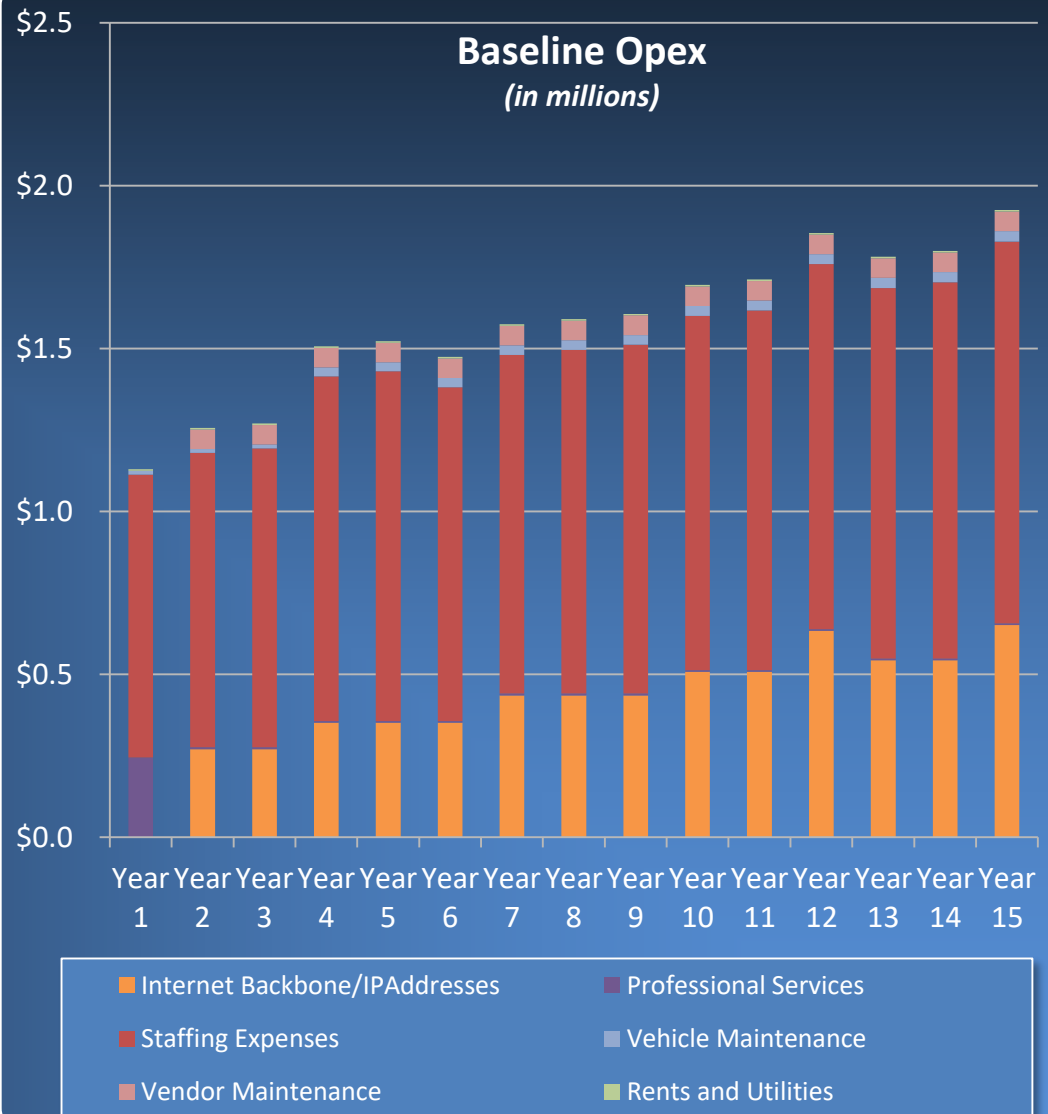
Voice Revenue & COGS
(in millions)



OPERATING EXPENSE

KEY INPUTS

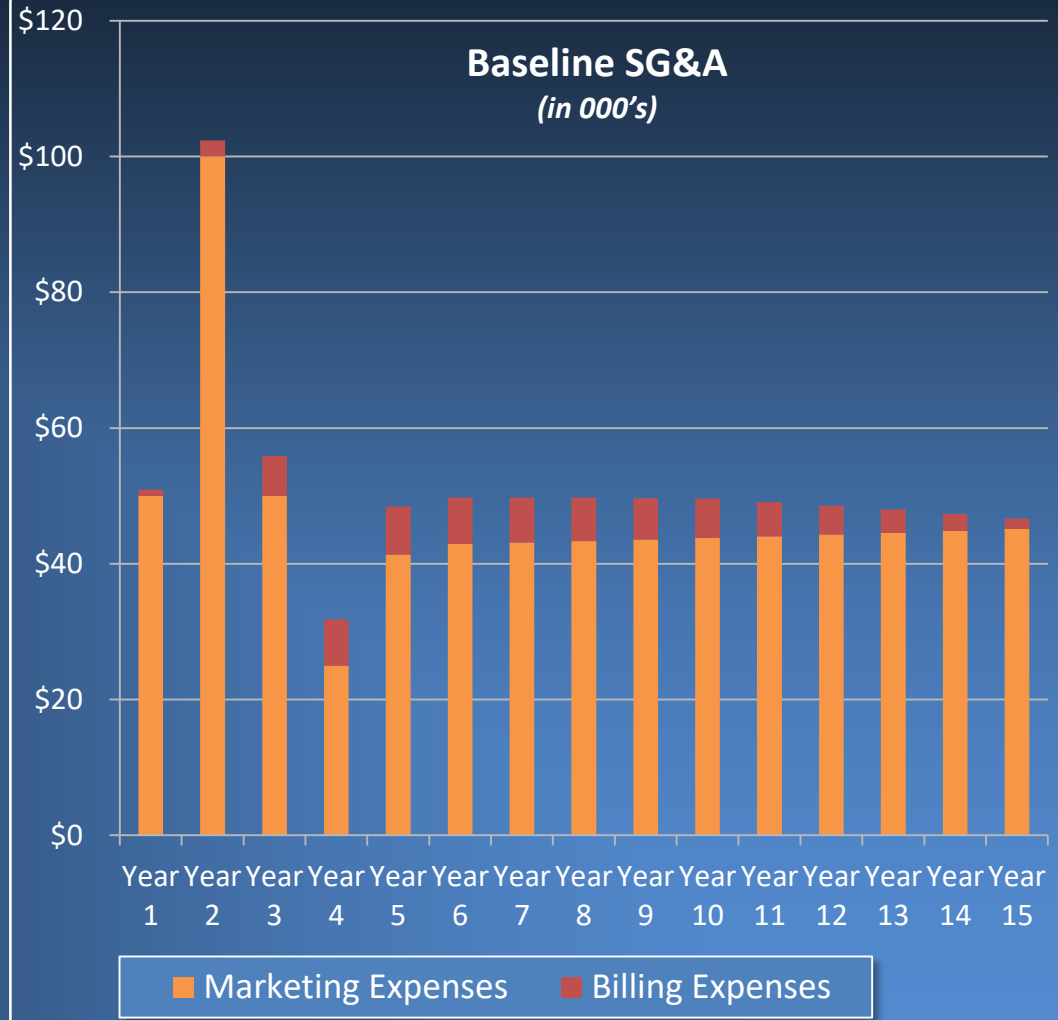
- Bandwidth/IP Addresses
 - Fees and usage per detail slide
- Staffing
 - Headcount per detail slide
 - 1.5% annual wage increase
 - 51% benefits loading
- Vehicle Maintenance
 - 10k miles annually per vehicle
 - \$.75/mile growing at 1.5%
- Professional Services
 - Implementation Support: \$240k
 - Legal/Acct: \$5k/year
- Other Opex
 - Vendor maintenance of \$60k/year for OSS/BSS and FTTP electronics
 - Utilities: \$4.8k/year



GENERAL & ADMINISTRATIVE EXPENSE

KEY INPUTS

- Marketing
 - Year 1: \$50k
 - Year 2: \$100k
 - Year 3: \$50k
 - Year 4: \$25k
 - Year 5+: 1% of revenues
- Billing
 - 80% of residential and 50% of commercial using paperless billing
 - Paper bill cost of \$.75/each/month and growing 3% annually
- Overhead Cost Allocation
 - None



FTE LEVELS: MANAGEMENT EMPLOYEES

- ◆ Dedicated FTTP System Full Time Equivalents (FTE)
 - ◆ System GM/'Broadband Manager': 1 FTE
 - ◆ Data Technician/'Fiber Technician': 1 FTE
 - ◆ Marketing Coordinator/'Broadband Assistant': .5 FTE 2018 then 1 FTE 2019+
 - ◆ Commercial Account Rep/'Office Manager': 1 FTE
- ◆ Position unloaded salaries based on current City salary ranges, 51% benefits loading, and 1.5% annual salary increase
- ◆ Benefits loading detail:
 - ◆ General Benefits excluding health care: 18%
 - ◆ Healthcare costs: \$1,800/month is 33% loading if average salary is \$65k (assumes family coverage)



FTE LEVELS: DEDICATED FRONTLINE EMPLOYEES

- ◆ Customer / Technical Service Representatives (CSRs/TSRs)
 - ◆ CSRs handle inbound/office sales, order entry and first tier support
 - ◆ TSRs handle all second tier customer support, dispatch and service provisioning
 - ◆ Staffed at 1 FTE per 2k accounts growing to 4k by Year 5, but with minimum of 3 CSR and 2 TSR positions to ensure phone coverage
- ◆ Install Technicians
 - ◆ Installs are 2-phase with pre-install followed by separate premise install
 - ◆ Pre-installs completed by a contractor at fixed rate (\$210) for 100% of connections for Years 1-3, 50% in Year 4, and then insourced
 - ◆ Premise installs are completed by a contractor at fixed rate (\$175), for 100% of connections for Years 1-3, 50% in Year 4, and then insourced
 - ◆ Each Install Tech can complete 3/day
- ◆ Service Technicians
 - ◆ Service techs fix subscriber problems
 - ◆ Service call volume equals 50% of all subscribers/year dropping to 25% by year 5
 - ◆ Each Service Tech can complete 4/day growing to 6/day by Year 5
- ◆ Maintenance Technicians
 - ◆ Network techs maintain the fiber system from the backbone to the network access point

INCREMENTAL BROADBAND FTE REQUIRED

Position Title	Salary (unloaded)	Year1	Year2	Year3	Year4	Year5	Year6	Year7
System GM	\$90,000	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Marketing Coordinator	\$30,000	0.5	1.0	1.0	1.0	1.0	1.0	1.0
MDU Account Manager	\$65,000	-	-	-	-	-	-	-
Comm. Acct Rep	\$70,000	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Sales Engineer / MDU Accounts	\$55,000	-	-	-	-	-	-	-
Headend Tech	\$70,000	-	-	-	-	-	-	-
Network Engineer	\$70,000	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Field Ops Supervisor	\$70,000	-	-	-	-	-	-	-
CSRs	\$40,000	3.0	3.0	3.0	3.0	3.0	3.0	3.0
TSRs	\$50,000	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Install Techs	\$40,000	-	-	-	2.0	2.0	1.0	1.0
Maintenance Techs	\$65,000	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Service Techs	\$45,000	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Total Headcount		10.5	11.0	11.0	13.0	13.0	12.0	12.0

Capital Budget

- ◆ Network Construction
 - ◆ OSP Construction: \$1,481 composite cost per premise passed
 - ◆ Subsequent plant extensions: \$500/meter passed
 - ◆ Backbone/Feeder Construction: \$40/meter passed
 - ◆ Make ready cost: \$0/pole
 - ◆ Year 10 Network electronics upgrade: \$75/premise passed
- ◆ Facility Capital Costs
 - ◆ New facility for broadband staff: Not required
 - ◆ Build-out of new office location: \$20k
- ◆ Software
 - ◆ OSS/BSS: \$25k (for module enhancement to GLDS)
 - ◆ Fiber Management & Network Management: Already acquired
- ◆ Fixed Equipment
 - ◆ Core HE switch/router: \$100k (enhancement of current platform)
 - ◆ Internet systems back office: \$60k
 - ◆ Field Tech Equipment/Tools: \$40k
 - ◆ Generator/UPS: \$15k (for upgrade to existing)

- ◆ Vehicles
 - ◆ Service Vans Per Install Technician: 1.0
 - ◆ Heavy Service Trucks Per Maintenance Technician: 0.5
 - ◆ Service vans: 2 at \$45k each
 - ◆ Heavy Service Trucks (non-insulated): 1 at \$90k each
 - ◆ Install Rigs: 1 per Install Technician at \$20k each
 - ◆ Vehicles replaced at 6 year intervals
- ◆ Contract Labor
 - ◆ Previous slide detail
- ◆ Optical Network Terminals (ONTs)
 - ◆ Residential/Business ONT (non-WiFi): \$150 each
 - ◆ Residential/Business ONT (80211.ac WiFi): \$200 each
 - ◆ Year 7 ONT upgrade: \$152k (\$40/ea.)
- ◆ Fiber Drop & Powering
 - ◆ Fiber drop and connectors: \$125 each
 - ◆ Power cord and UPS: \$52 each (\$12 for non-voice install without UPS)

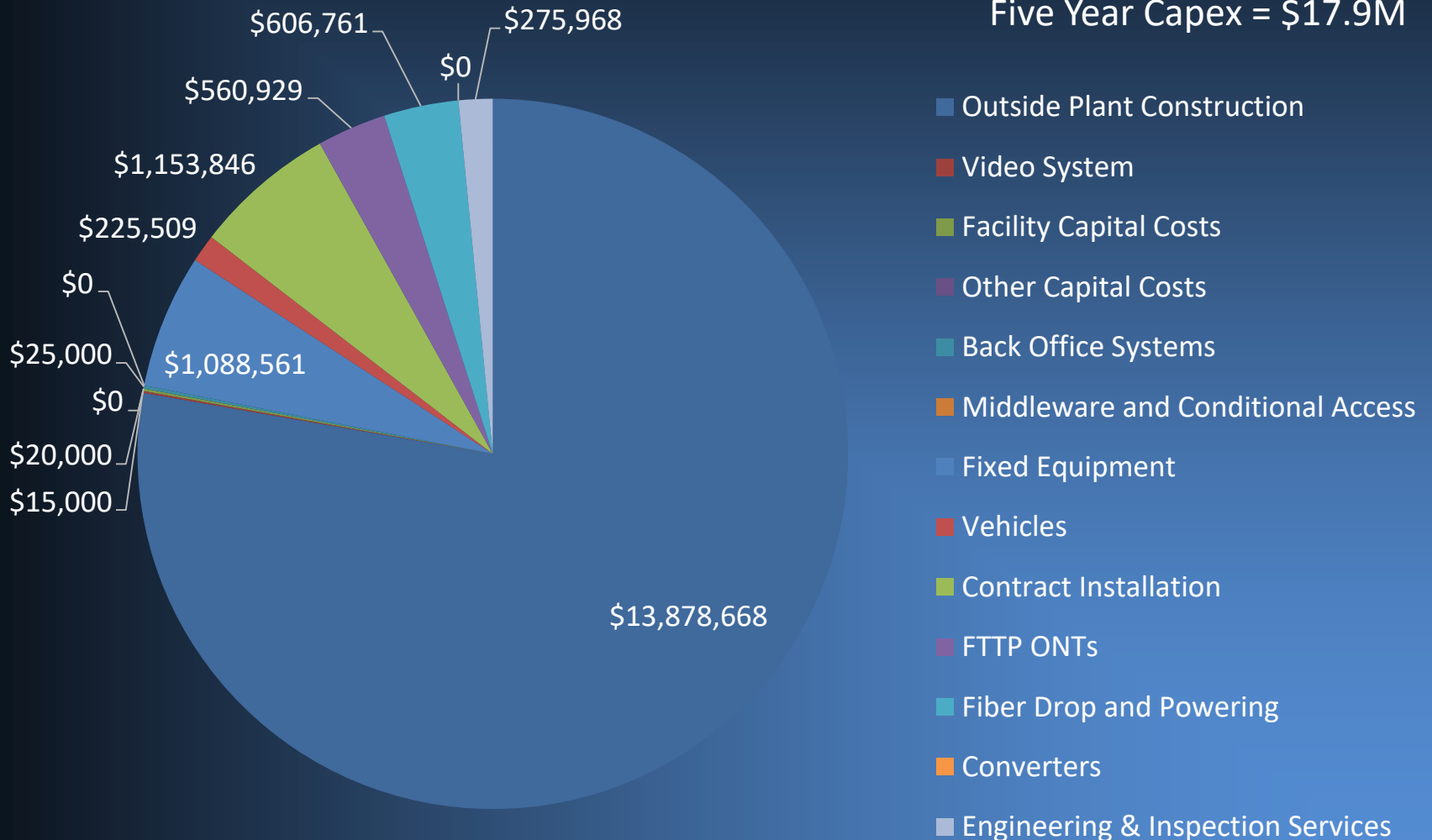
- ◆ Engineering and Integration
 - ◆ Walk out & strand mapping: \$0 per mile
 - ◆ Make ready engineering: \$0 per mile
 - ◆ FTTP design: \$1,300 per mile
 - ◆ Construction management services: \$3,000 per mile
 - ◆ As-built drawings: \$250 per mile
 - ◆ Backbone/Feeder design: \$25k flat fee

- ◆ Locates
 - ◆ Not included

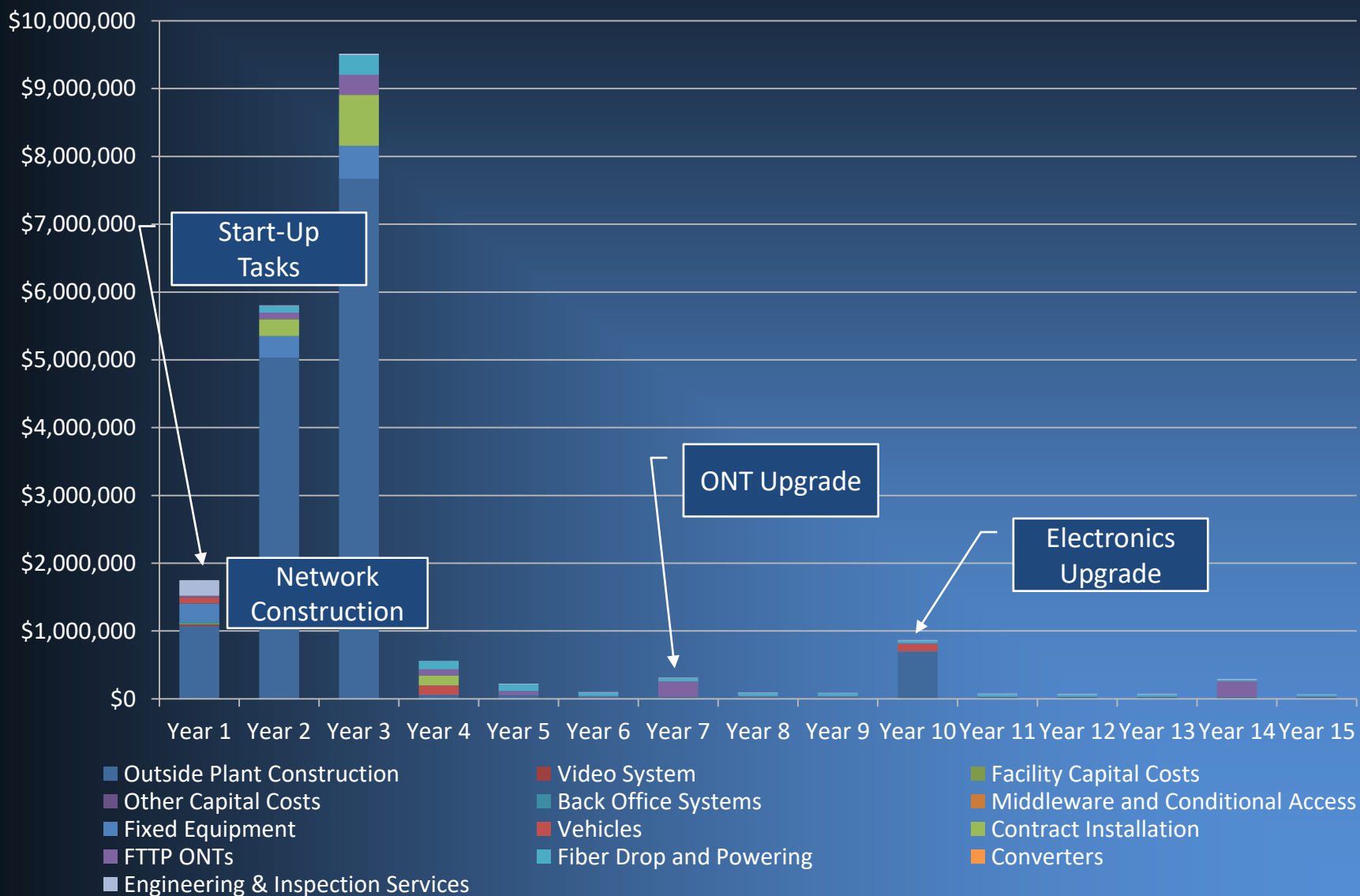
- ◆ Long term financing
 - ◆ A 10 year General Obligation bond with 4% rate is anticipated and that a property tax levy would be implemented to obtain and securitize third party financing
 - ◆ Pro forma estimate is that total proceeds required is \$20.9M with \$100k allowance for issuance costs (maintains minimum \$2.5M cash balance)
 - ◆ The annual debt service of the bond would be paid through the tax levy
- ◆ Short term financing
 - ◆ Operating losses in Years 1 and 2 of the plan total $\approx$ \$2M and may need to be separately funded depending upon long term debt terms
- ◆ Start-up period included as Year 1 of the business case
 - ◆ Only middle mile revenues (commercial data and voice) assumed during first year of the plan, and with rate reductions for commercial Internet service
 - ◆ FTTP technical Trial underway at the end of Year 1
- ◆ Other assumptions
 - ◆ Bad debt = 3% of gross revenues
 - ◆ 2% interest on cash reserves
 - ◆ Discount rate = 4% for present value calculations
 - ◆ 12 billable months in Year 2

BASELINE CAPEX – YEARS 1-5

Five Year Capex = \$17.9M



BASELINE CAPEX BY YEAR



Pro Forma Outcome

UNLEVERED KEY FINANCIAL METRICS (\$M)

