2019 Annual Meeting

Iowa Events Center, Des Moines, March 25-26, 2019

Pros & Cons – Latest Wireless Options for the Last Mile

Image source: Telecoms.com "Arqiva, Samsung to trial 5G fixed wireless in London soon" by Tim Skinner, 2/24/2017

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VantagePoint
An Employee Owned Company

FWA Overview & "Sooth"

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FWA Overview & "Sooth"

Chris Konechne,
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1981 Engebretson Ave.
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(507) 777-2255
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FWA System Types & Fits

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FINLEY ENGINEERING

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Pete McNally,
Founder & Principal
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(515) 314-0219
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THE GRINNELL GROUP

Structures will be Needed!

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Pros & Cons – Latest Wireless Options for the Last Mile

OVERVIEW

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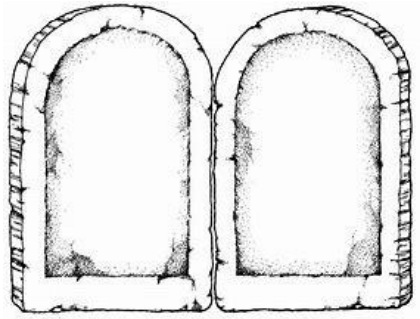
OVERVIEW – Latest Wireless Options for the Last Mile

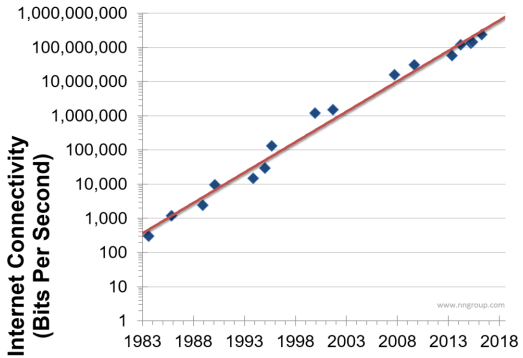
Topics

- The Fixed Wireless Access "Sooth"

- Will 5G Help? (& What *Is* It?)

Wireless Truths





I. The Broadband of Today is the *Narrowband* of *Tomorrow*.

During AT&T's earnings call with investors on Jan. 30, CEO Randall Stephenson predicted that fixed 5G wireless ***will have*** enough broadband capacity for consumers to access streaming video services ***similar to what cable broadband offers today***.

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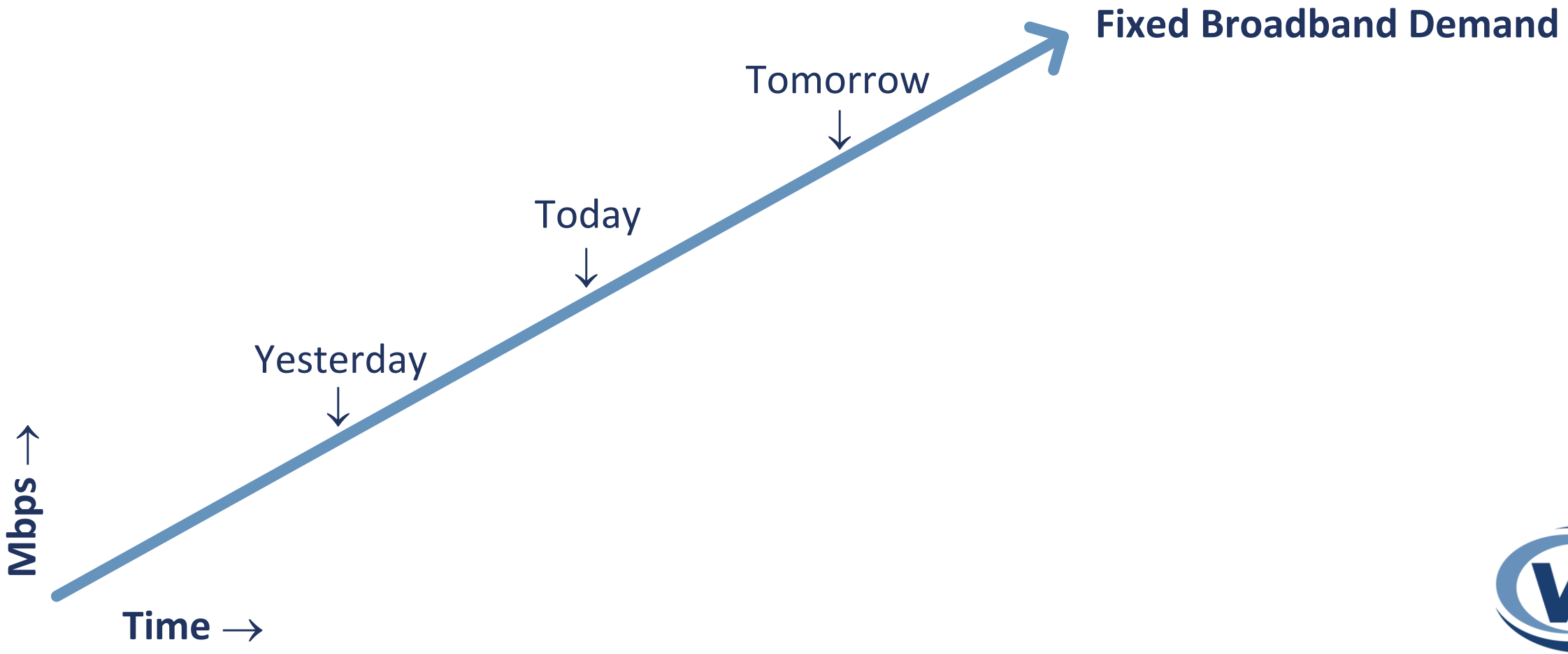
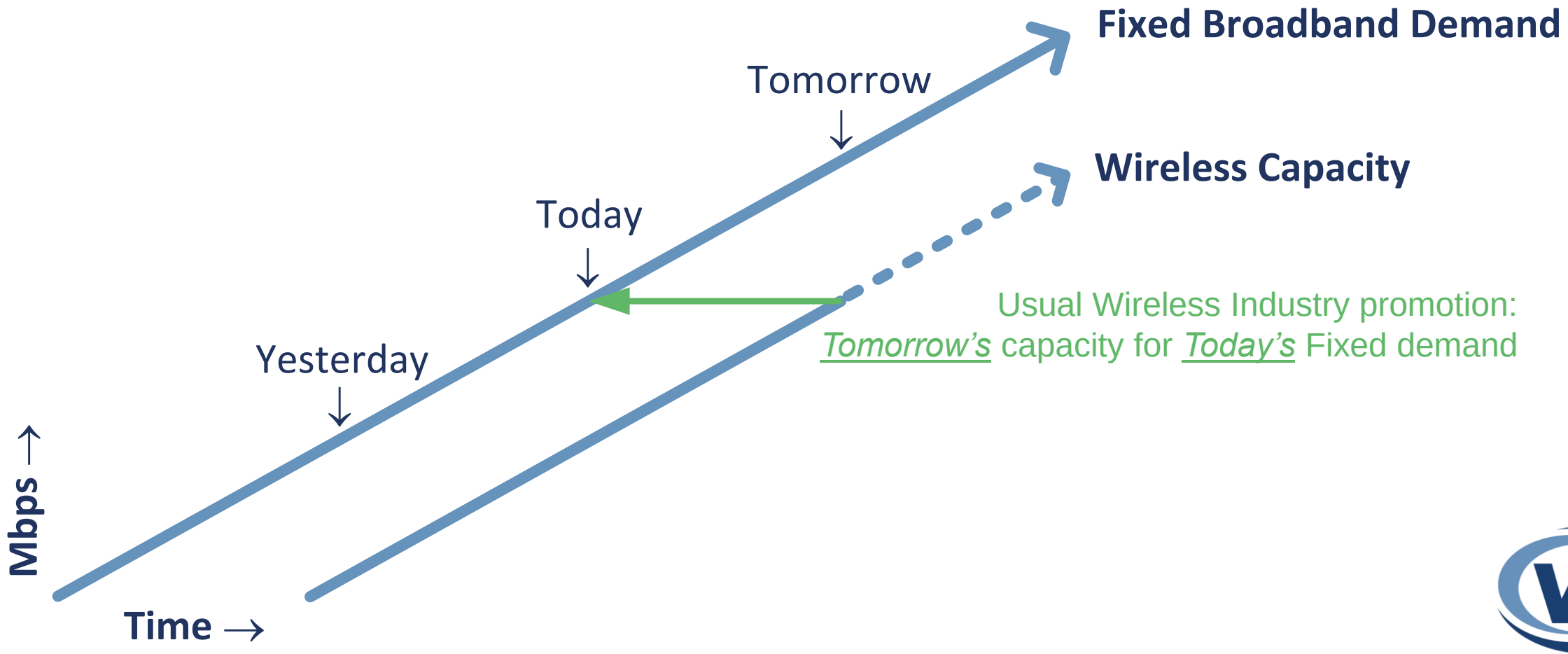

Fixed Broadband Demand
Tomorrow
Today
Yesterday
Mbps →
Time →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Usual Wireless Industry promotion:
Tomorrow's capacity for Today's Fixed demand
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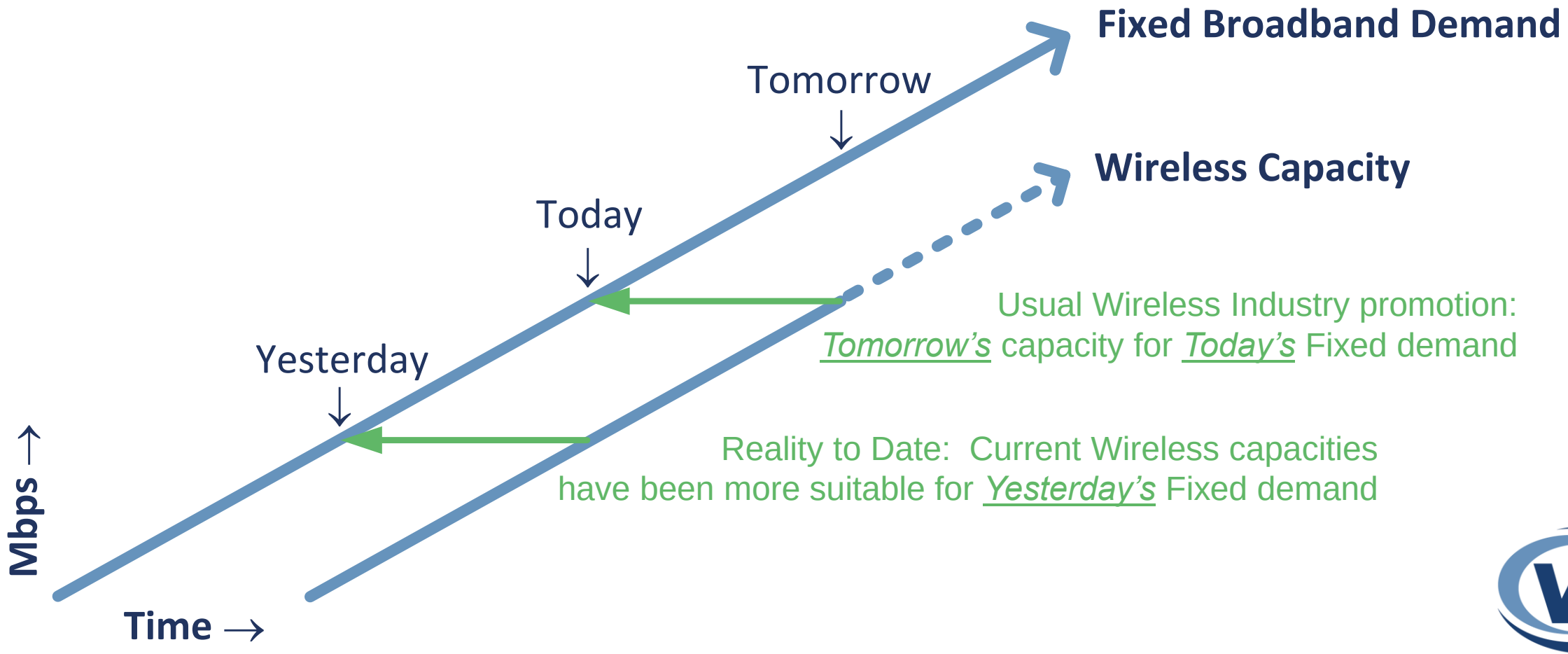
Fixed Broadband Demand
Tomorrow
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Usual Wireless Industry promotion:
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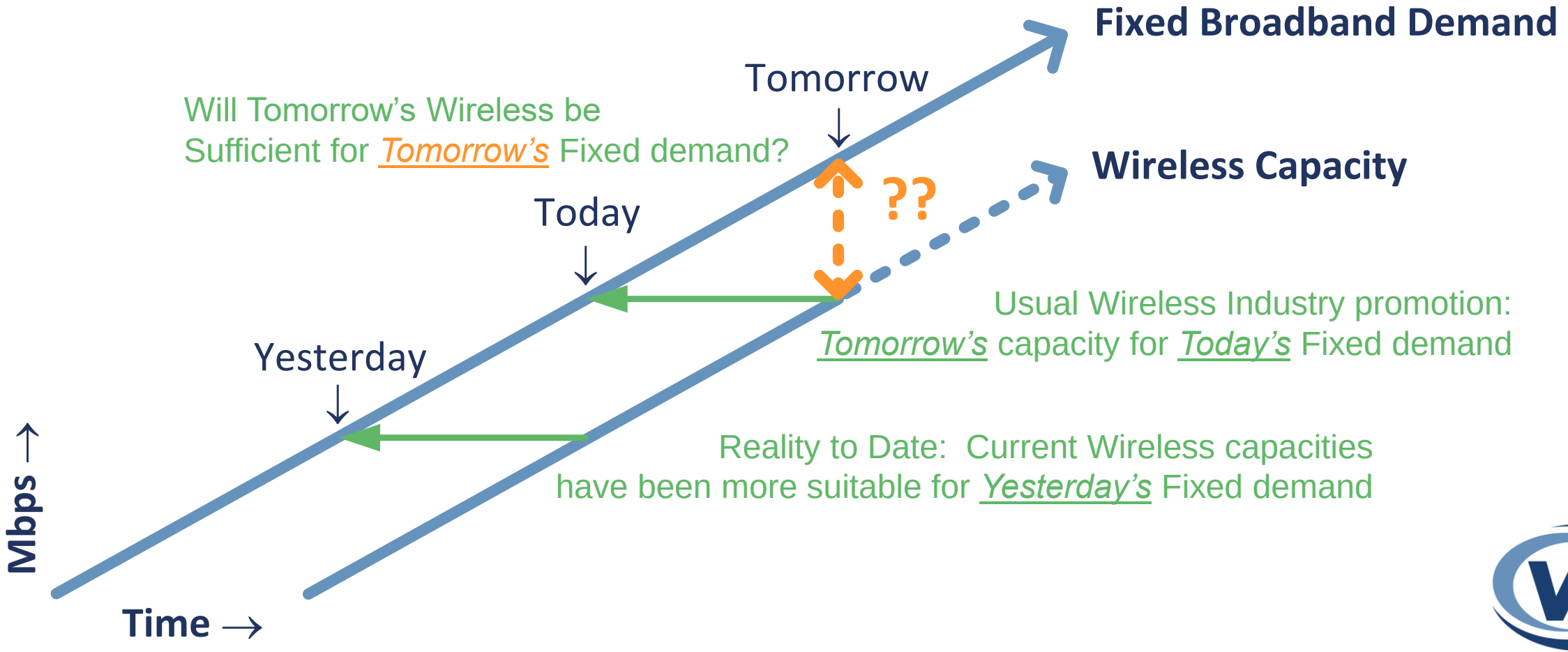
Reality to Date: Current Wireless capacities
have been more suitable for Yesterday's Fixed demand
Mbps →
Time →

What will fixed broadband demand *be* by the time *Rural* FWA can deliver *Fiber-like* SLAs?



Will 5G Help Us Provide this *Rural* Broadband?

(and What the Heck Is It?)

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Best Buy Super Bowl commercial 2013

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"...particularly as we turn up **mmWave** spectrum," Stephenson said. "That's where the capacity and the performance comes from..."

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Will 5G Help Us Provide this *Rural* Broadband?

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Will 5G Help Us Provide this *Rural* Broadband?

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VantagePoint EMPLOYEE OWNED

Best Buy Super Bowl commercial 2013

Actually *Three* Use Cases:

1) **Enhanced *Mobile* Broadband**
   ***10 x* 4G** – up to *10 Gbps!*
   (Typ. 1.5 Gbps peak, 100 Mbps avg. in crowds)
   - » Initially “Nomadic” (& Fixed)
   - » Eventually for Mobile devices

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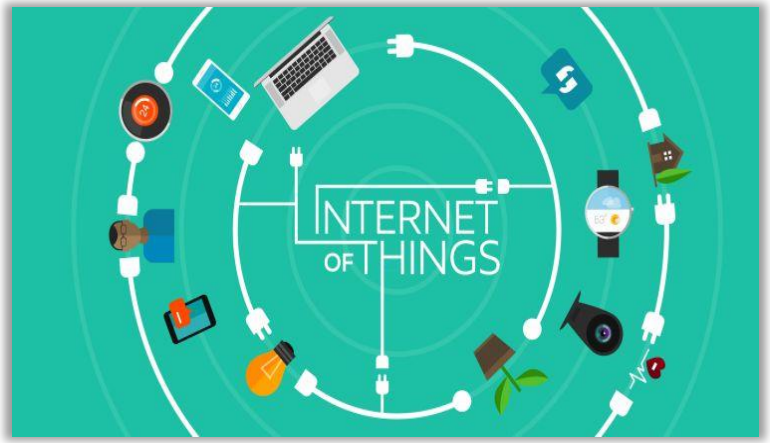
2) **Massive Machine Type Communications**
   (Opposite of #1)
   - » Supporting a profuse proliferation of low power, low throughput sensors and actuators for the **“IoT”**
     - » Could include Smart Farms



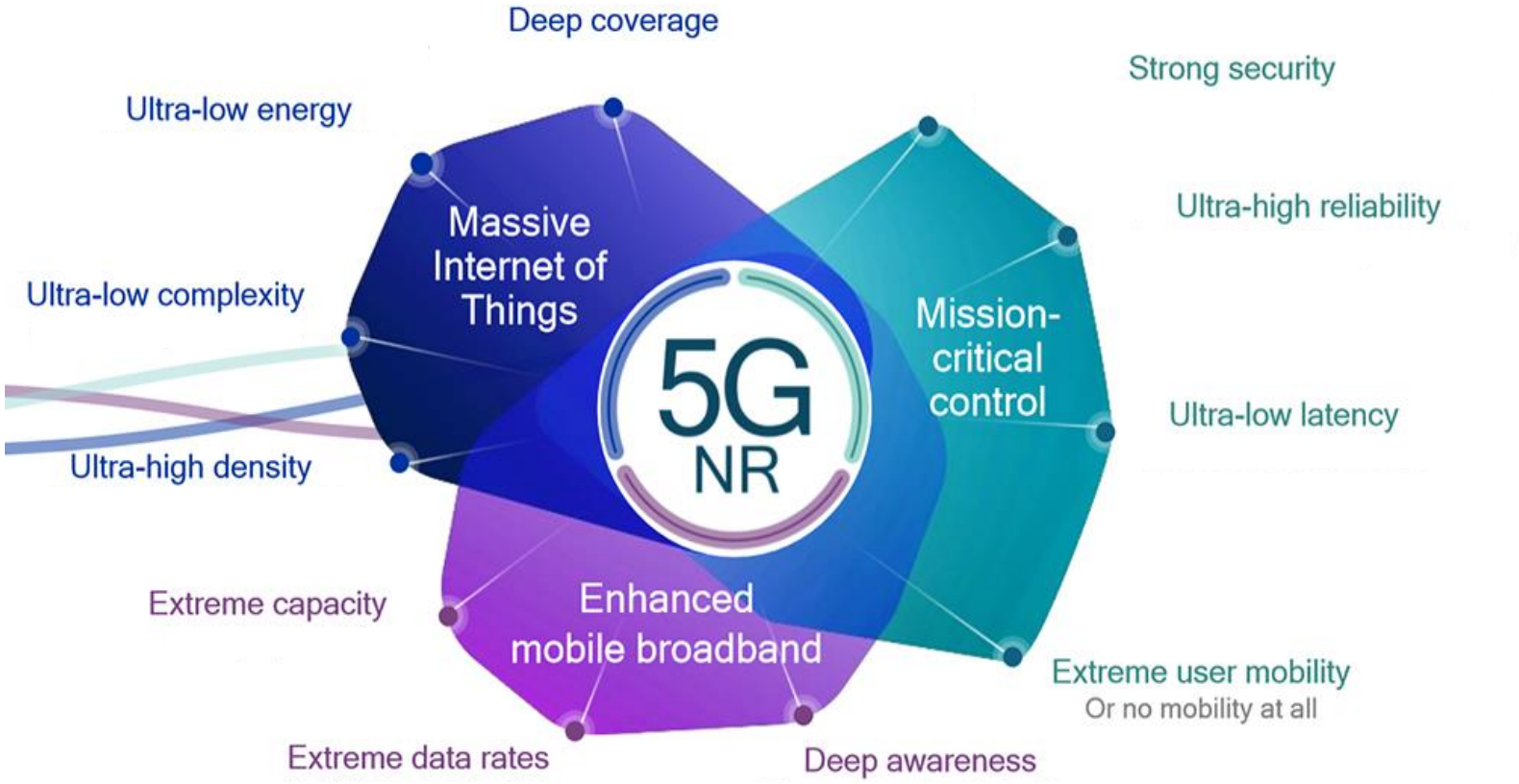
Actually *Three* Use Cases:

3) Ultra-Reliable & Low Latency Communications

- Mission Critical applications requiring <4ms latency and/or 99.999% availability
- Examples
  - eHealth
  - Drones
  - Autonomous Vehicles
    - *e.g.,* for collision avoidance, traffic avoidance
    - Even fully driverless, freight & passenger vehicles
    - Could include automated Tractors, *e.g.*

Actually *Three* Use Cases:

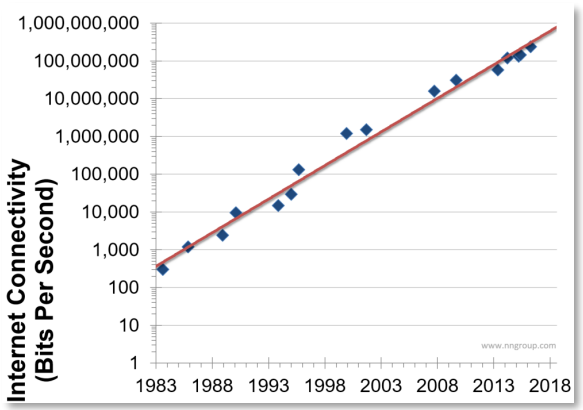
All three have technically divergent requirements, but are handled under the one new 5G standard.



Source: Qualcomm

What Is *Truly* Dictating 5G?

- *Exponential* Demand Growth per Mobile User! And crowds of Users!
- What's a Mobility Provider to *DO?!*



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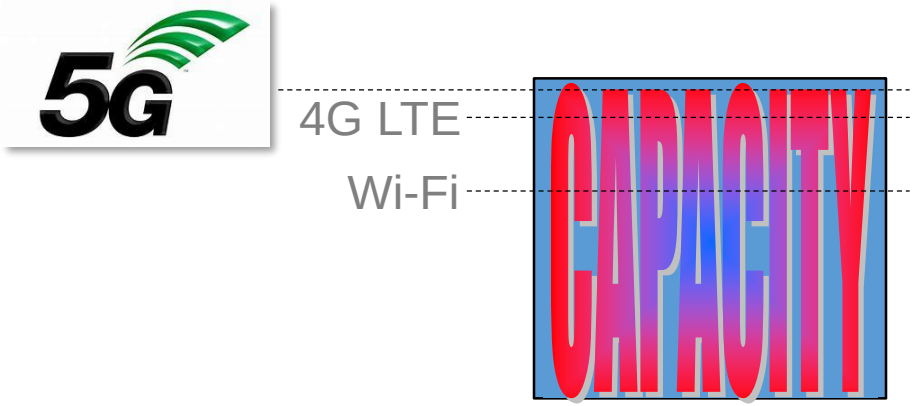

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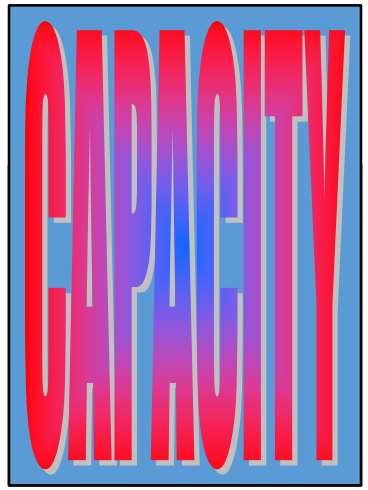

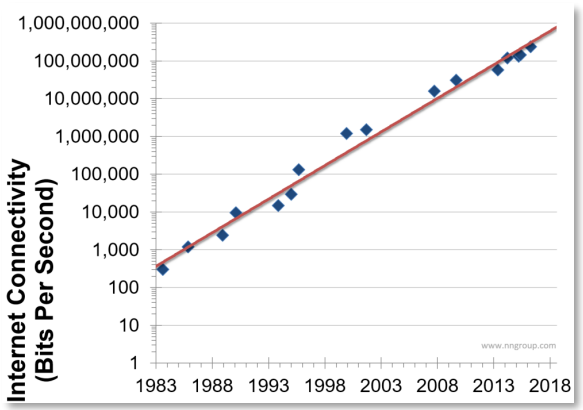

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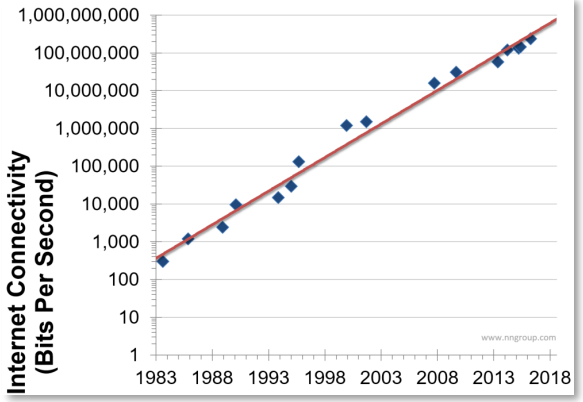

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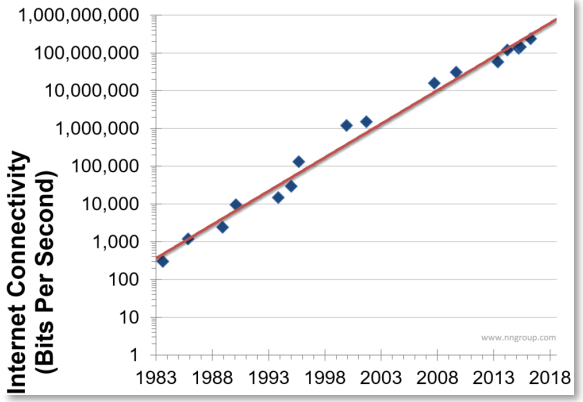

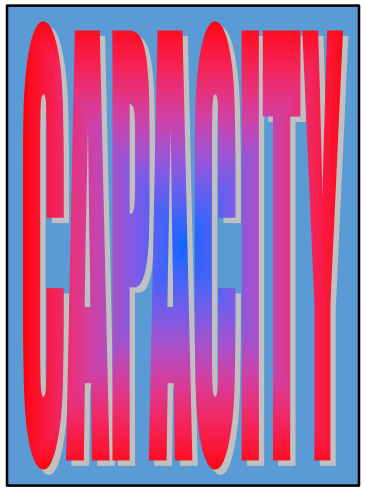

Less Noise & Interference?

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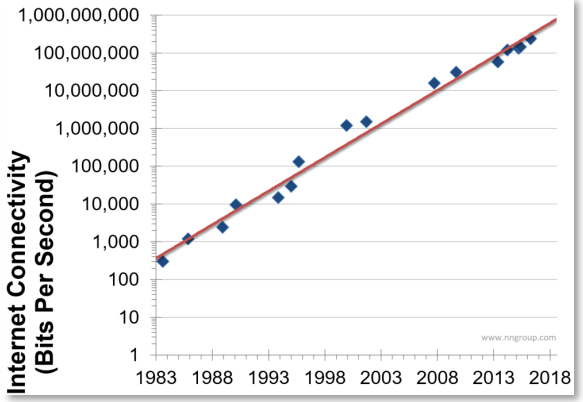

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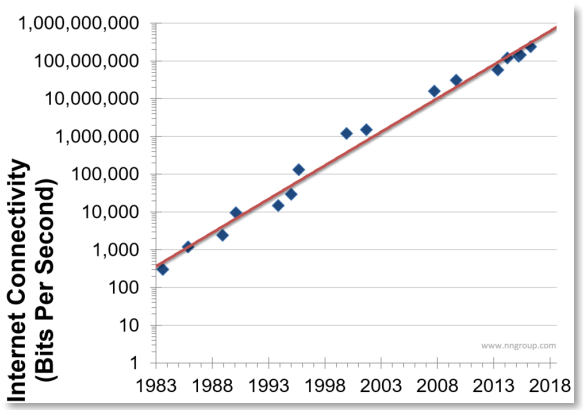

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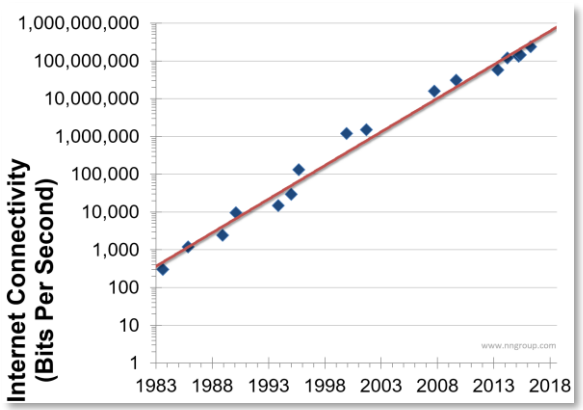

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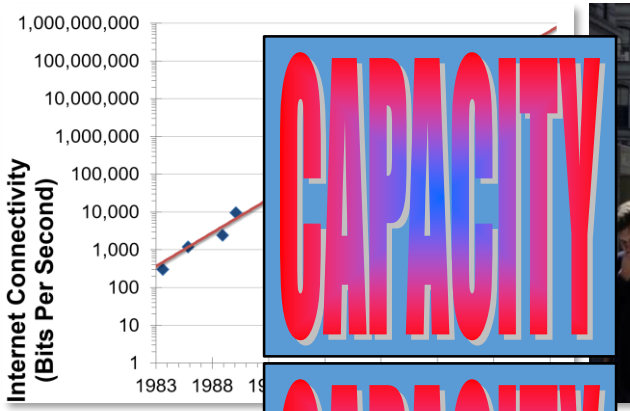
← →

CAPACITY

~~Less Noise & Interference~~



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And/Or… Use It Over and Over Again!

We'll get to this, but first…

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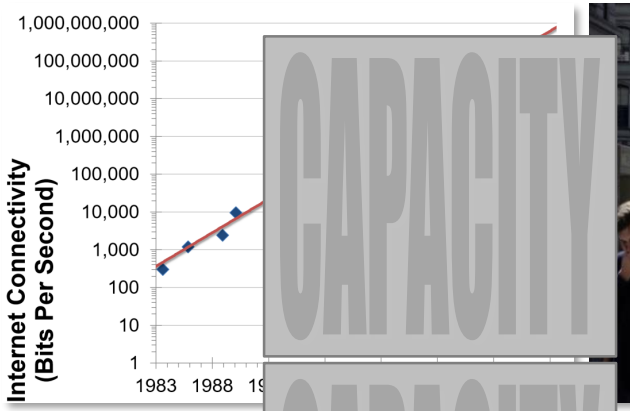

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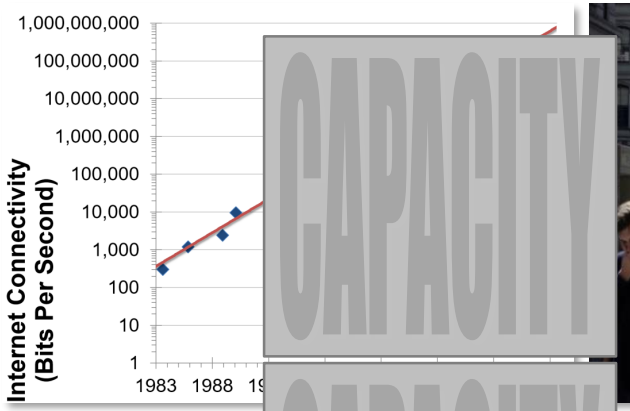

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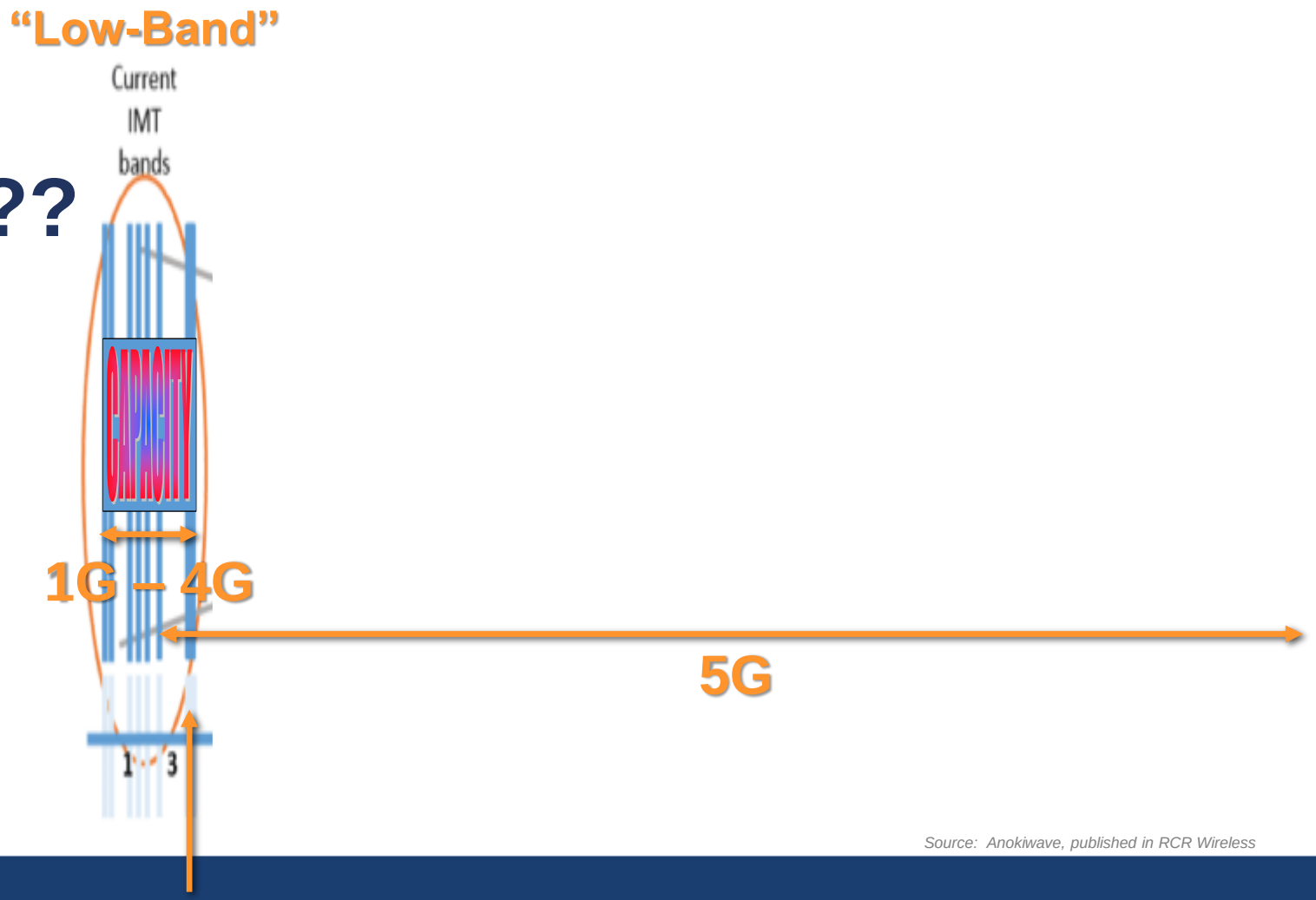
What Is *Truly* Dictating 5G?

- Where are they going to get all of this Capacity??

***10 x* 4G??**



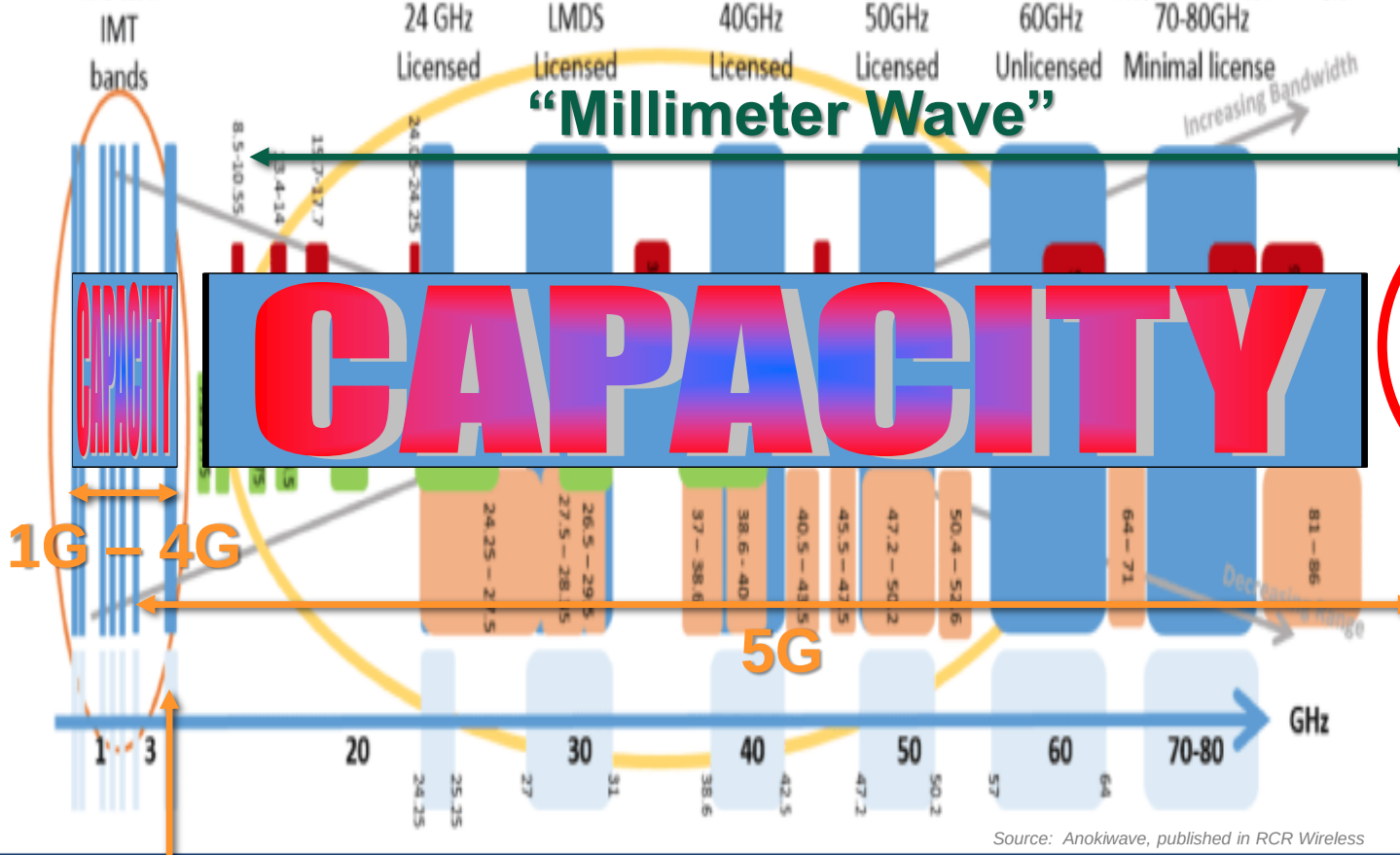
Source: Anokiwave, published in RCR Wireless

But a Word about Wireless Frequencies…

Lower Frequency

More range and penetration power

Less Throughput



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"Mid-Band", *e.g.* 3.5 GHz CBRS

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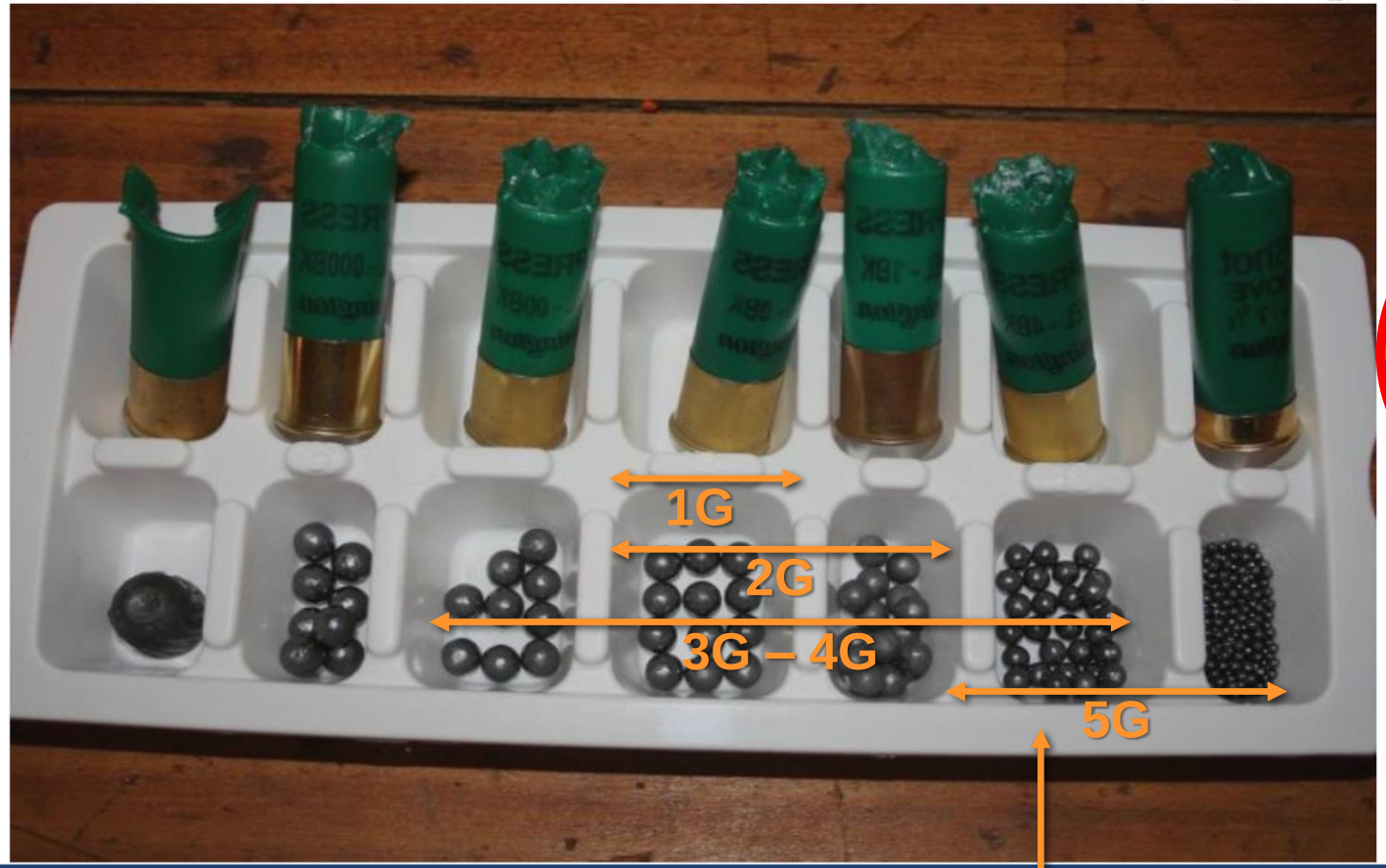

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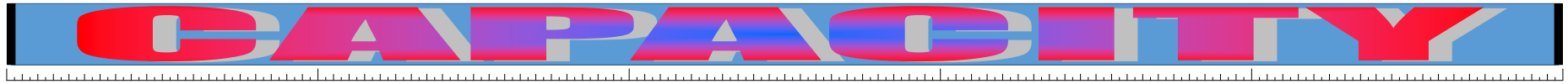

Spectrum, Channel Bandwidth

This does play into Small Cell "Densification"…

So, Small Cells not only use Spectrum over and over again…

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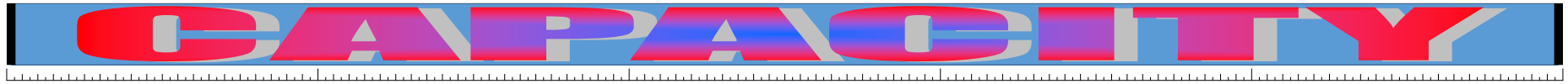

Spectrum, Channel Bandwidth!!!

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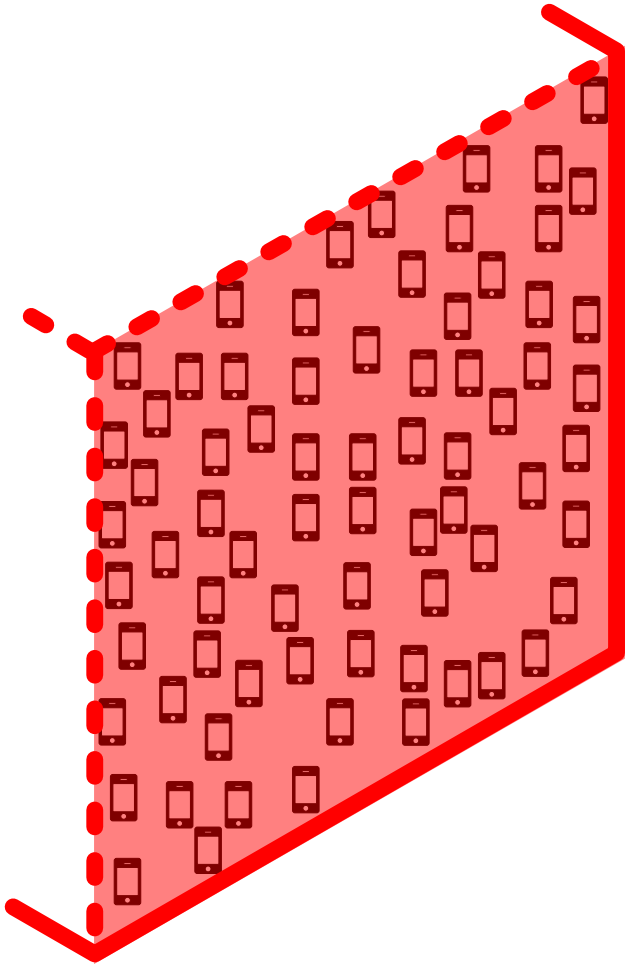
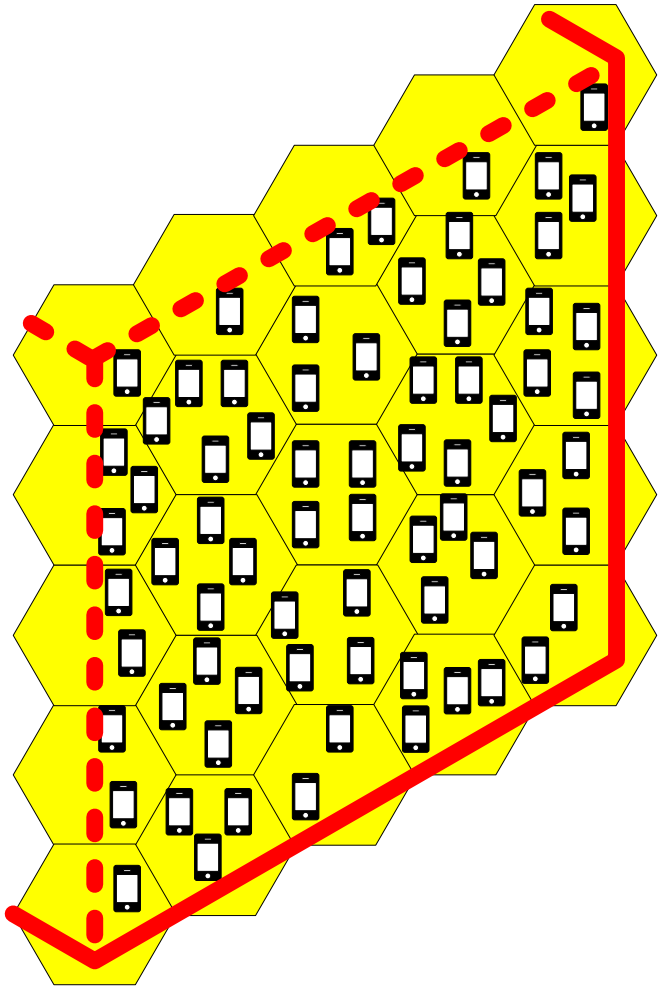
With mmWave, each could have 5-20x more Channel Bandwidth & Capacity, too

4G…



5G – Employs Dense Cell-Splitting (“Densification”); Same Capacity each Small Cell



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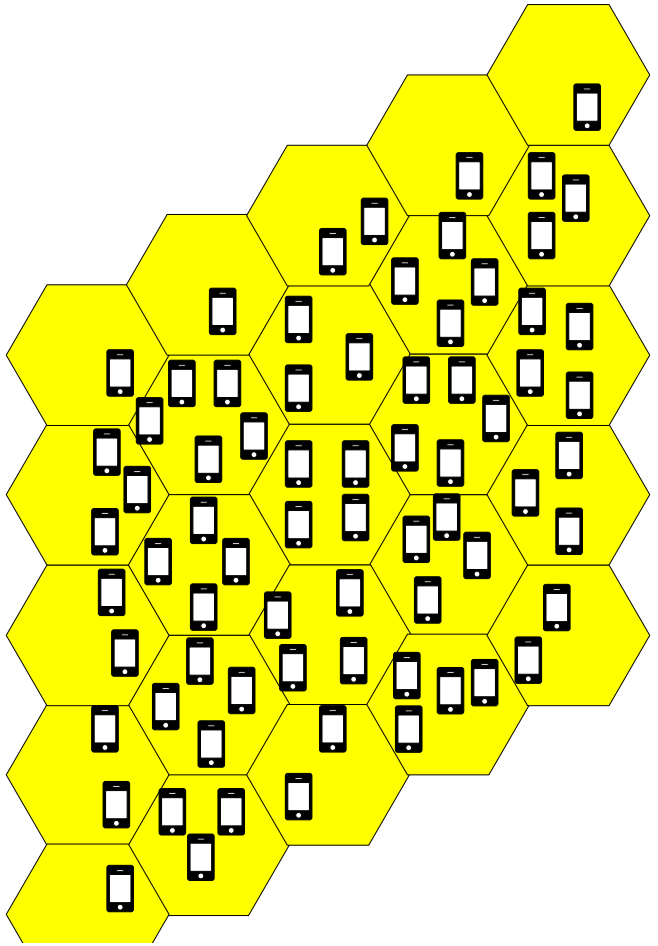

Small Cells also permit eventual use of mmWave, with 5-20x wider channels and associated throughput.

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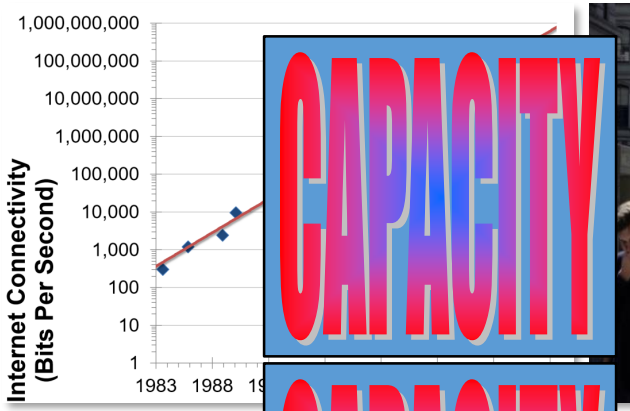
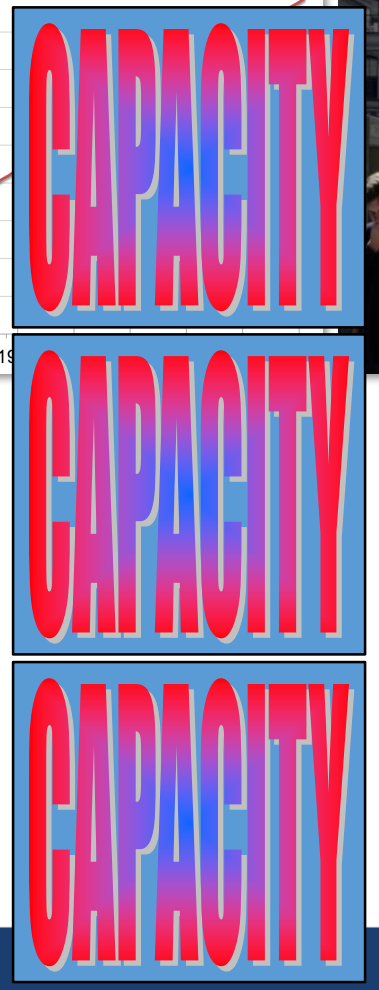


***10 x* 4G??**

More Spectrum, Channel Bandwidth

And Even More Use of It Over and Over Again…



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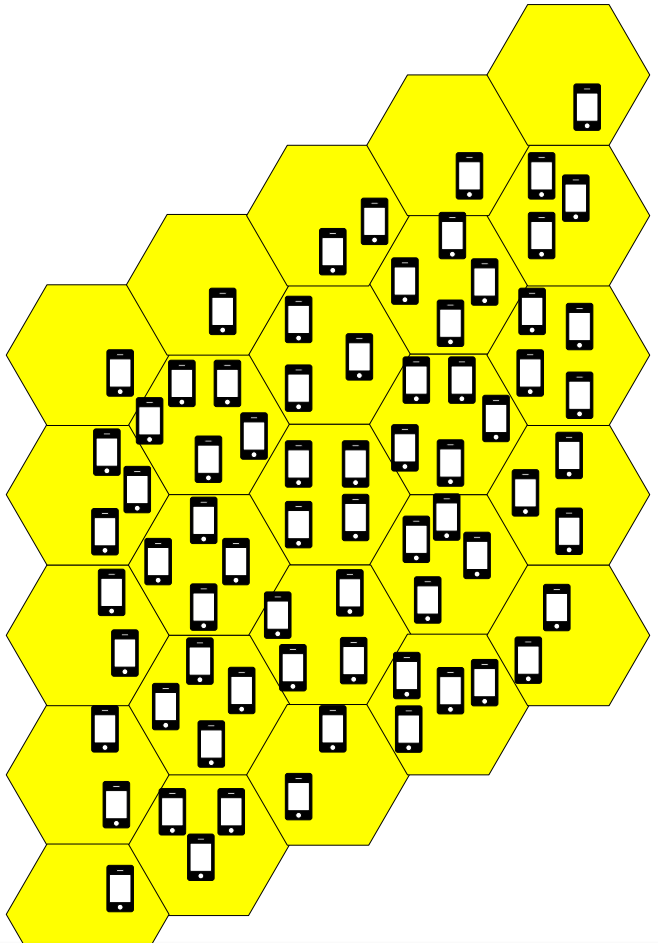

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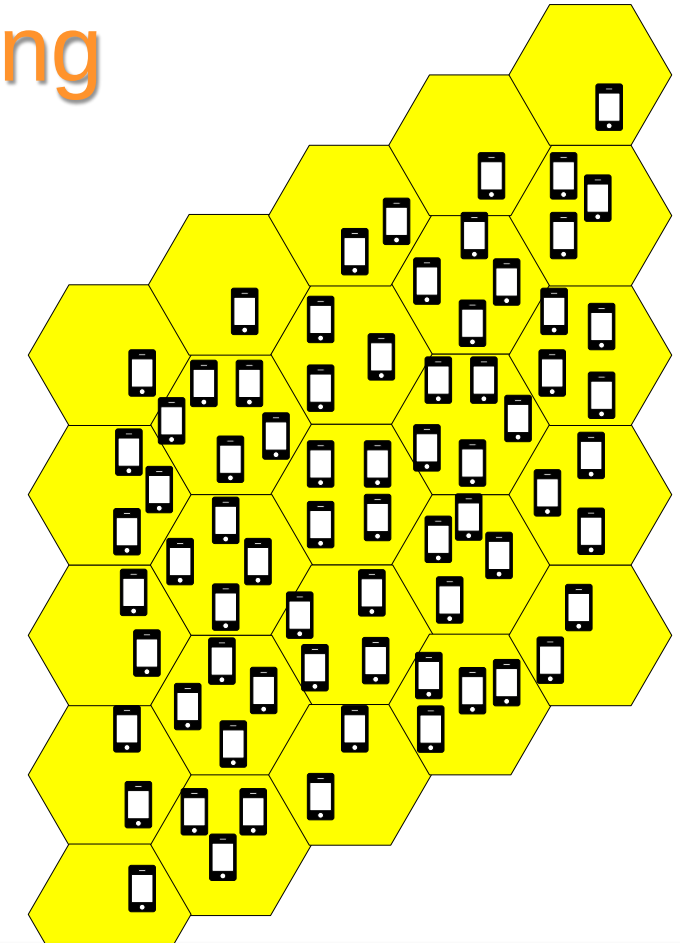
5G – Employs Dense Cell-Splitting ("Densification"); Even More Re-Use with Beamforming



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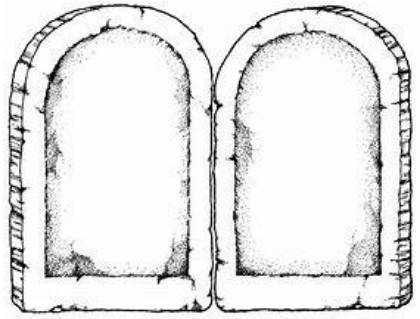
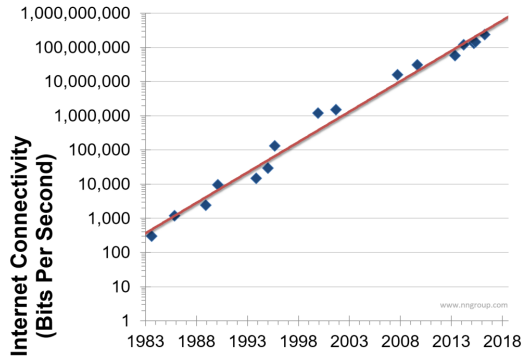
Wireless Truths





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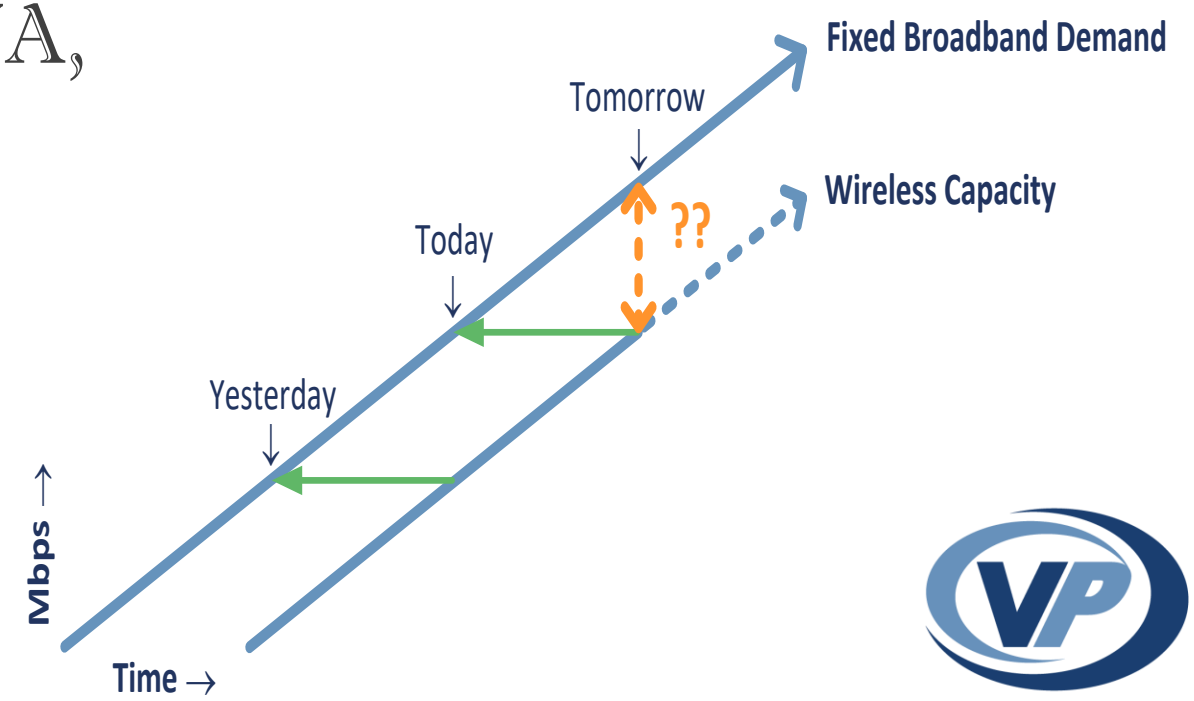
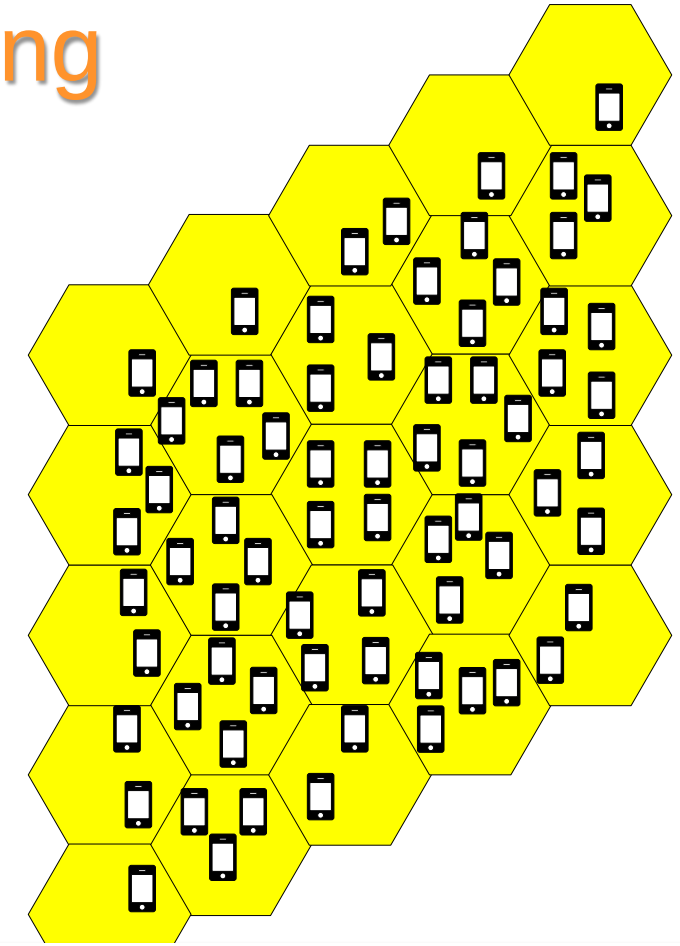
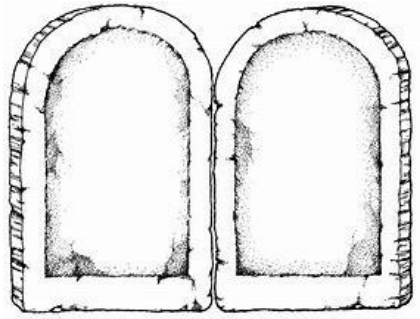


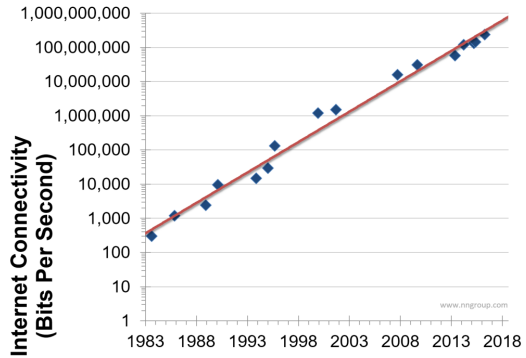
5G – Employs Dense Cell-Splitting ("Densification"); Even More Re-Use with Beamforming



Small Cells also permit eventual use of mmWave, with 5-20x wider channels and associated throughput…with beamforming, to get to that ***10x*** **4G LTE, 10Gbps**

Wireless Truths





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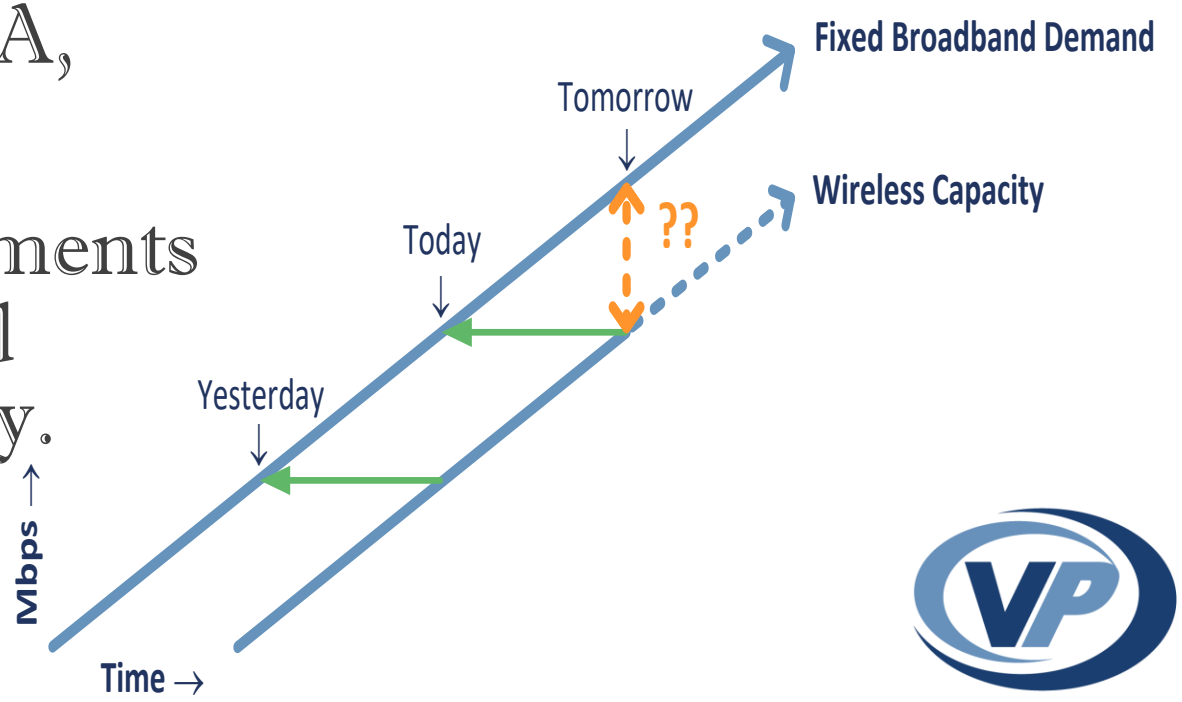
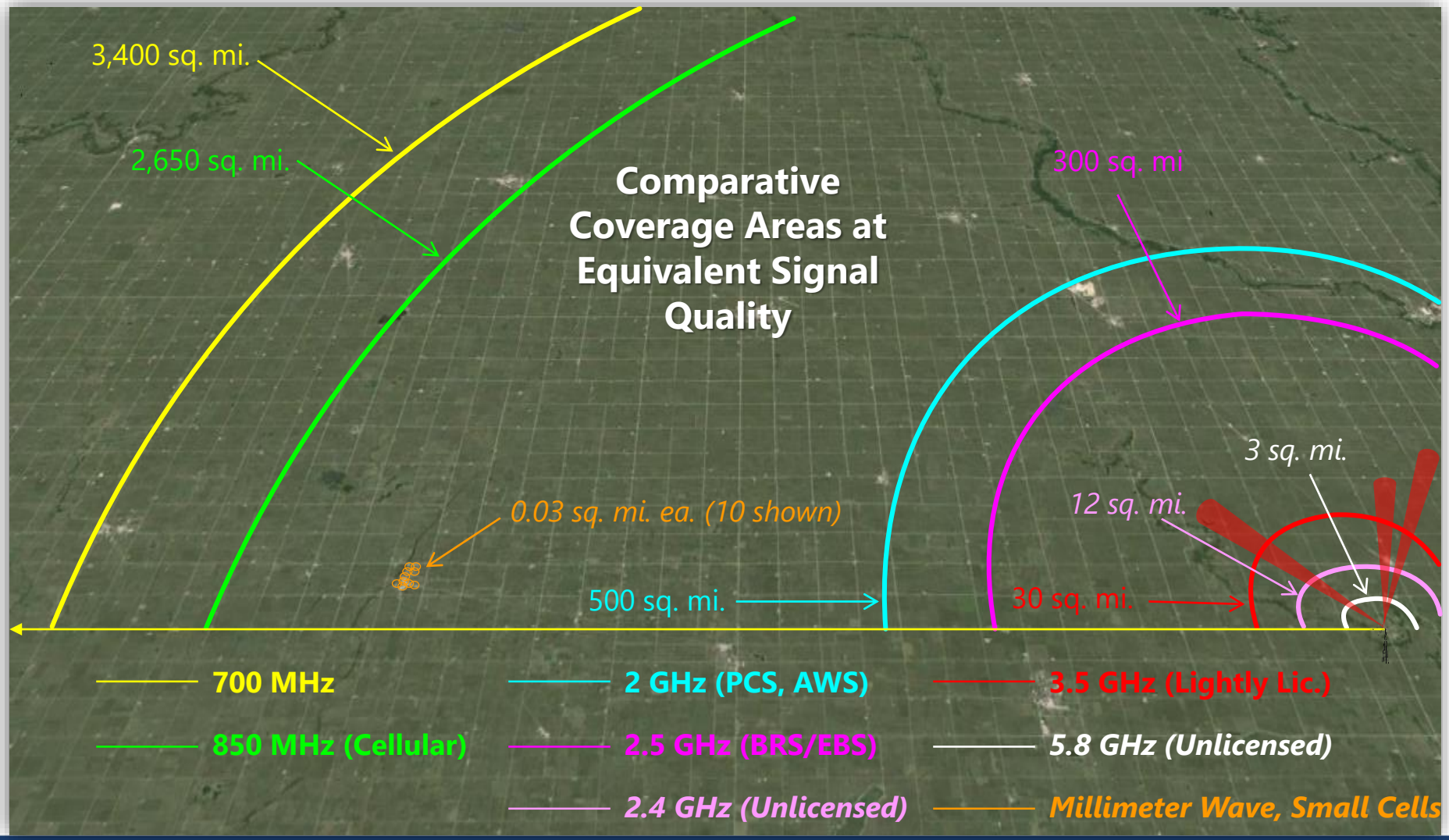


Is 5G a Rural (Non-Town) Solution?



- Not with mmWave! So no *10x* 4G from mmWave's huge channels
- But Mid-Band is high enough for feasible beamforming while still having some range
- Beamforming + MU-MIMO, Hi-Pwr UE, CoMP, wider Mid-Band channels, & other 4+G/5G efficiencies could improve Fixed Broadband to non-town Rural locations

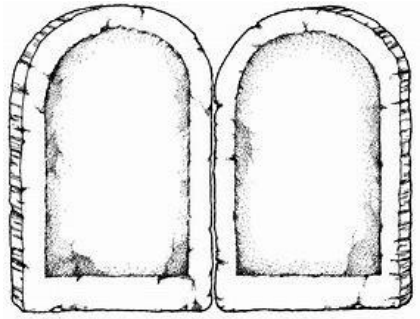
YOUR MILEAGE MAY VARY! This is intended only to suggest relative ranges and coverage areas at FCC-authorized power levels among various single carrier frequencies, at a common Receive Signal Level (RSL) and noise floor throughout, which may be above or below the lowest RSL at which a particular technology can operate, assuming sufficient SINR. Actual range will vary depending upon the actual signal level and quality targeted as well as numerous other factors, including power level transmitted, elevation of transmitter and receiver antennas, directionality, gain and MIMO configuration of both the transmitting and receiving antennas, terrain, clutter, manmade interference and atmospheric and electromagnetic conditions, among others.

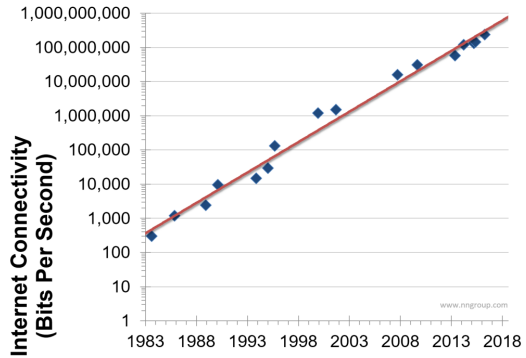
For operators, 5G is a massive investment in hardware and software based on the promise it will deliver totally new user experiences that take advantage of significant increases in throughput and decreases in latency.

VIAVI Solutions

REGISTER

Wireless Truths





I. The Broadband of Today is the *Narrowband* of *Tomorrow*.

II. For *Fiber-like* SLAs for FWA, one must get *Really Close*.

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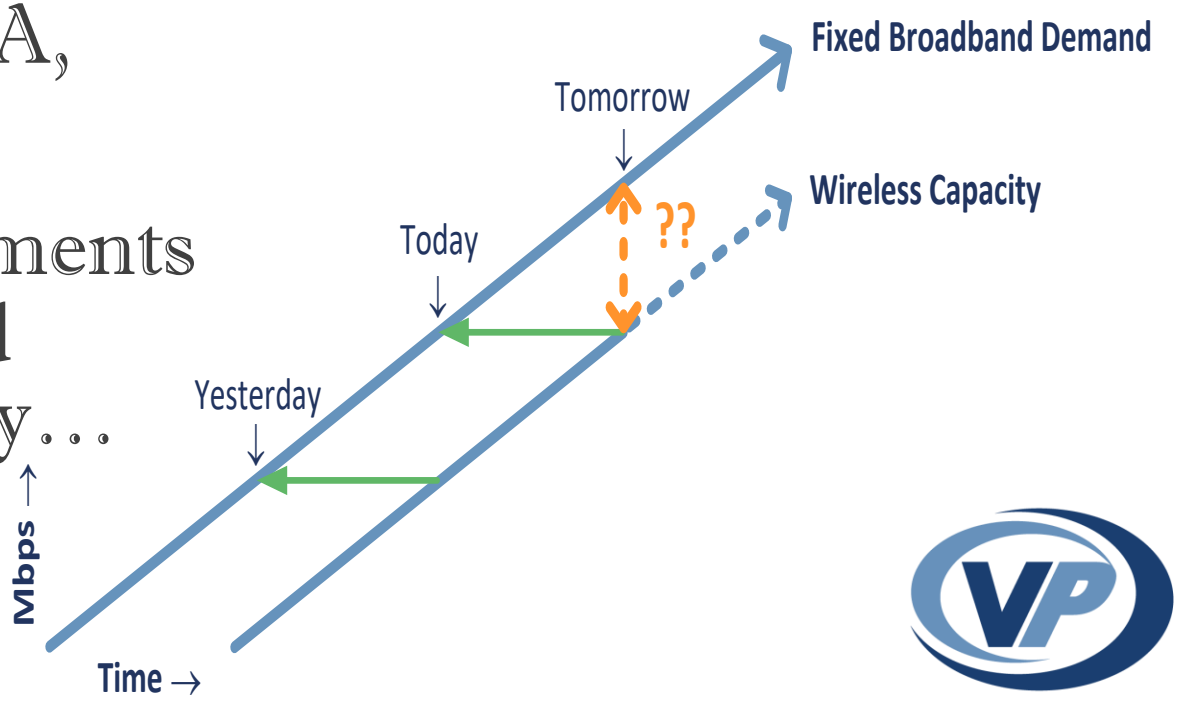
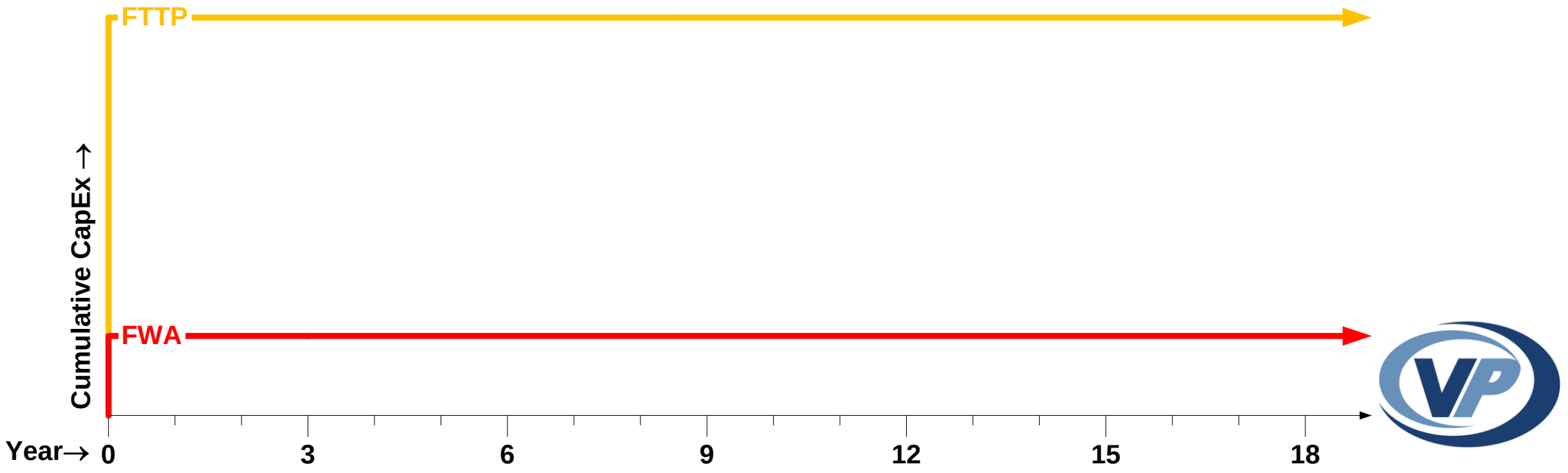
IV. FWA is likely to struggle as a *Long-Term* rural solution.



The Fixed Wireless Appeal…



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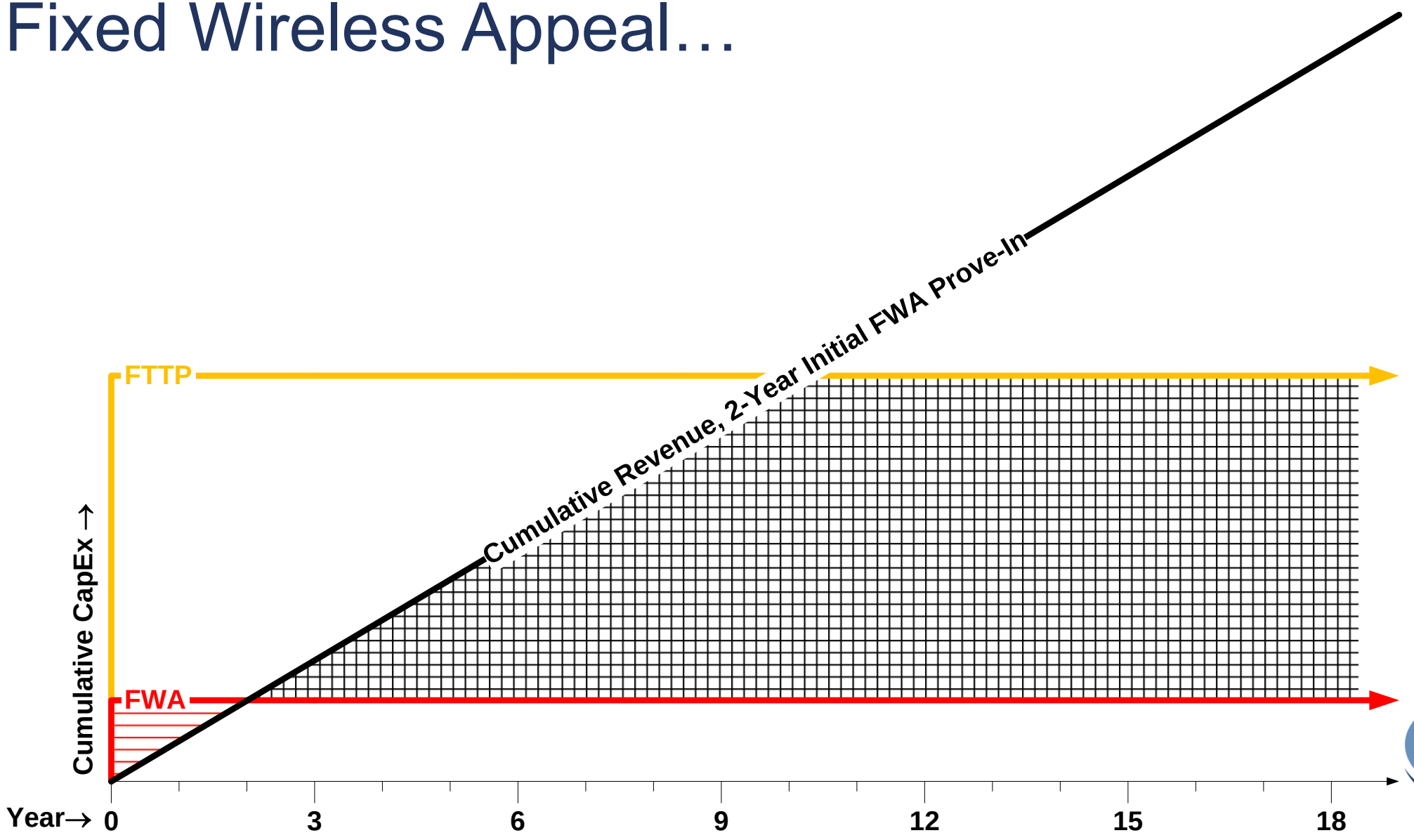

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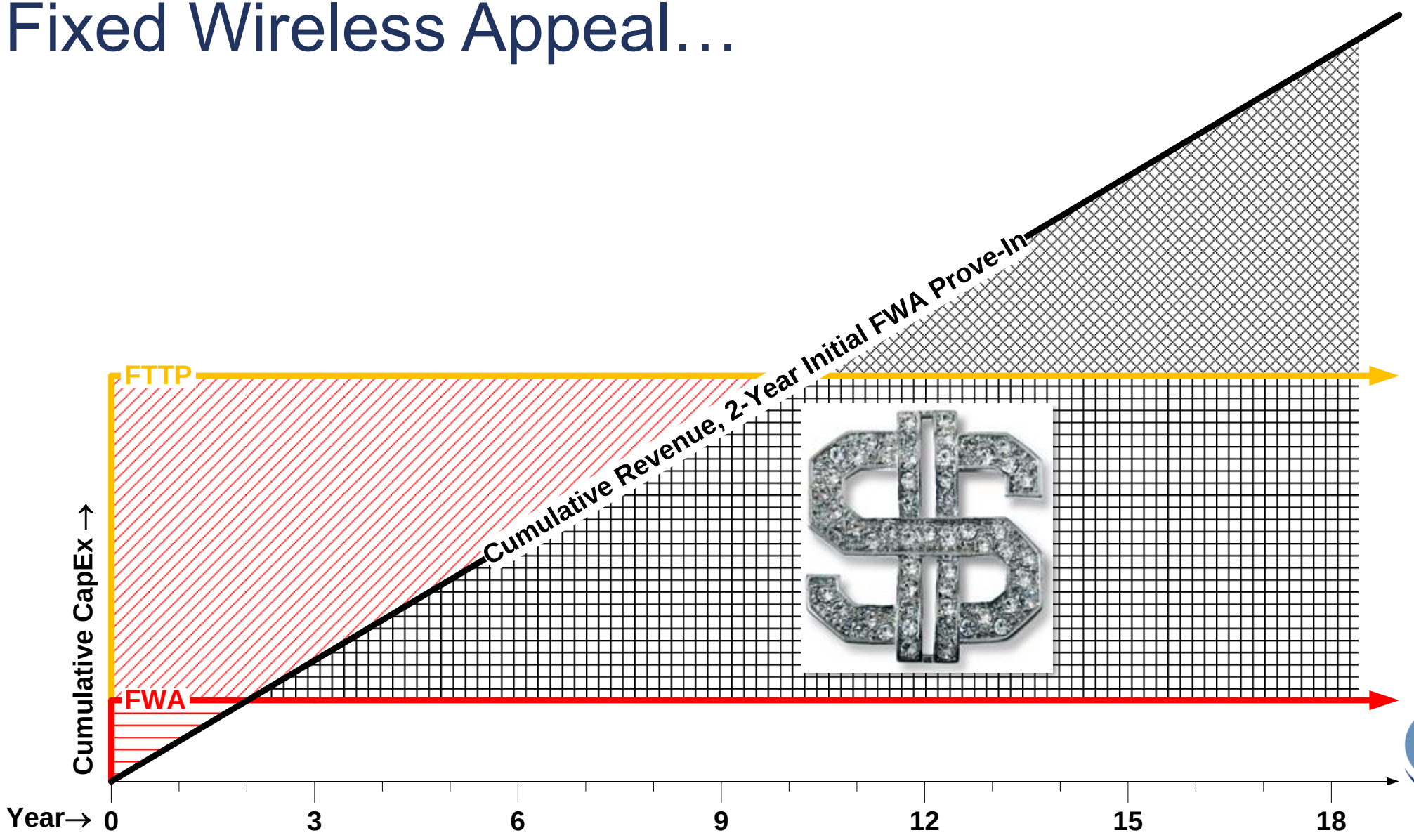

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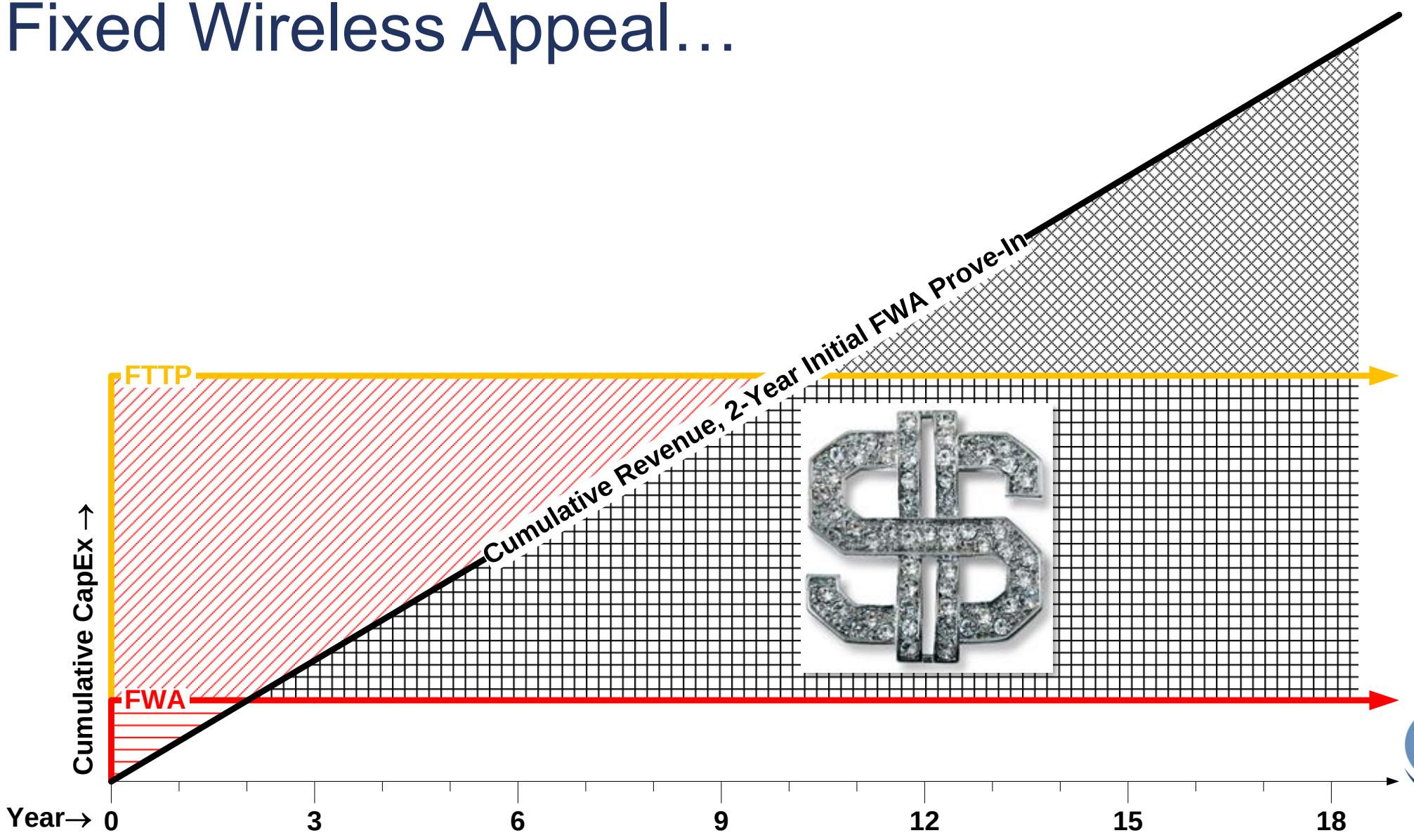
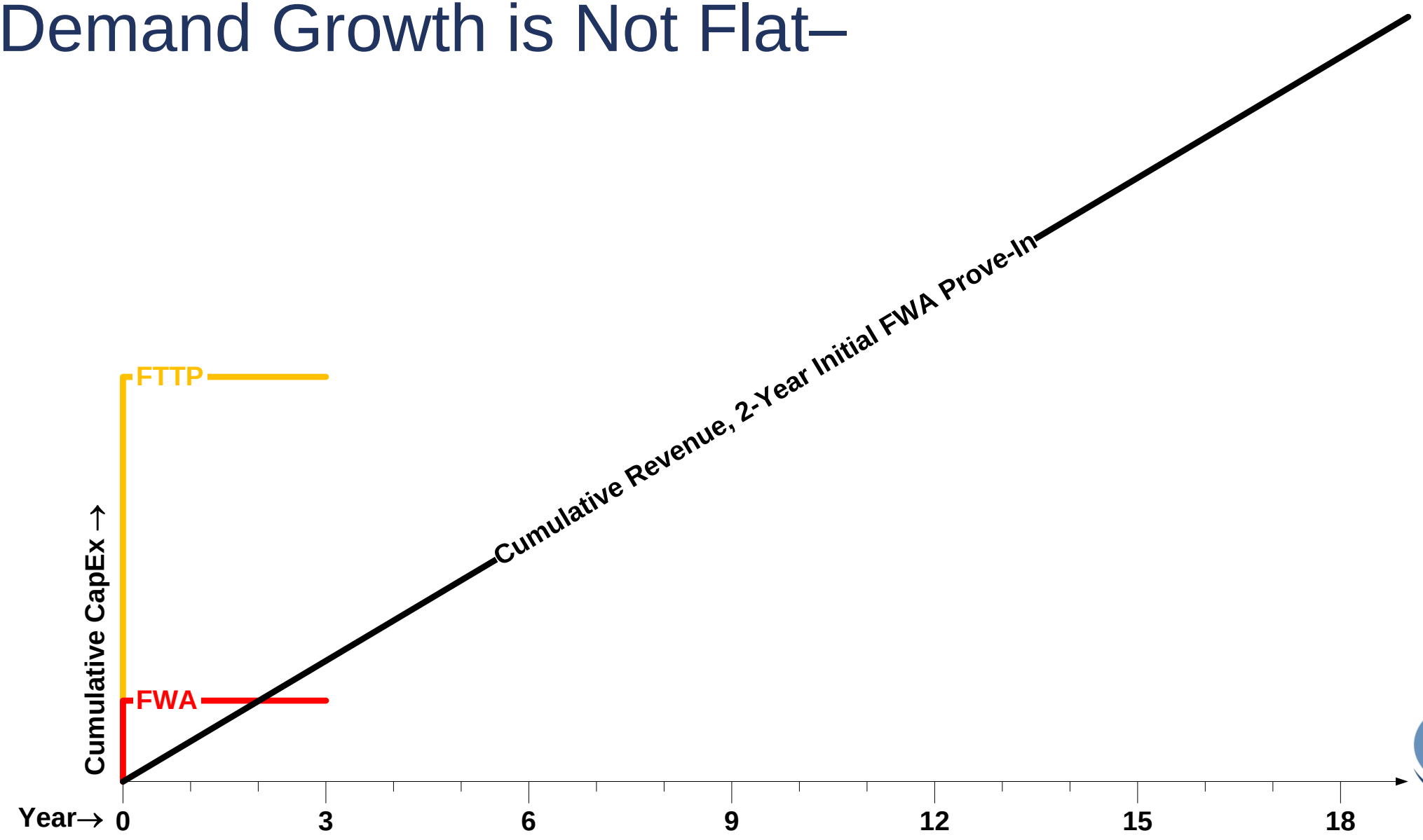
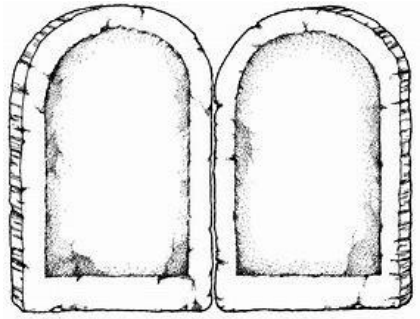


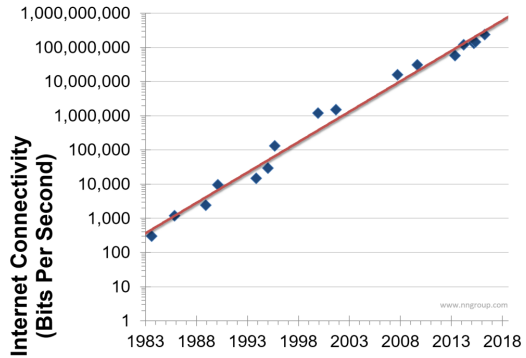
But Demand Growth is Not Flat–



Baseline (Mbps): 50

Wireless Truths





I. The Broadband of Today is the *Narrowband* of *Tomorrow*.

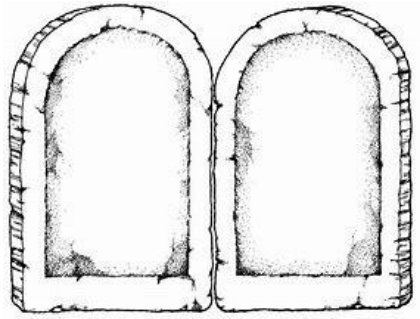
Cisco VNI Internet Data: Traffic Levels in 2022 Will Exceed All Prior Years Combined

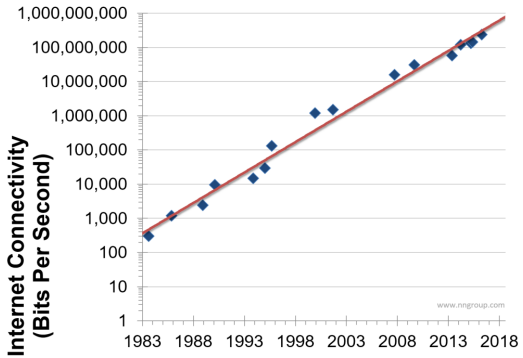
11/27/18 at 3:18 PM *by* Carl Weinschenk

telecompetitor

- Users will average 261 GB of traffic per month (up from 94 GB last year)
- Average broadband speed will be 94 Mbps (up from 43 Mbps in 2017)

Wireless Truths





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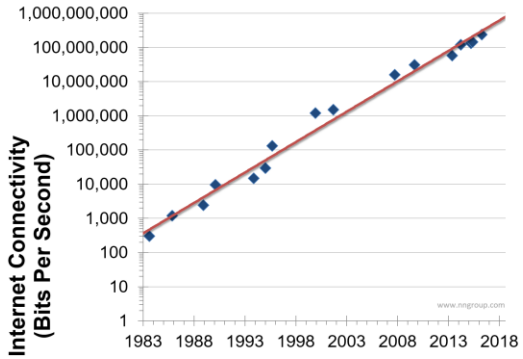
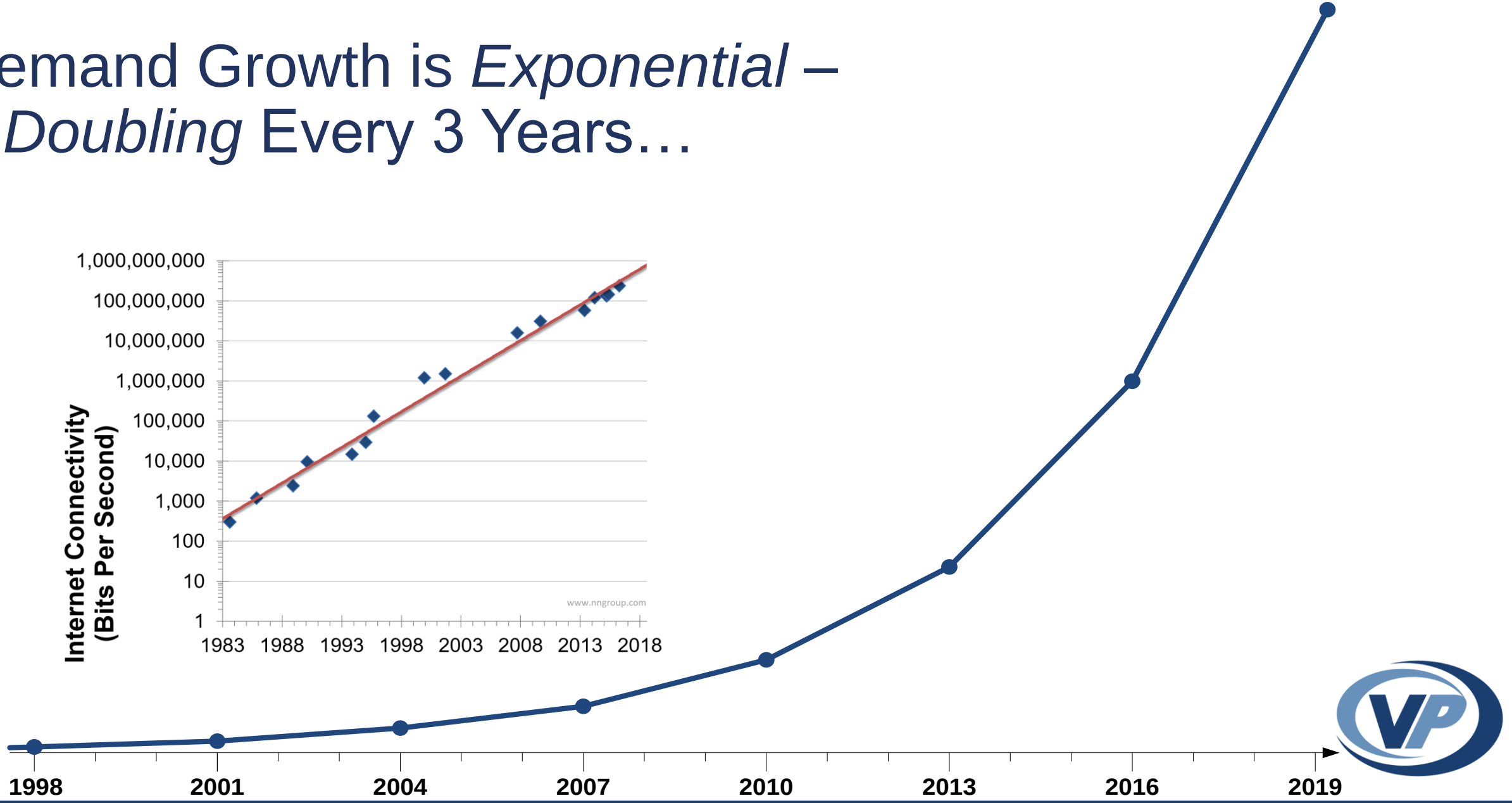
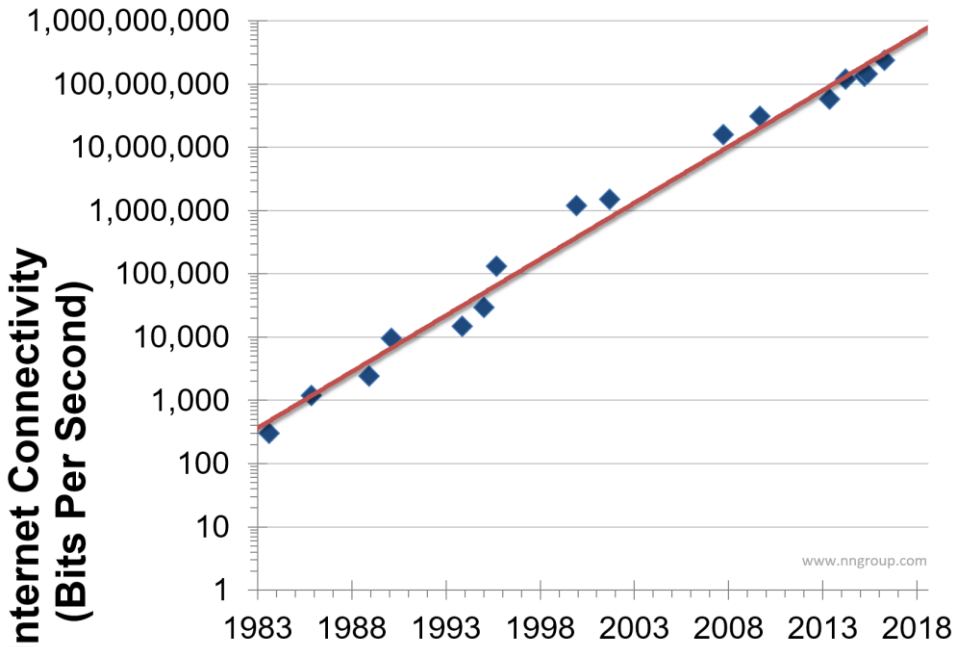
Demand Growth is *Exponential* –

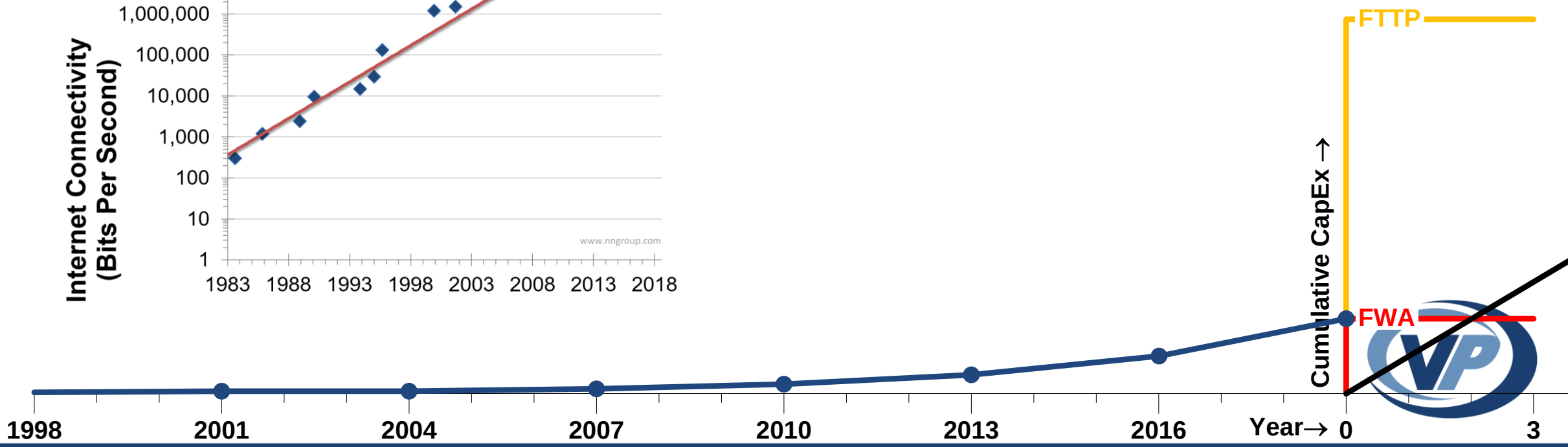


Demand Growth is *Exponential* – *Doubling* Every 3 Years…



Demand Growth is *Exponential* – *Doubling* Every 3 Years… …and cannot be ignored.





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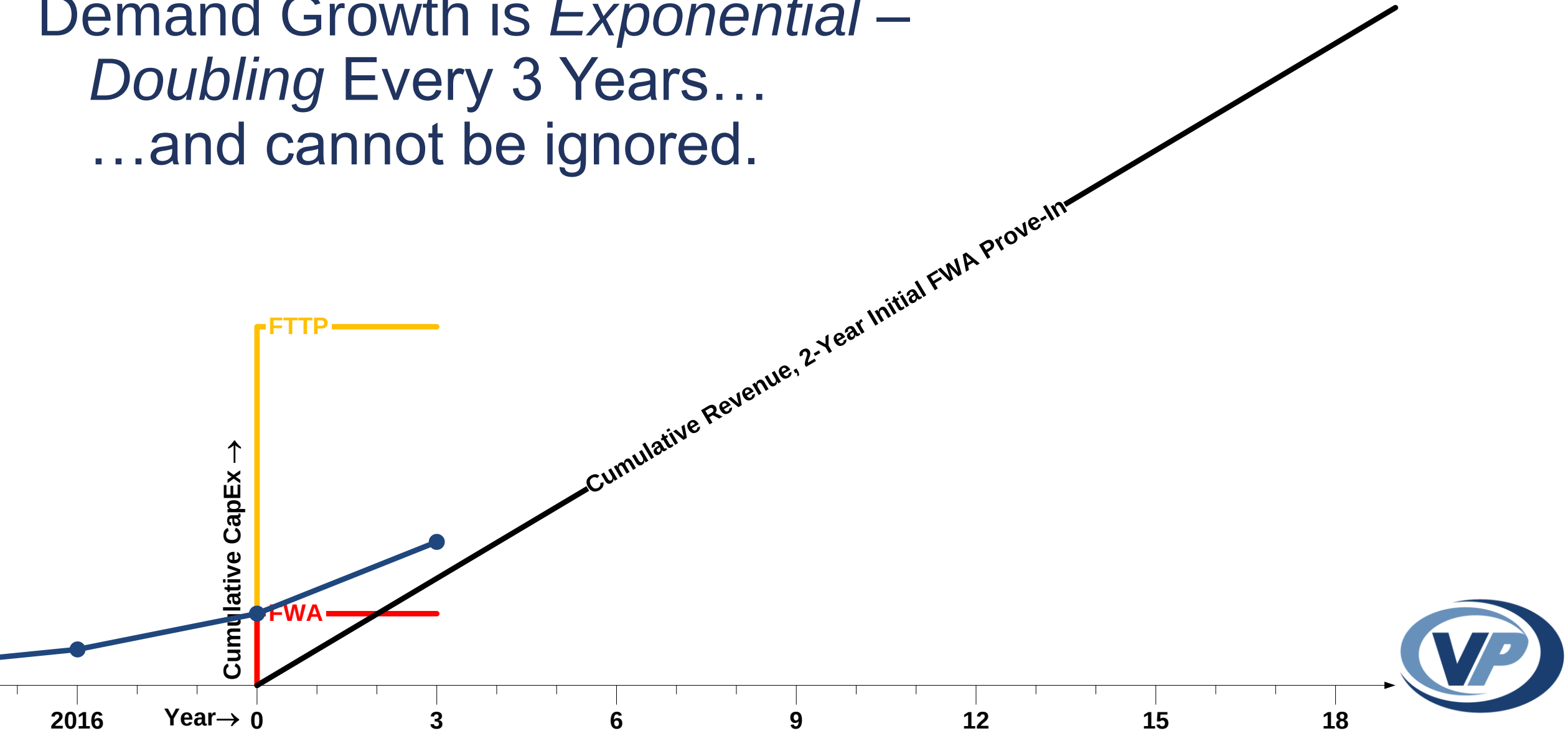


Baseline (Mbps): 50 100

What Is *Truly* Dictating 5G?

- *Exponential* Demand Growth per Mobile User! And crowds of Users!
- What's a Wireless Provider to *Do?!*

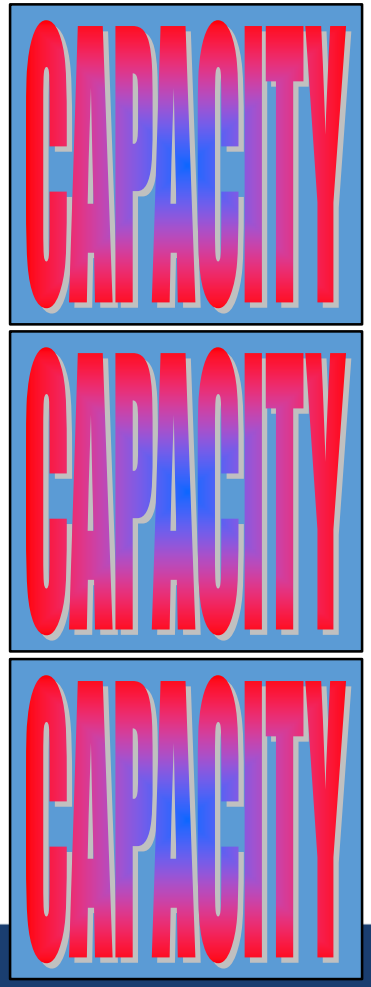
***10 x* 4G??**

More Spectrum, Channel Bandwidth

← →

Only available on higher, shorter-haul frequencies

And/Or Use It Over and Over Again



e.g., Cell-Splitting, Ch. Concatenation, Massive MIMO, Beamforming, etc.

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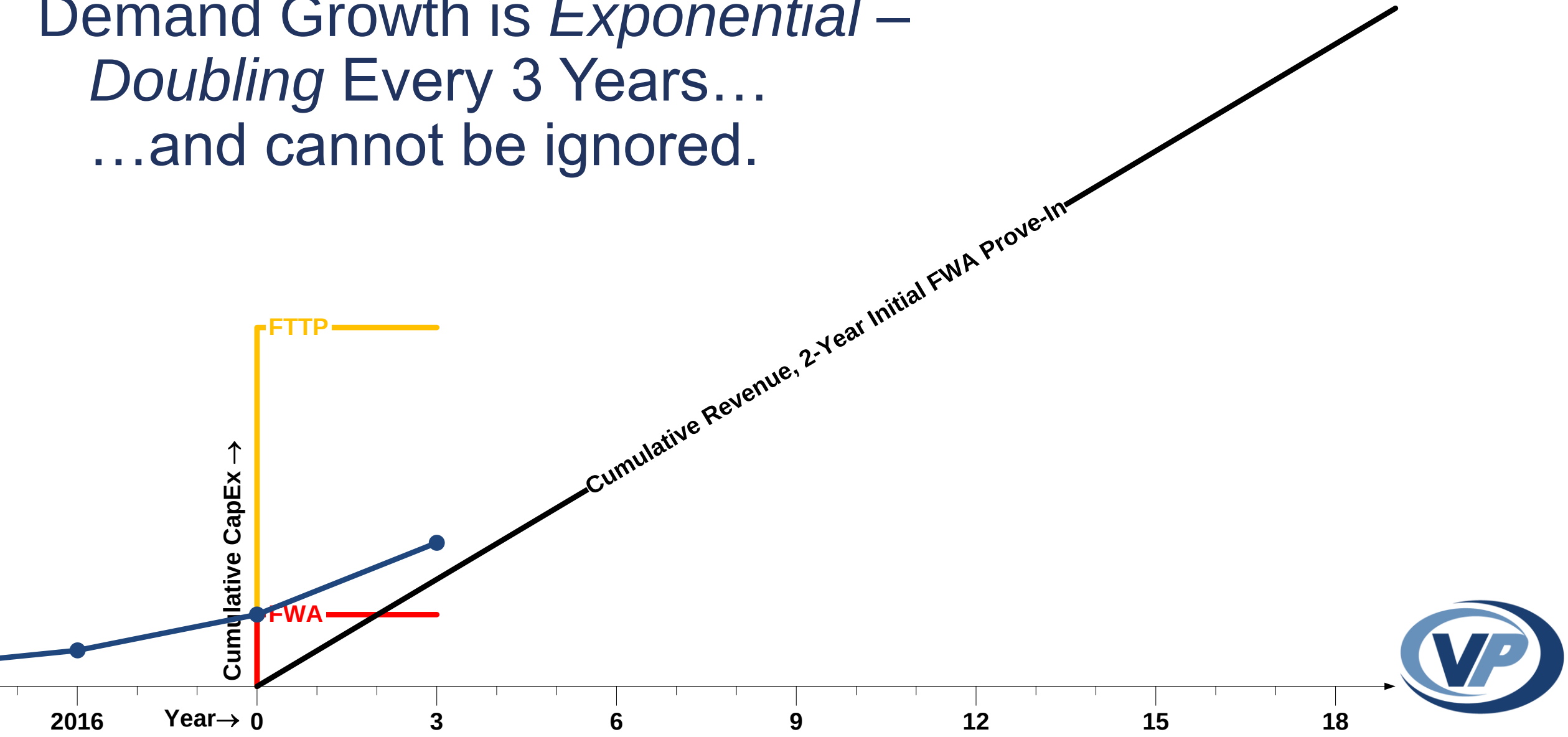

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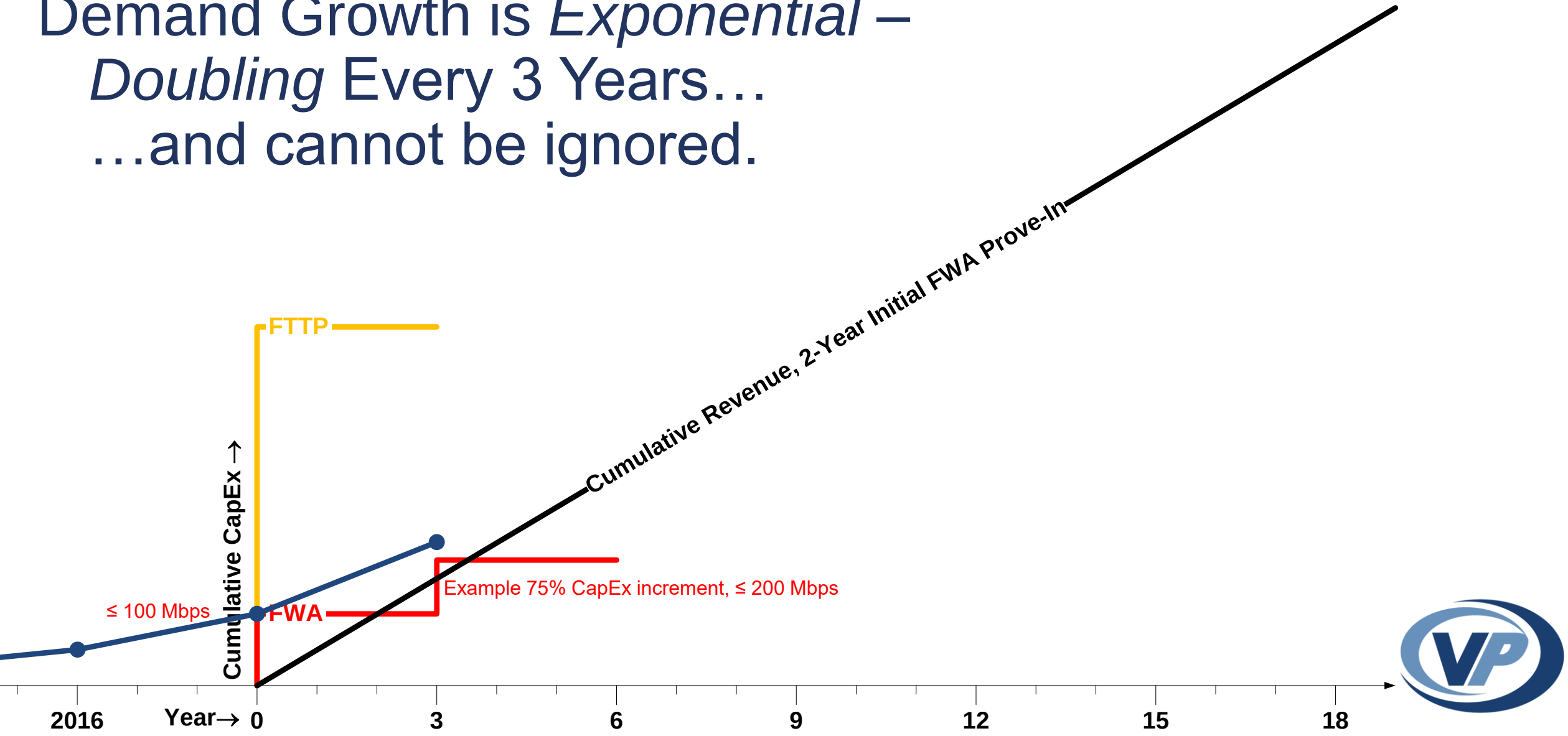

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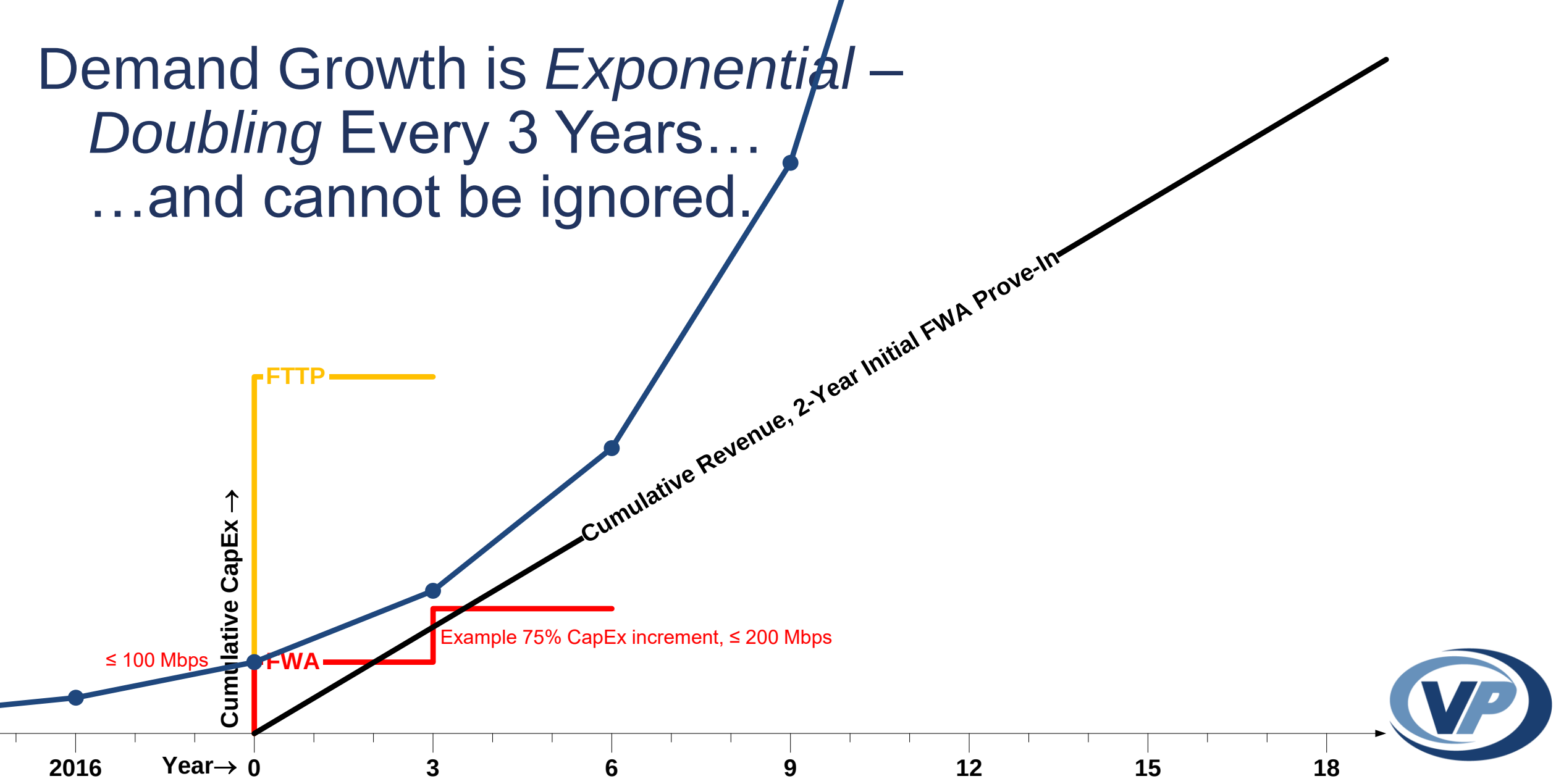

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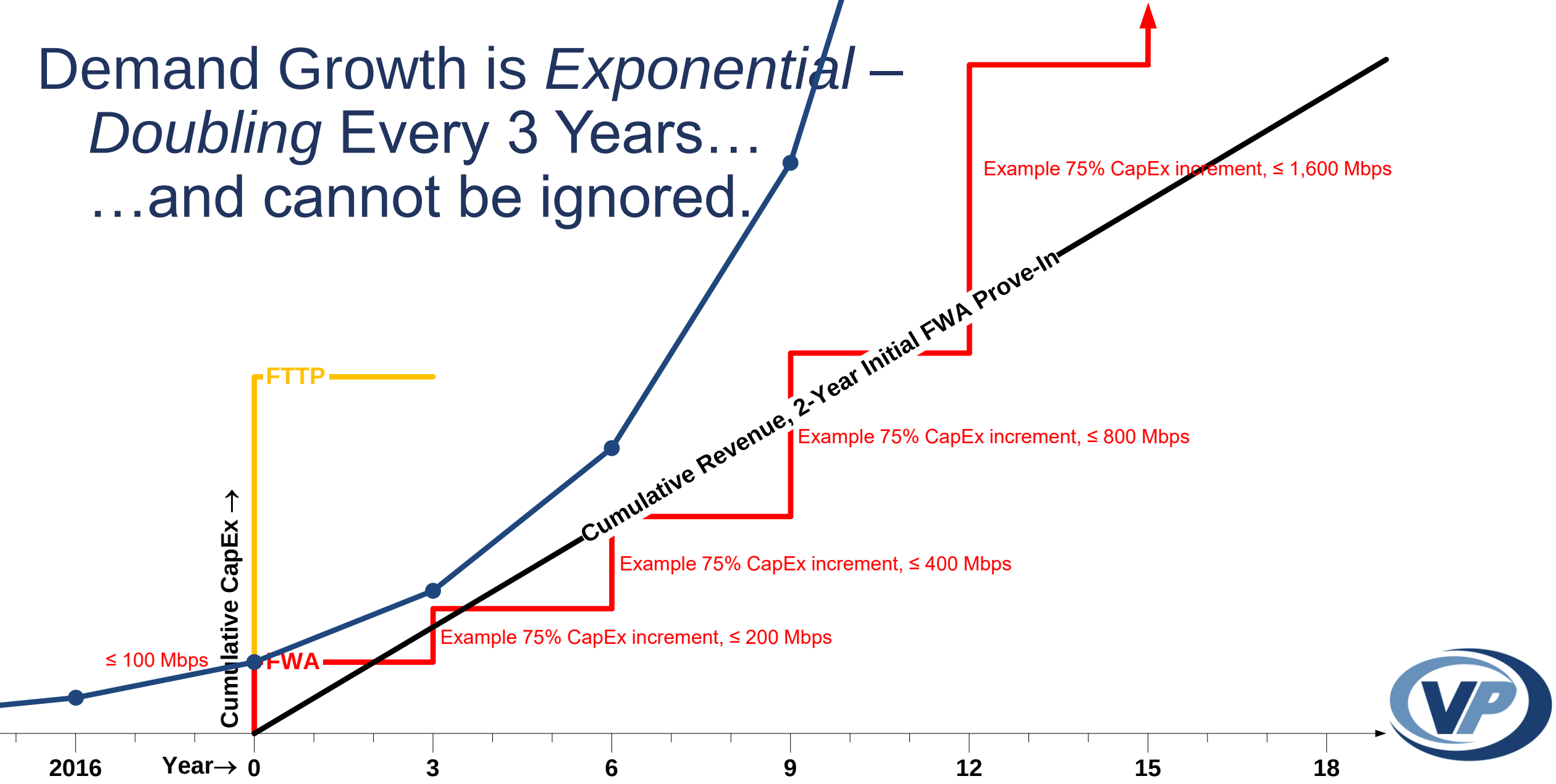

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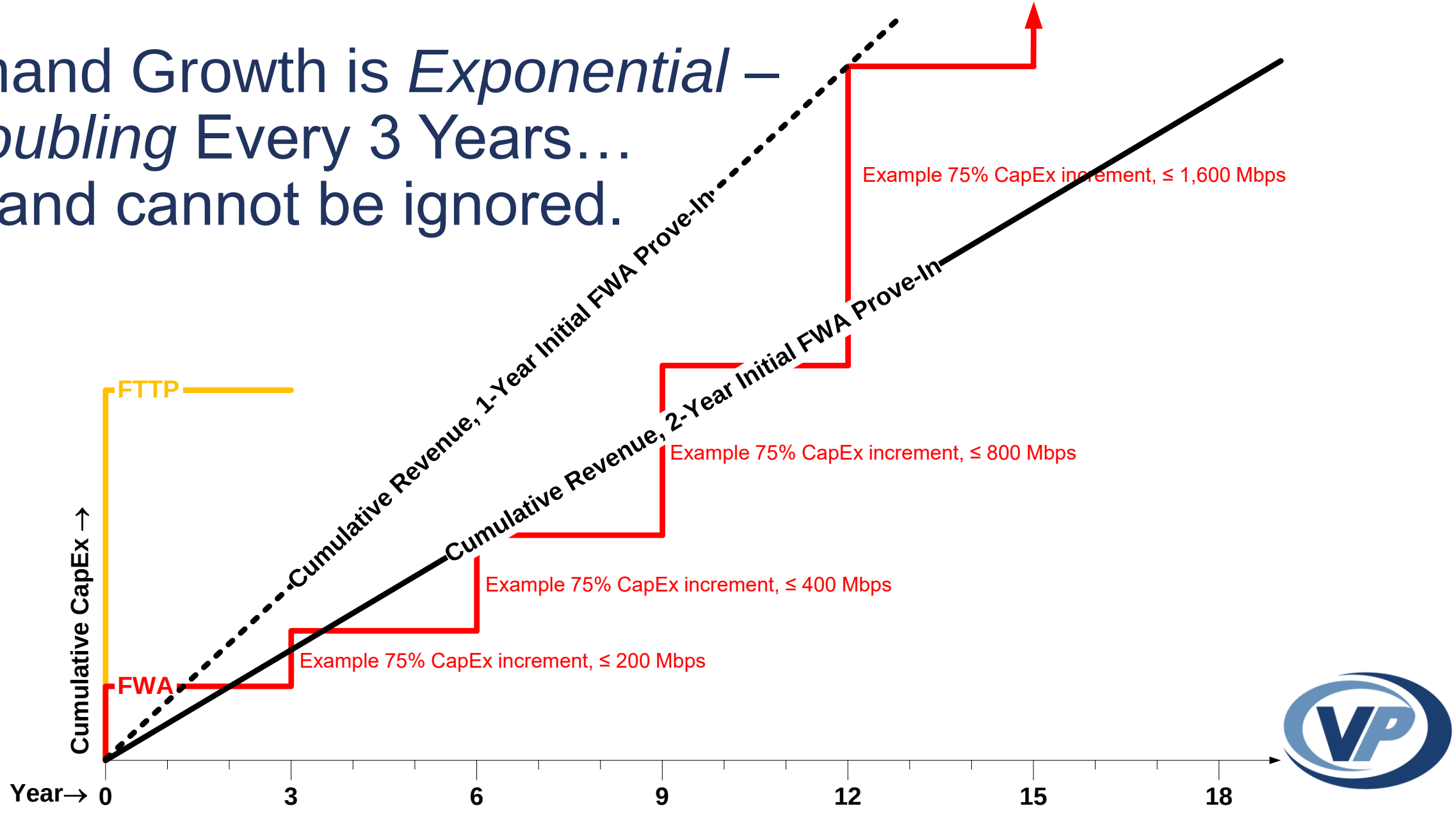

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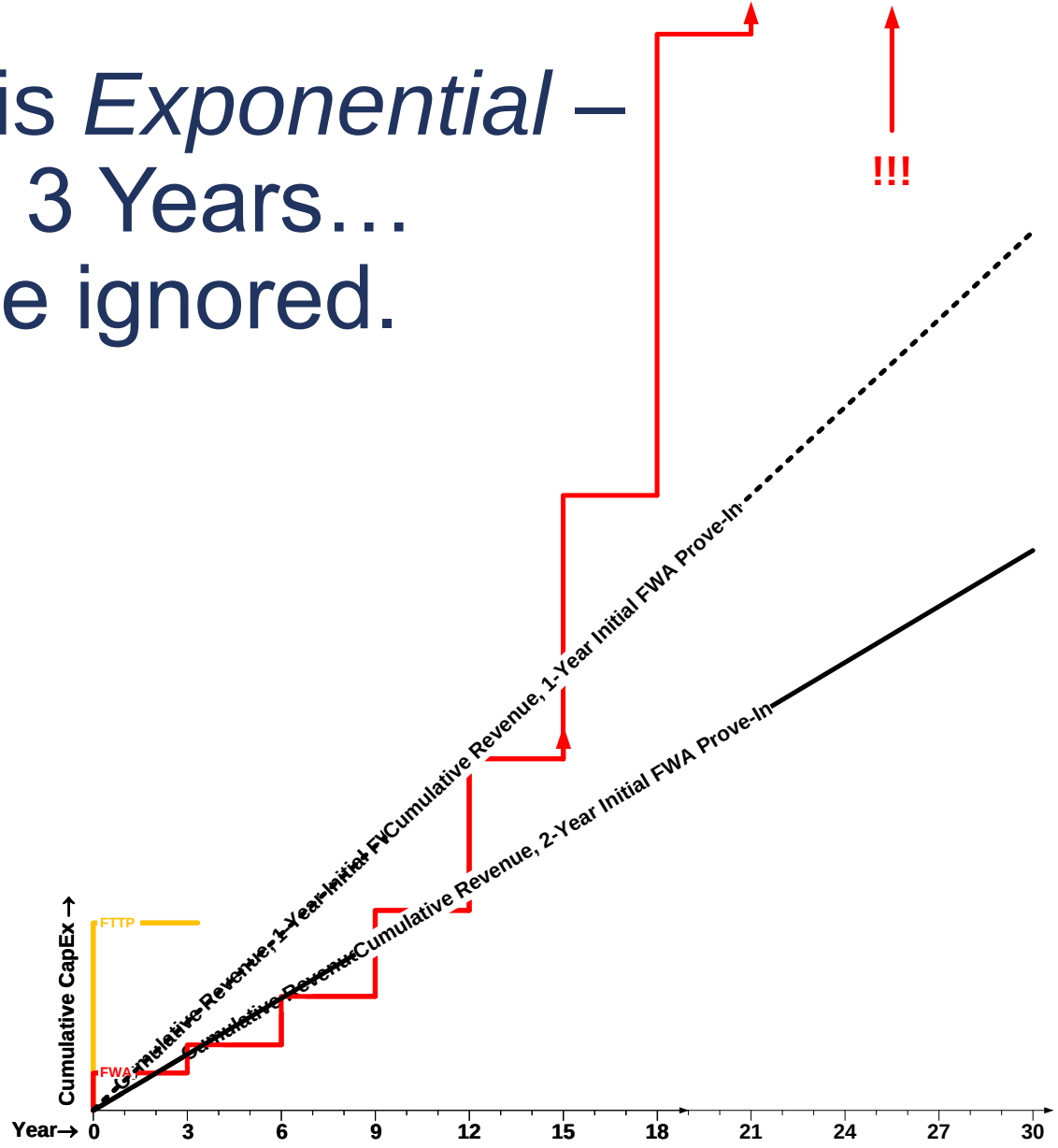

Without careful planning, FWA could still get *Out of Hand*

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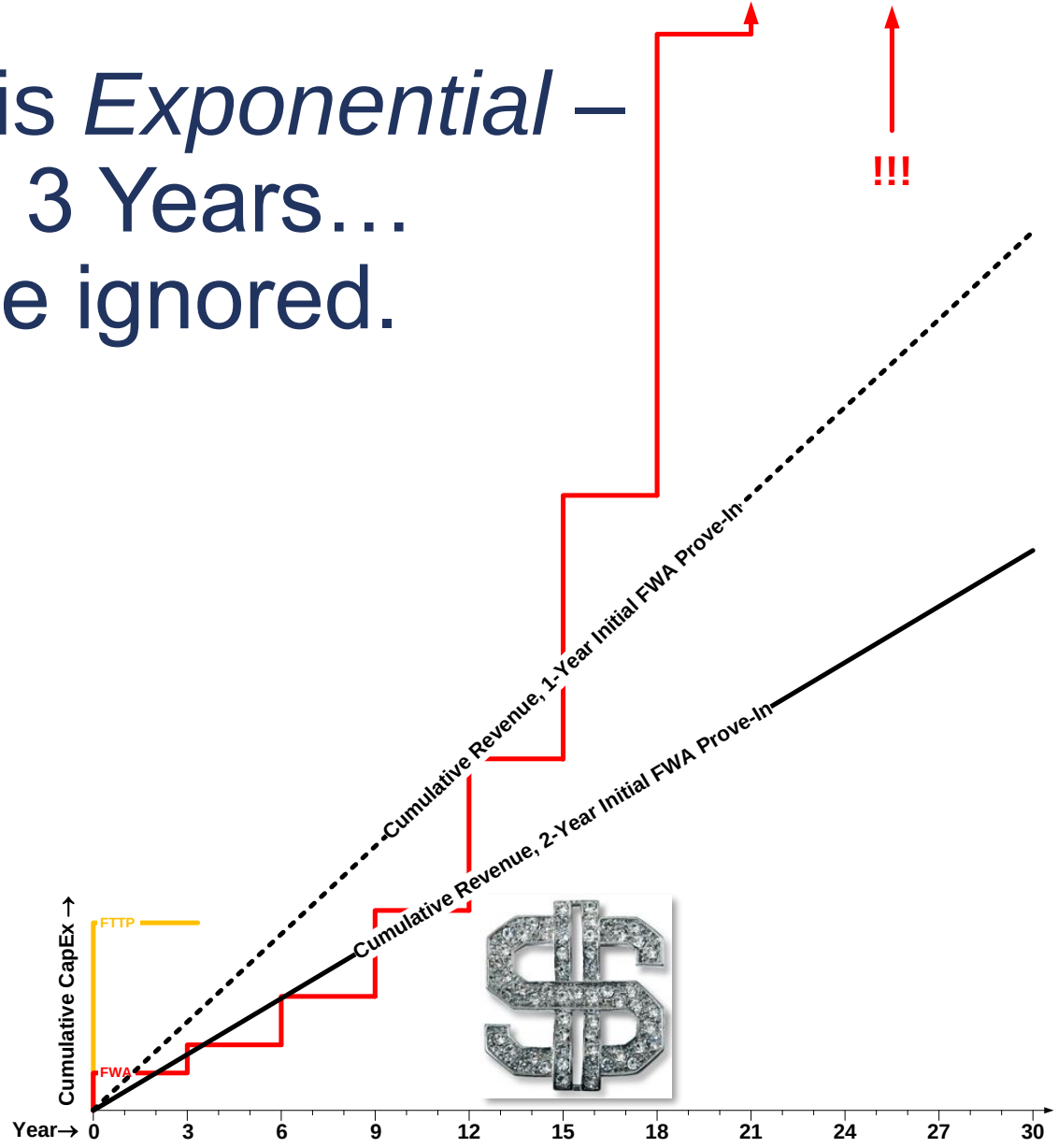

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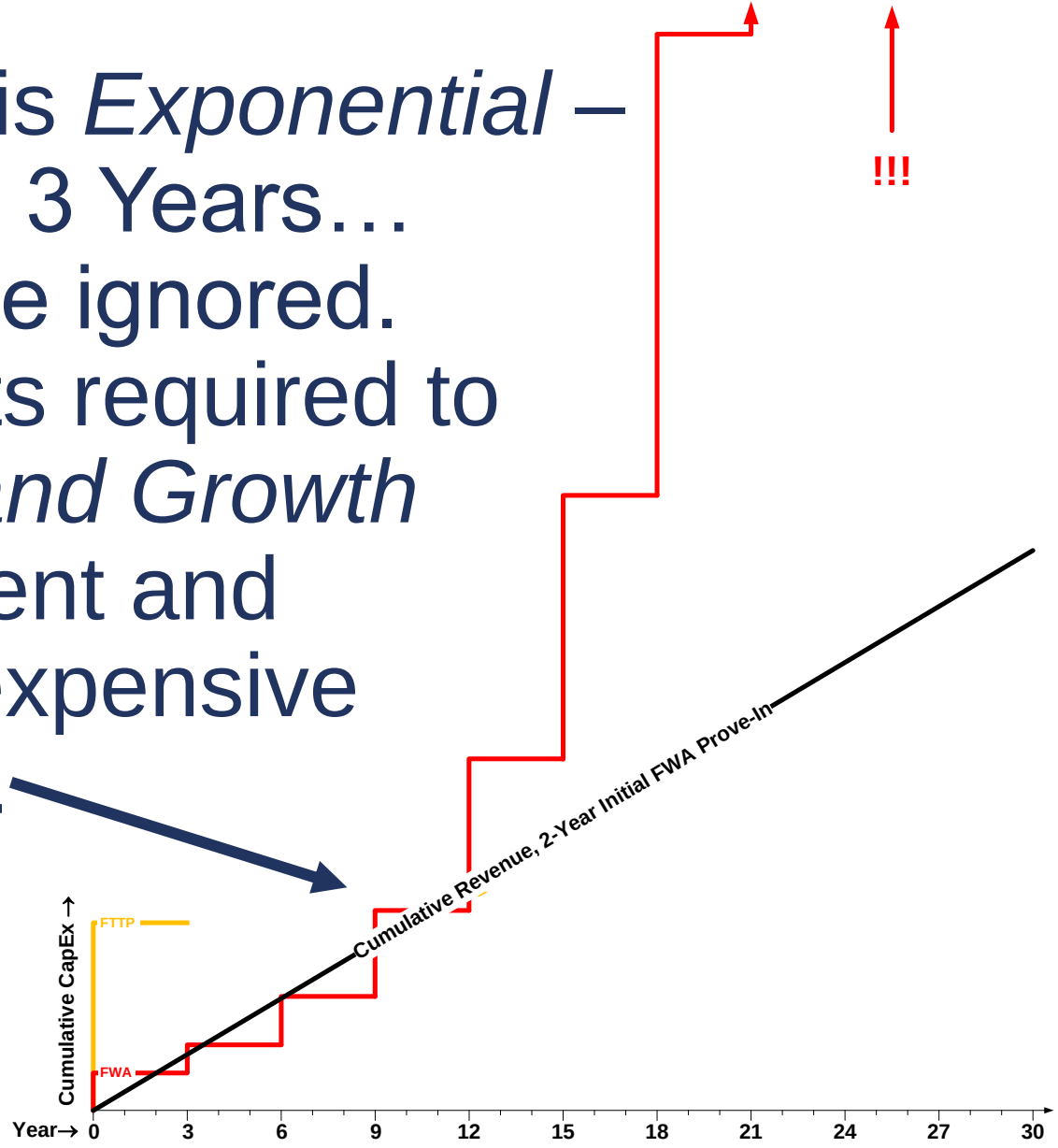

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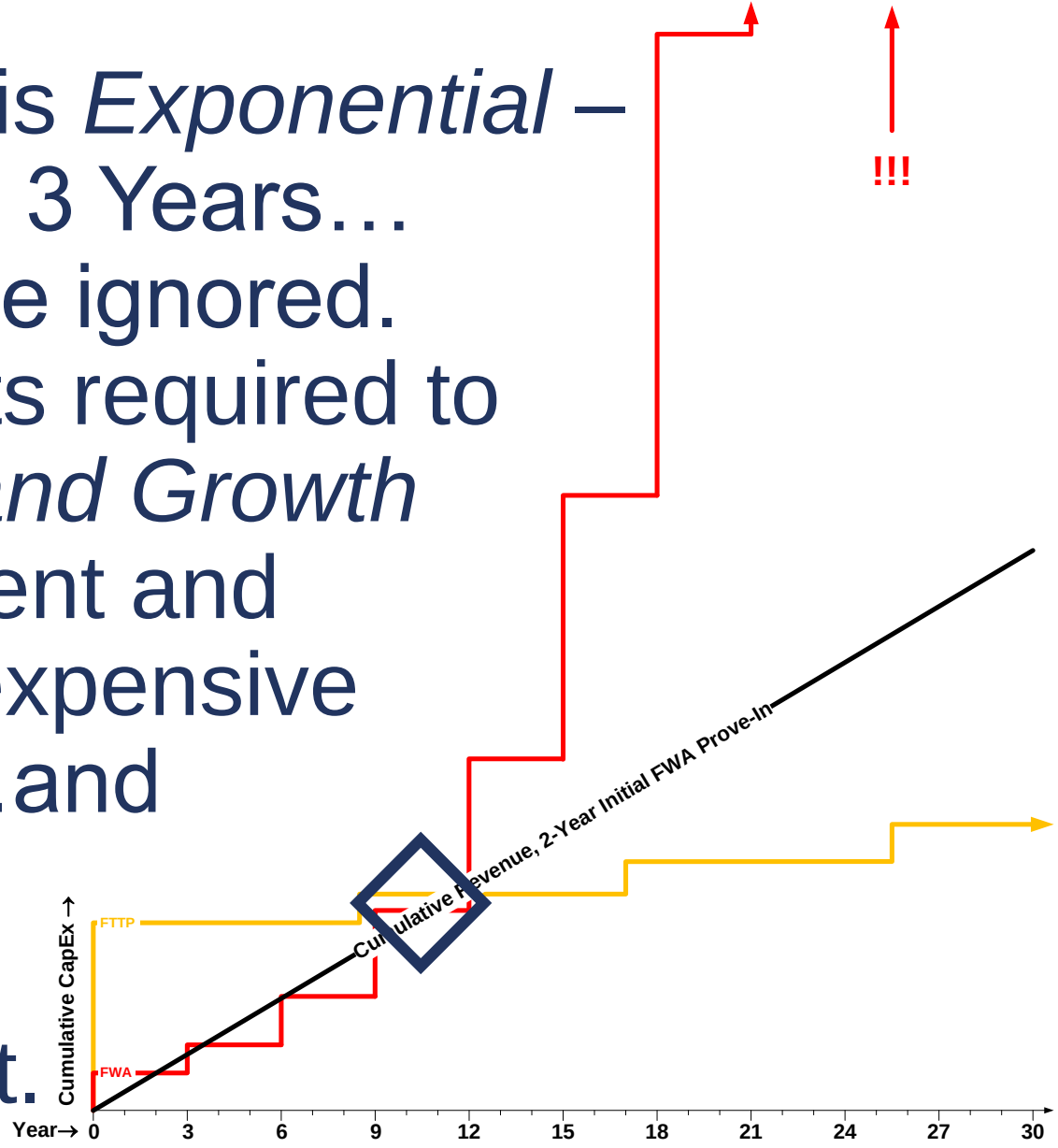

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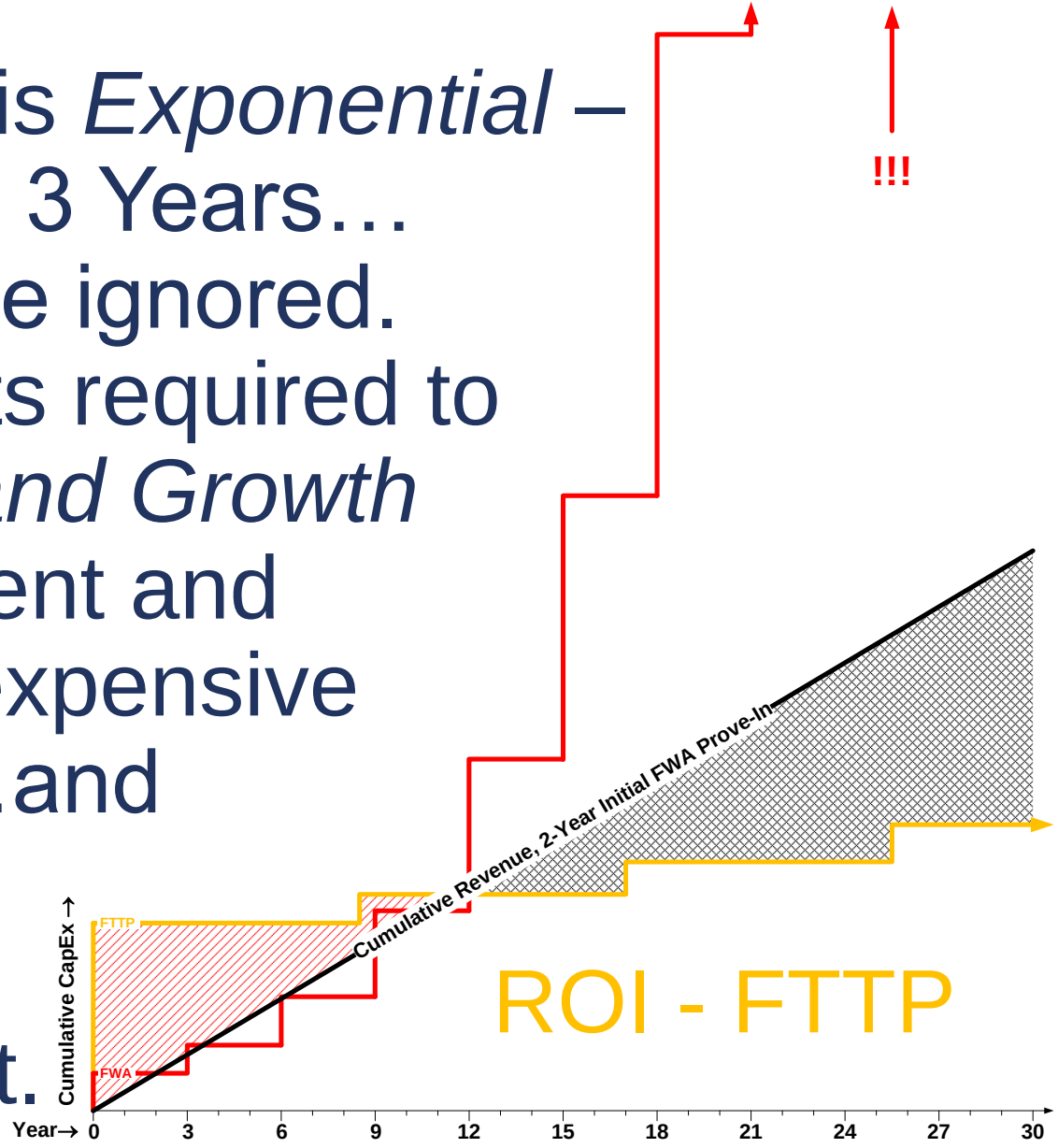

ROI - FTTP

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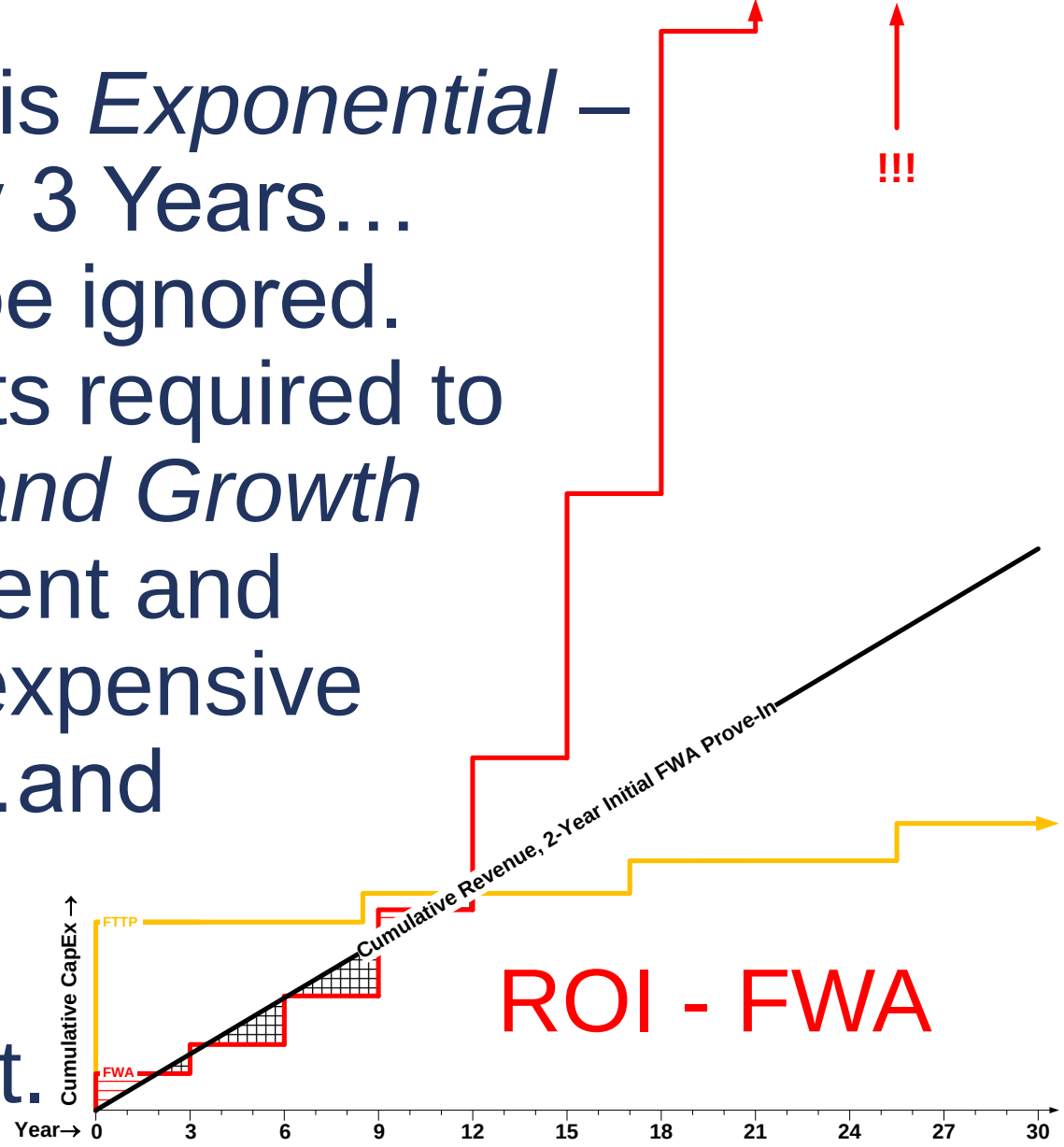

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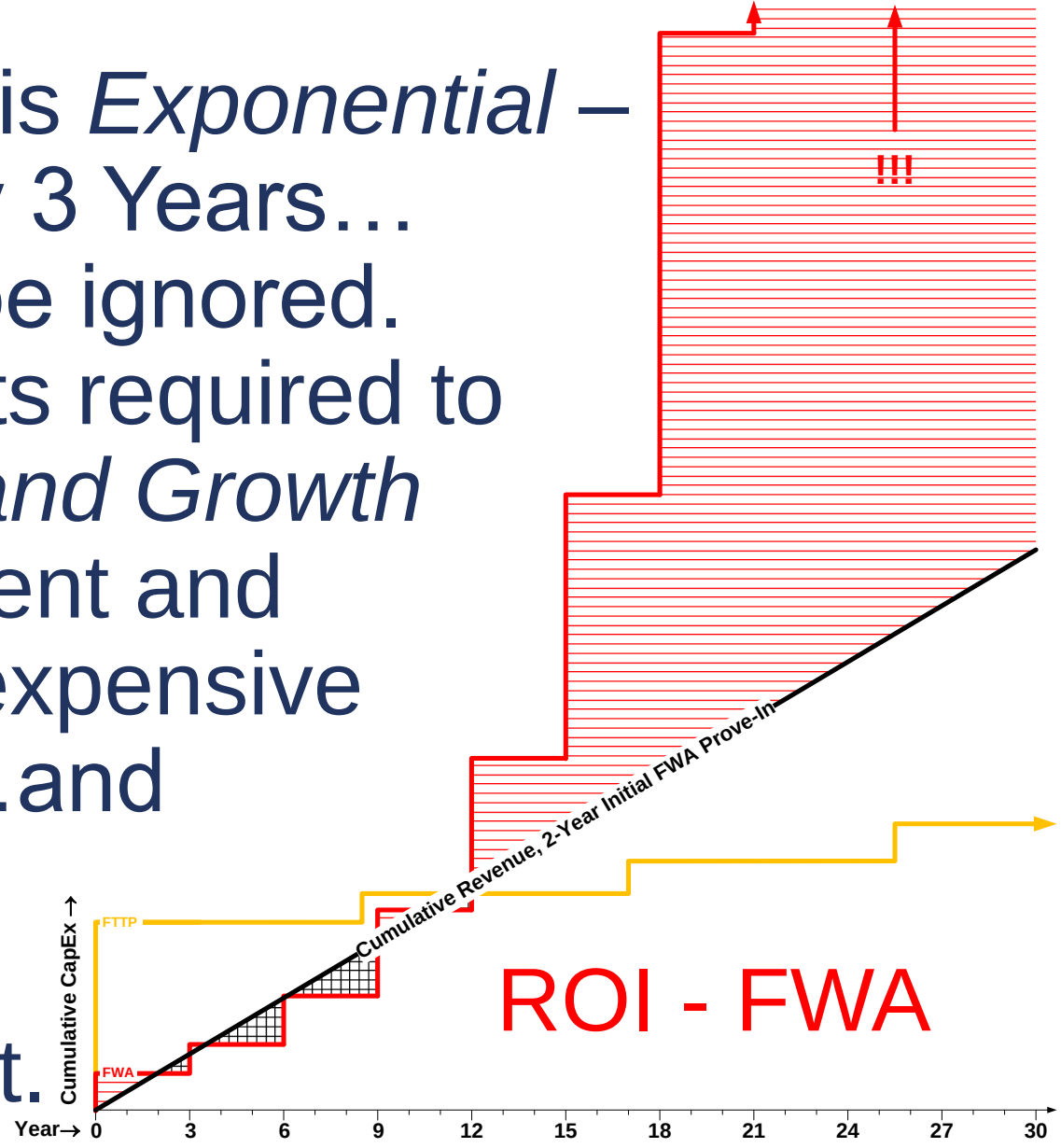

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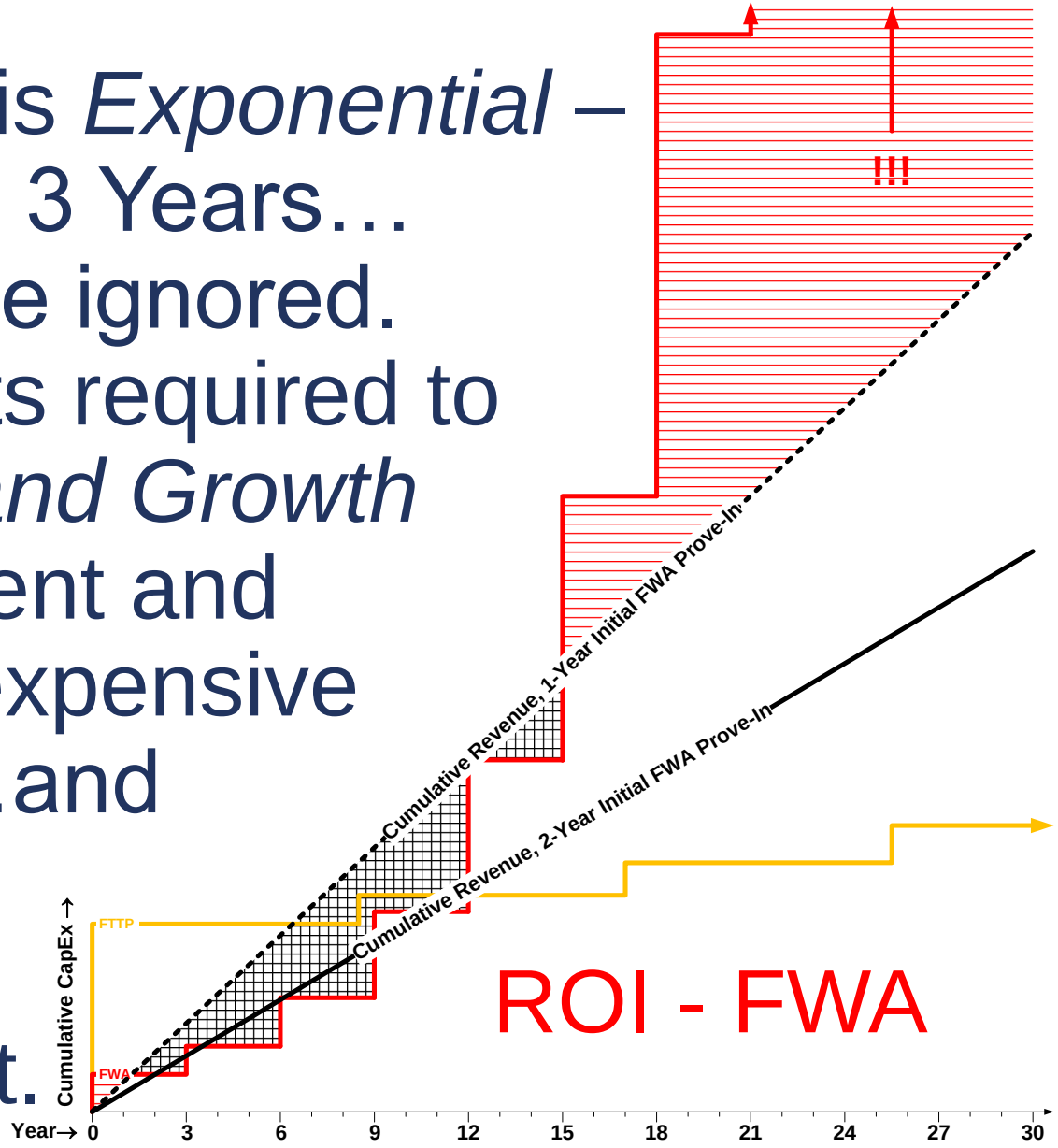

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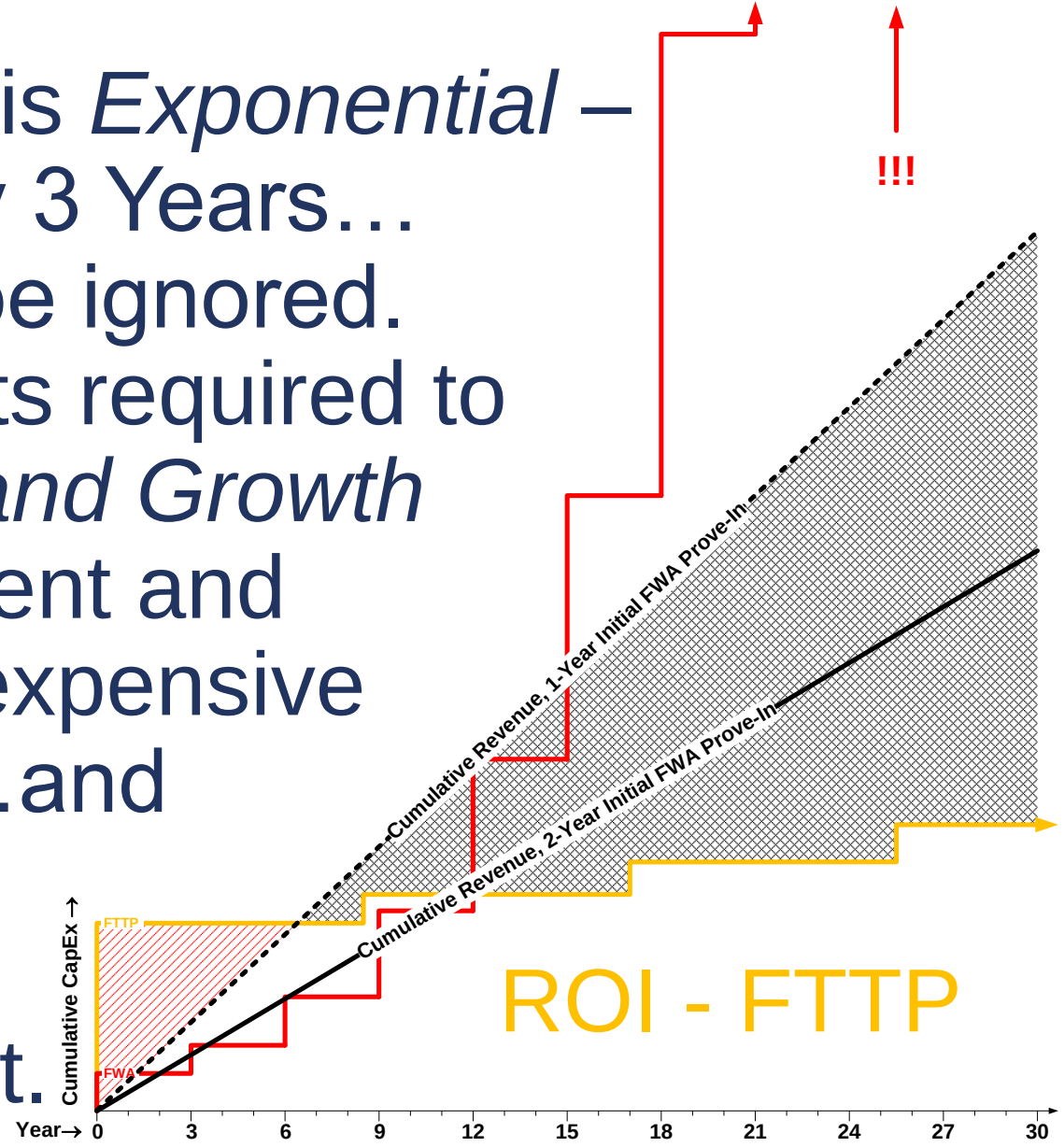

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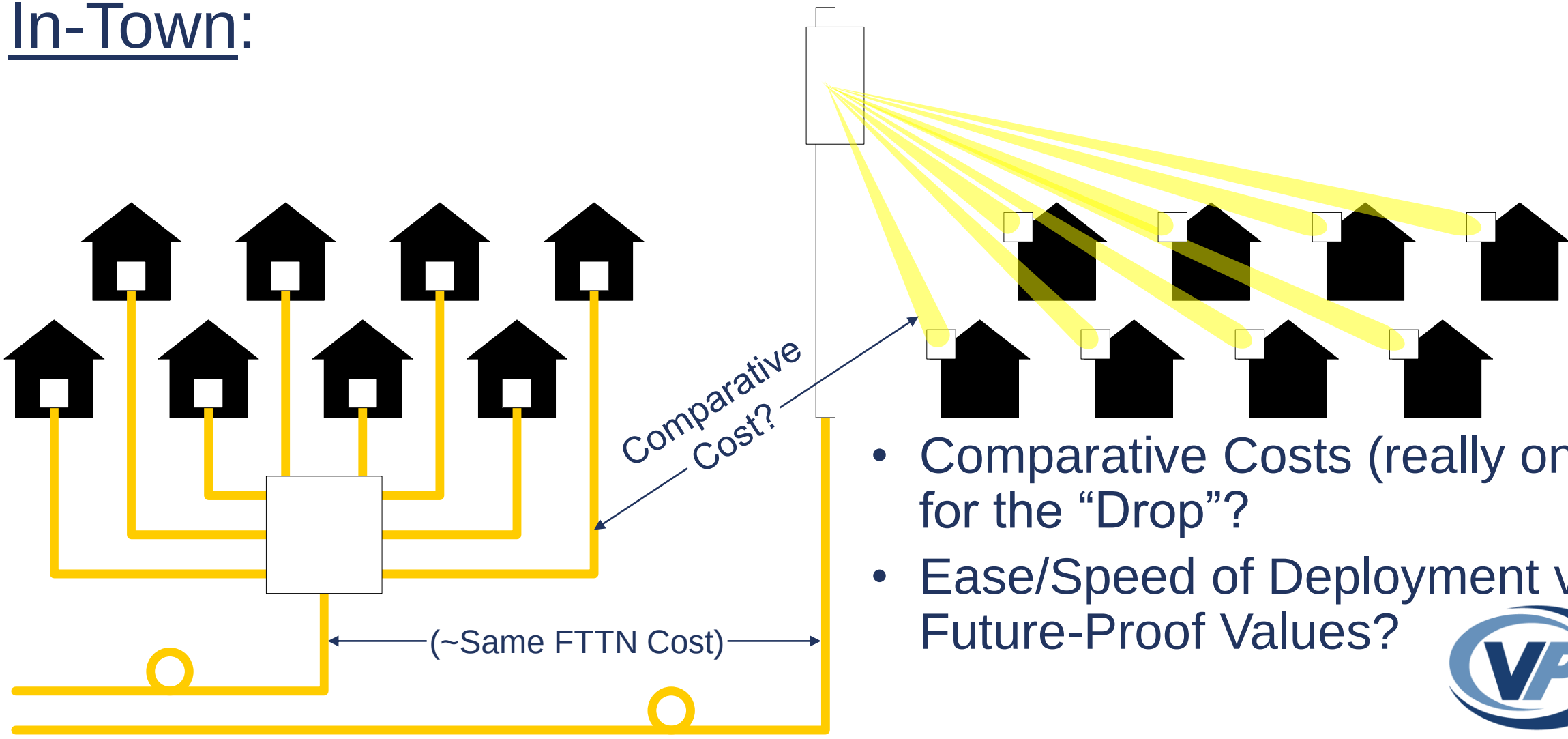
The Keys will be in determining:

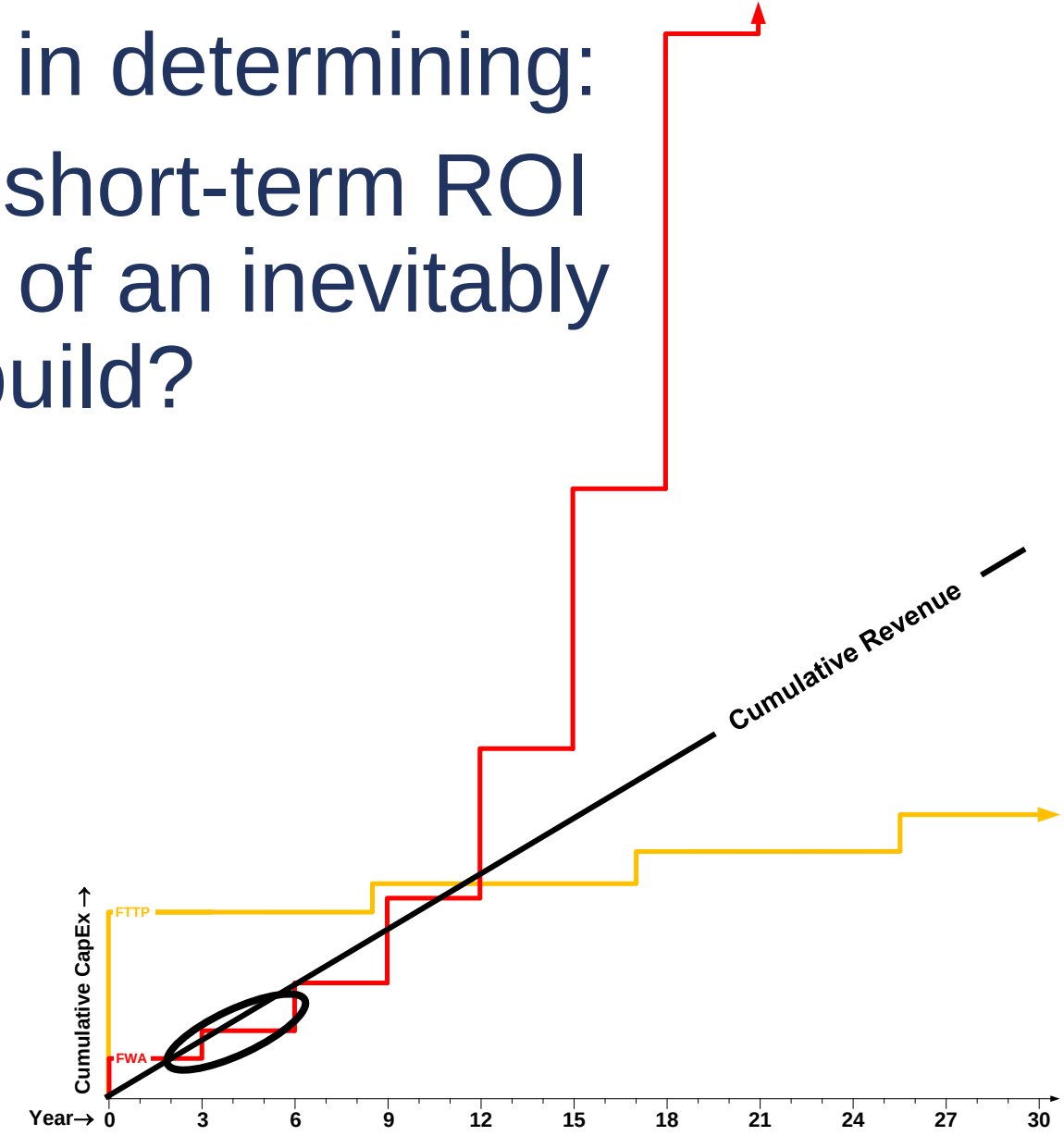
- In-Town:



- Comparative Costs (really only) for the “Drop”?
- Ease/Speed of Deployment vs. Future-Proof Values?

The Keys will be in determining:

- Rural: Could a short-term ROI defray the cost of an inevitably required fiber build?



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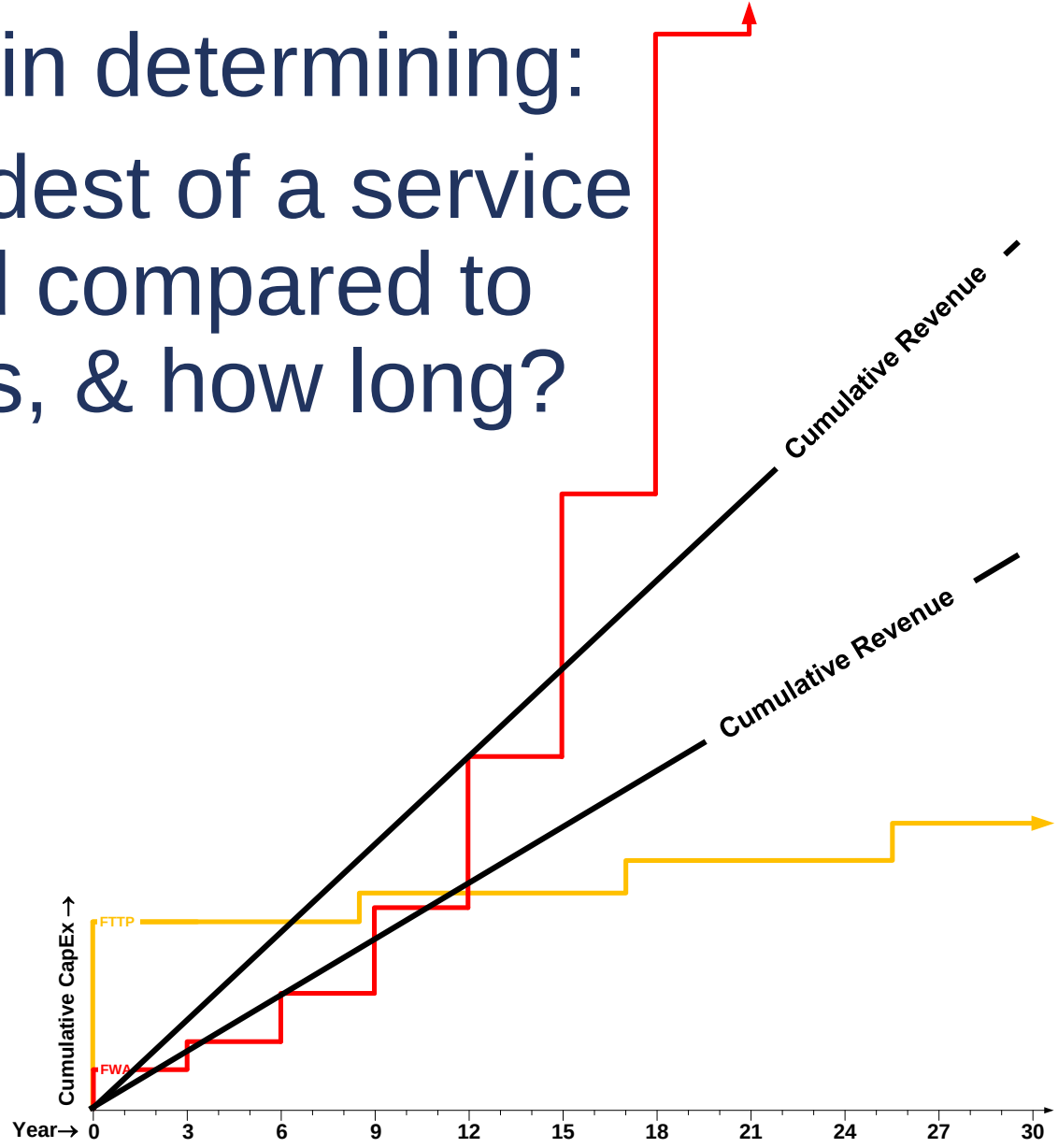
The Keys will be in determining:

- Rural: How Modest of a service will be tolerated compared to your FTTP subs, & how long?



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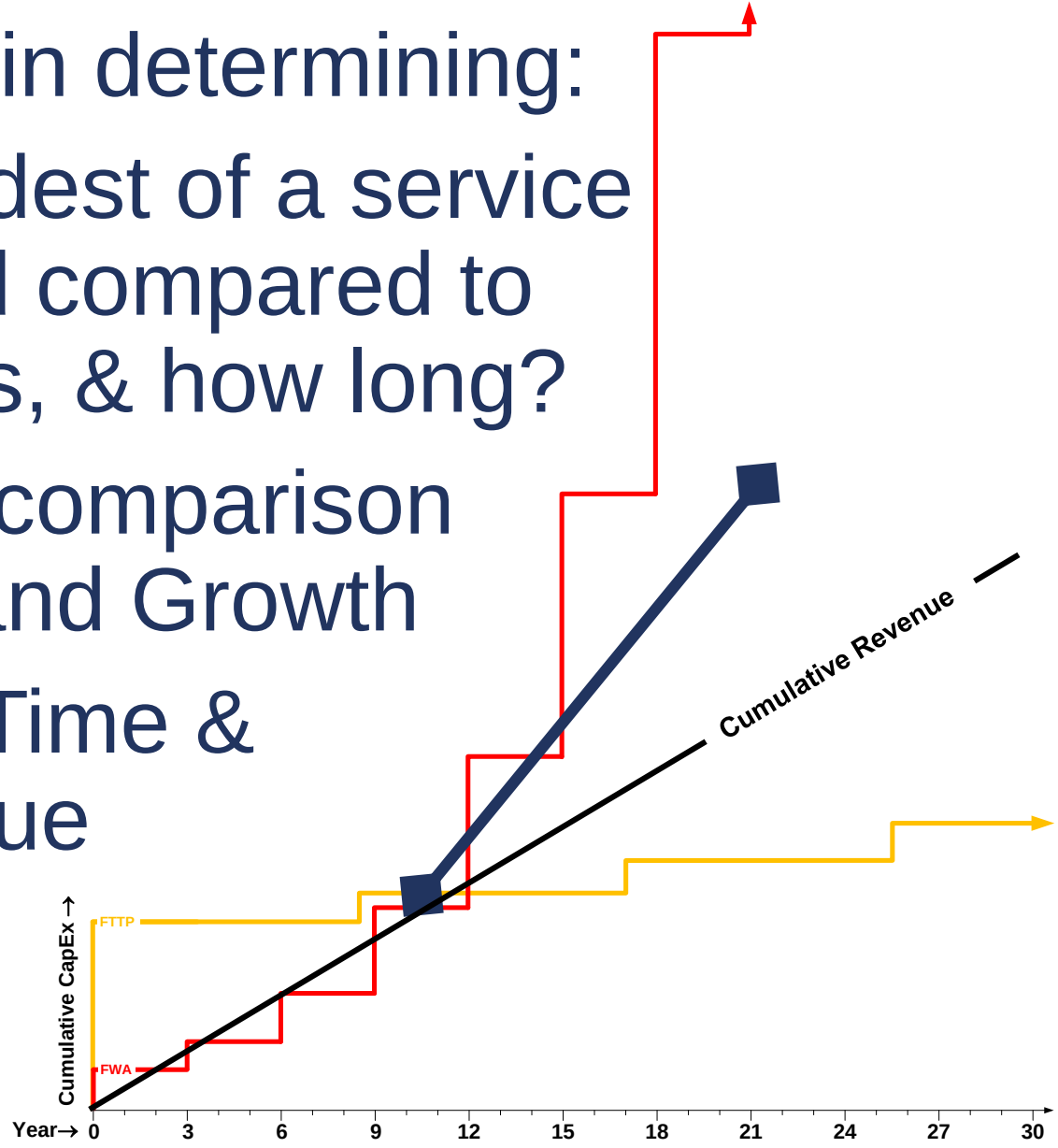
The Keys will be in determining:

- Rural: How Modest of a service will be tolerated compared to your FTTP subs, & how long?
- Cumul. CapEx comparison *including* Demand Growth
- Fiber Prove-in Time & Futureproof value
- (Unless an exit strategy), ROI Comparison, Long Term



Without careful planning, FWA could still get *Out of Hand*, especially for the Long Term

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So have your eyes OPEN when evaluating FWA

- There *can be* good fits for FWA, but…
- No one solution fits all; different strengths & weaknesses for ea.
- Have a competent engineering/consulting firm help you with:
  - FWA Uses – Recommended and *Not*-Recommended
  - Best Spectrum/Technology Fit (if any)
  - *Realistic:*
    - Speeds
    - Ranges
    - *Especially* Capacities,
    - *Network Growth Requirements over Time, and*
    - Associated CapEx –
  - Long-Term Comparative Evaluation and Business Planning

2019 Annual Meeting

Iowa Events Center, Des Moines, March 25-26, 2019

Pros & Cons – Latest Wireless Options for the Last Mile

OVERVIEW

Thank You!

Warren Vande Stadt,
Sr. Technology Leader - Wireless
2211 N. Minnesota St.
Mitchell, SD 57301

(605) 995-1777
Warren.VandeStadt@VantagePnt.com

VantagePoint
EMPLOYEE OWNED

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VantagePoint
An Employee Owned Company

FWA Overview & "Sooth"

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FINLEY ENGINEERING

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THE GRINNELL GROUP

Structures will be Needed!

2019 Annual Meeting

Iowa Events Center, Des Moines, March 25-26, 2019

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FWA Overview & "Sooth"

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FINLEY ENGINEERING

FWA System Types & Fits

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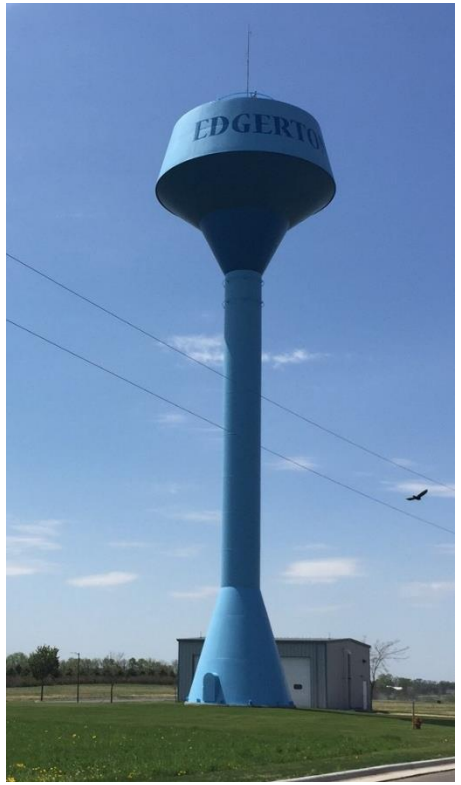
Ways to Deploy

- Towers
- Water Towers
- Grain Elevators
- Small Cells
- Rooftops
- Suburban



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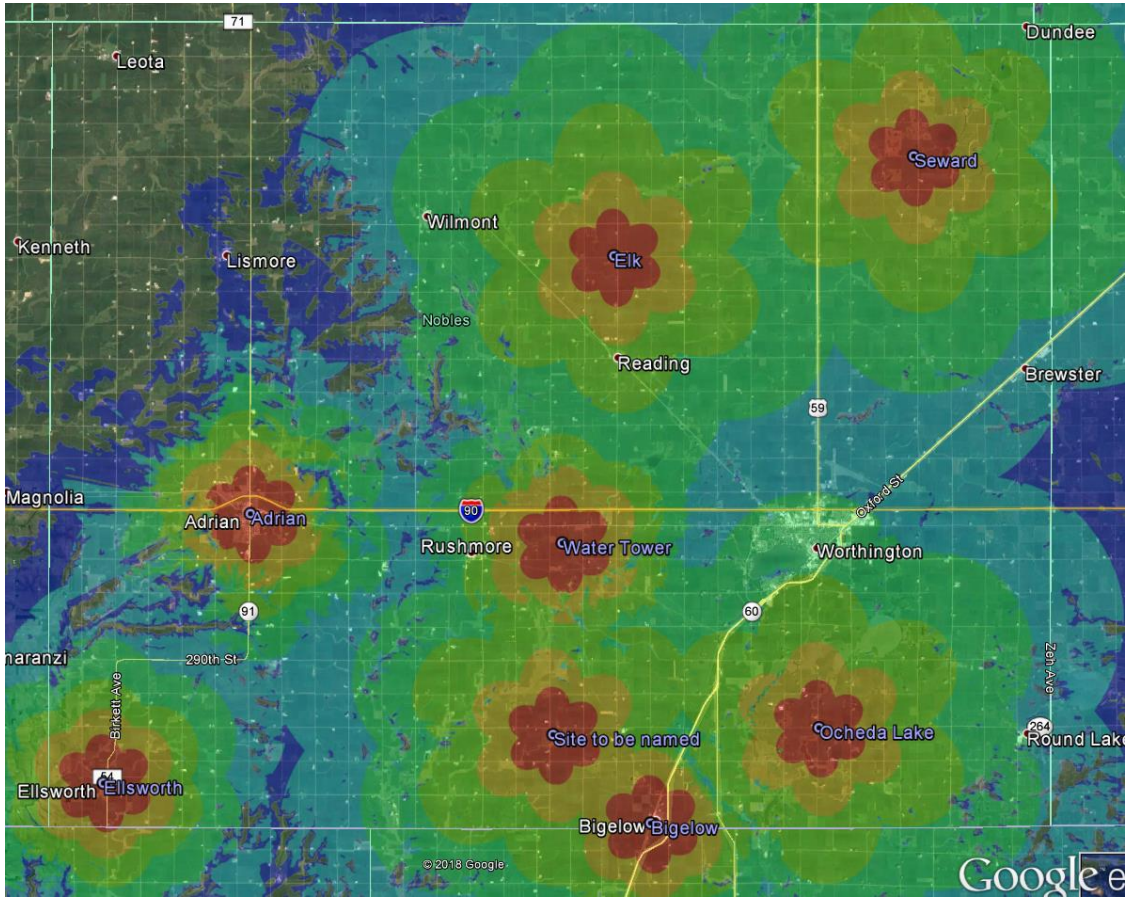
Keys to a Successful Wireless Network

- Appropriate Spectrum & Technology Selection
- Spectral Efficiency
- Cell Density for Sufficient Capacity
- Sufficient Backhaul
- Realistic Pro-Forma Business Case



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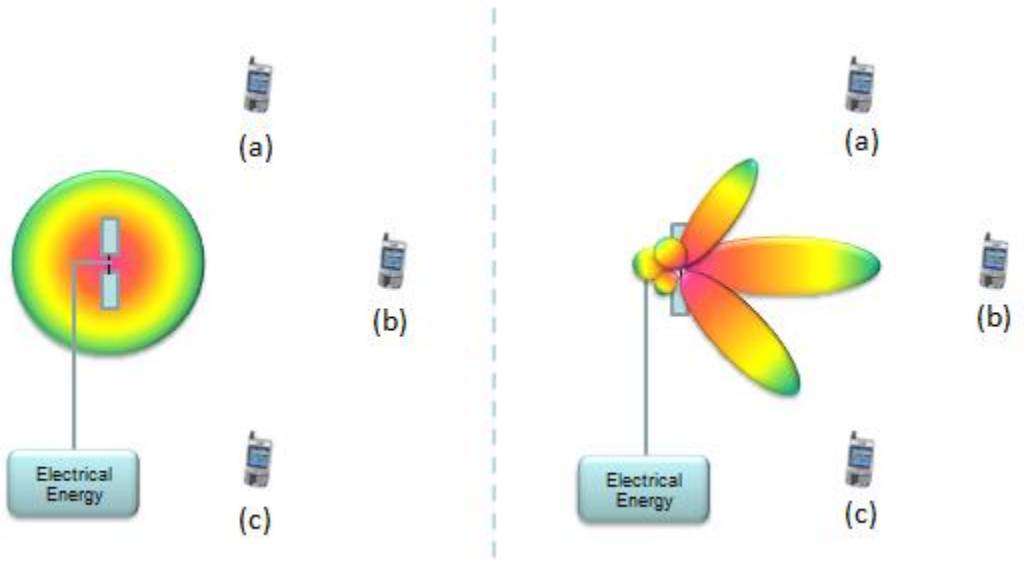
Technological Improvements in Wireless

- Movement towards standards based tech such as LTE and Wi-Fi.
  - Lower prices, faster improvements
  - Not locked into one manufacturer
- Interference Mitigation = Better Spectral Efficiency
  - Software
  - Beamforming to avoid interference sources
- MIMO Advances = Better Spectral Efficiency
  - Increasing numbers of streams,
  - User-dedicated beams, with multiple streams



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Selecting a Frequency Band

- Decide if licensed or unlicensed spectrum will be used.
  - Cost
  - Noise
  - Level of Service
  - Time to Deploy

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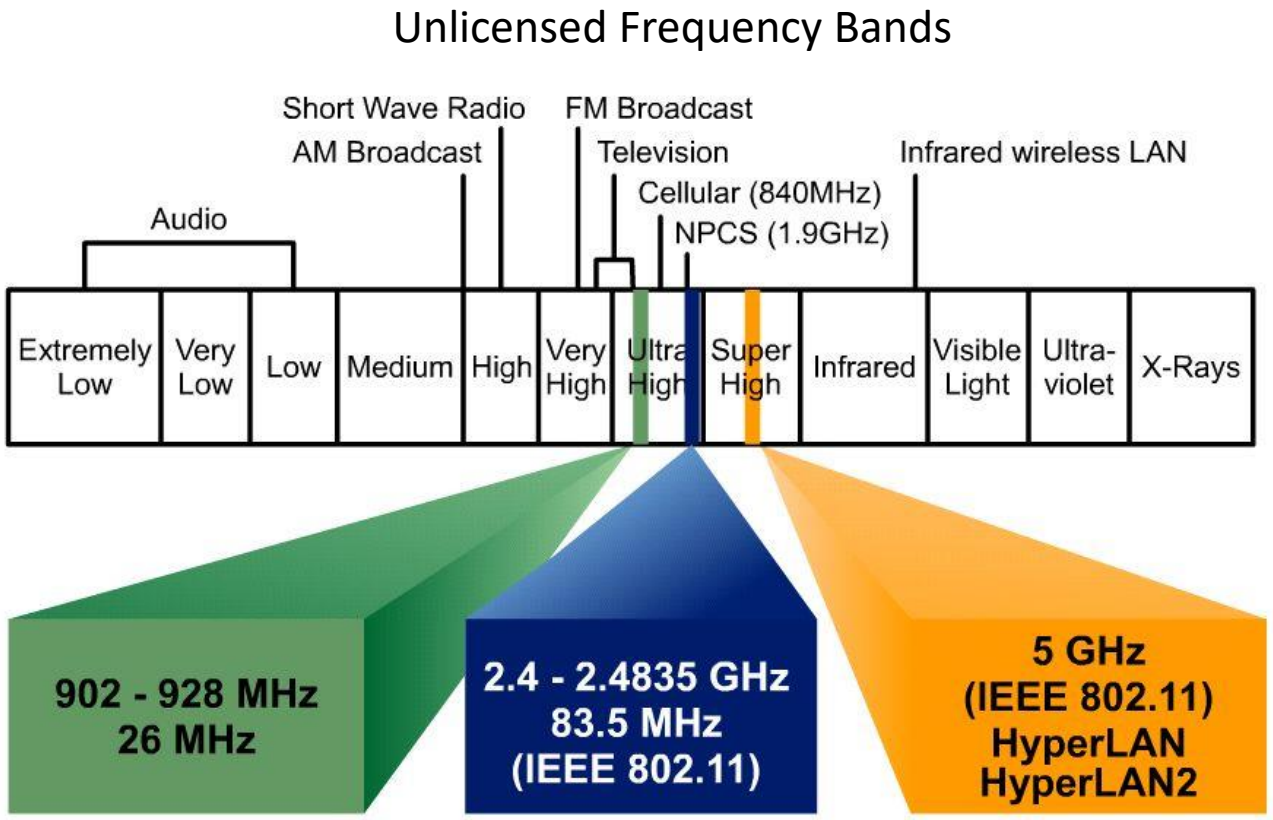
Selecting a Frequency Band

- Unlicensed Bands
  - TV white space
  - 900MHz (low bandwidth availability has limited the use of this band)
  - 2.4 GHz
  - 5.8 GHz
  - 60 GHz
- Licensed Bands
  - 2.5 GHz BRS/EBS
  - 3.5 GHz CBRS
- Future
  - 5G – millimeter wavelengths



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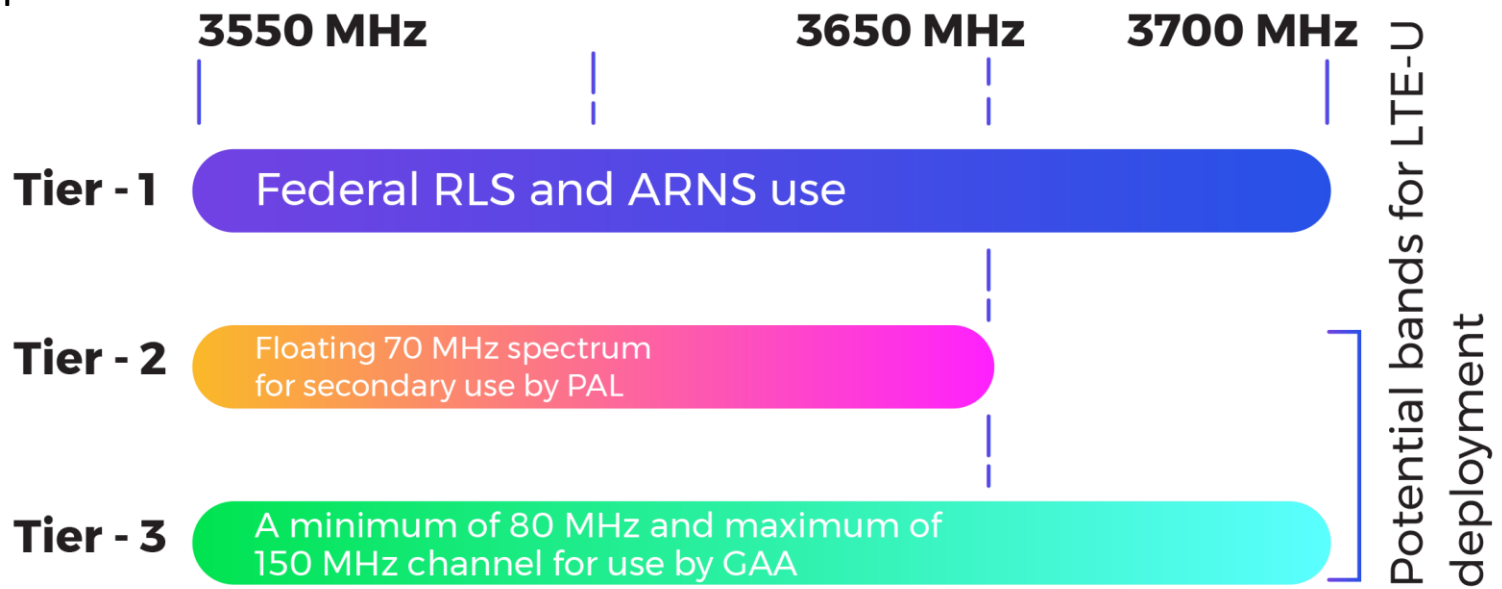
CBRS – Citizens Broadband Radio Service

- LTE or equiv.-based today, 5G NR future
- 3.55-3.70 GHz, 150MHz of new spectrum
- Automated Spectrum Access System (SAS) will dictate spectrum usage for all
- 3 levels of access
  - Incumbent – Military, Government
  - Priority Access License (PAL) – Spectrum Blocks awarded by auction to highest bidder per county. (2020)
  - Generally Authorized Access (GAA) – No license required, some regulation. (2019)



Hwang, Y (2017, June 9) What is CBRS? Retrieved from www.leverage.com

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3.5 GHz LTE, or Equiv. Proprietary Eqpt.

- Good capacity
- SAS bring automatic channel coordination, licensed spectrum options.
- NLOS capable
- Best Range for broadband speeds
- CBRS Spectrum Auctions
- High cost of entry
- Complex installations, heavy equipment

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3.5 GHz

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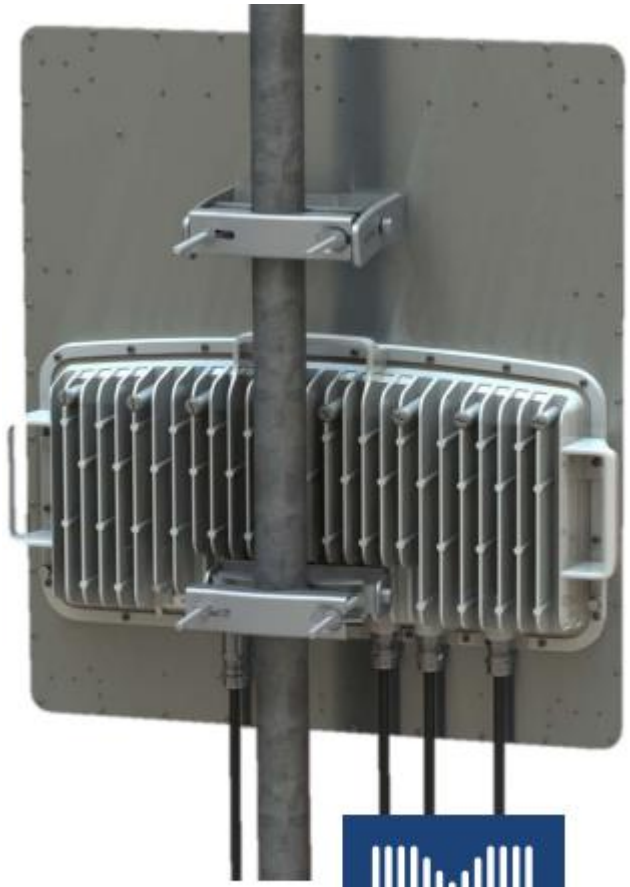
BaiCells
NOVA R9 BASE STATION FAMILY

Cambium Networks



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5 GHz

- Good capacity if there are unlicensed channels available.
- Susceptible to interference, unlicensed. Beamforming, GPS sync, and appropriate antenna selection help.
- NLOS capable, but requires LOS for true broadband speeds.
- Good range, 6-8 miles in favorable conditions.
- 5 GHz band has a stable and certain future
- Low/medium cost of entry
- Low weight, easily deployed

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Other 5 GHz w/Beamforming

Cambium Networks™

Cambium Networks industry-leading 450 platform adds Massive Multi-User MIMO capability with *cn*Medusa™ technology.

ePMP™ 3000

Cambium Networks™

mimosa

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PMP 450m Access Point

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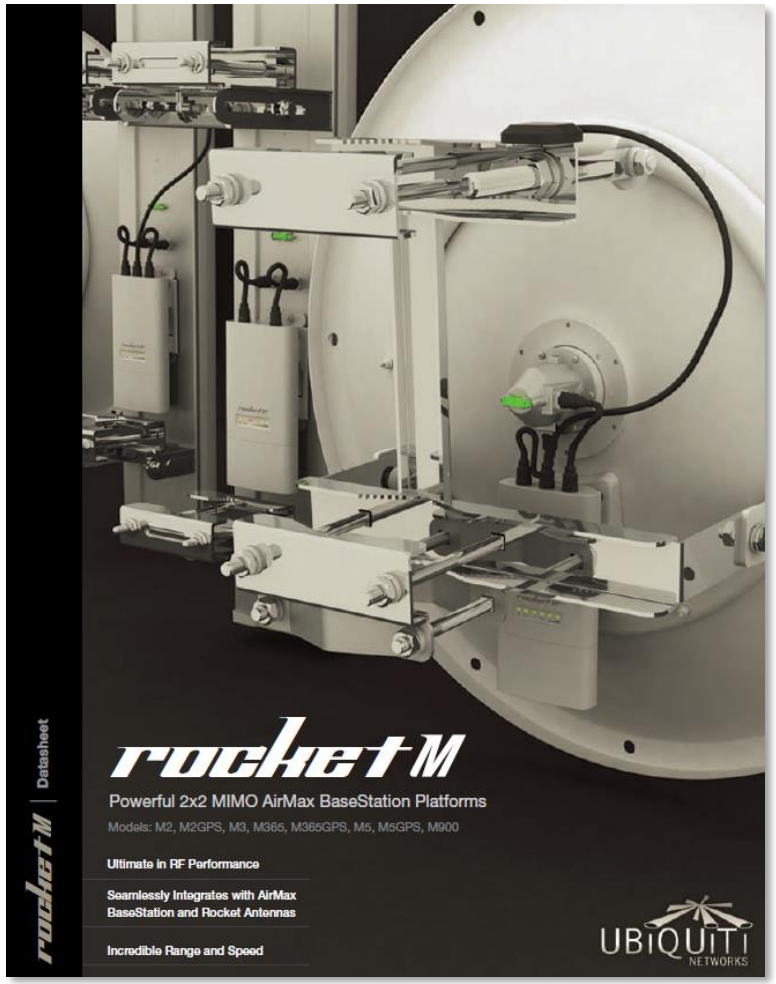
Other 5 GHz Vendors



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60 GHz

- Excellent Capacity, low density - 8 client connections
- Good interference mitigation, short haul, beamforming
- Strict LOS, rain fade must be accounted for
- Very short, <500m
- Band is large and has a stable future
- High cost of entry, although prices are falling
- Low weight, very easily deployed

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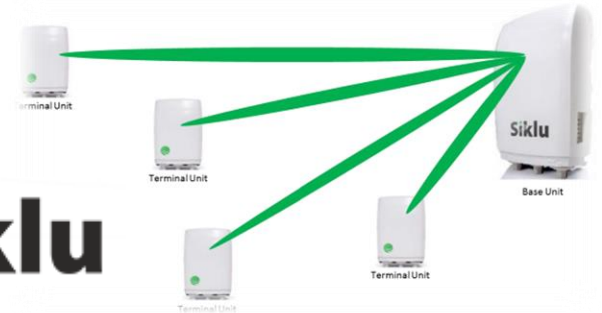
60 GHz

IgniteNet

MikroTik

Siklu



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TheGrinnellGroup
Real Estate Development Solutions

Introduction

The Grinnell Group is a site acquisition firm specializing in the wireless and broadcast industries with an established reputation for quality and timely service established over two decades.

Based in Des Moines, The Grinnell Group has served clients throughout the United States but is focused on Iowa, Minnesota, Wisconsin, Illinois,, Missouri, Nebraska, Colorado, and South Dakota

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Overview

- New site development
- Tower asset management
- Trends

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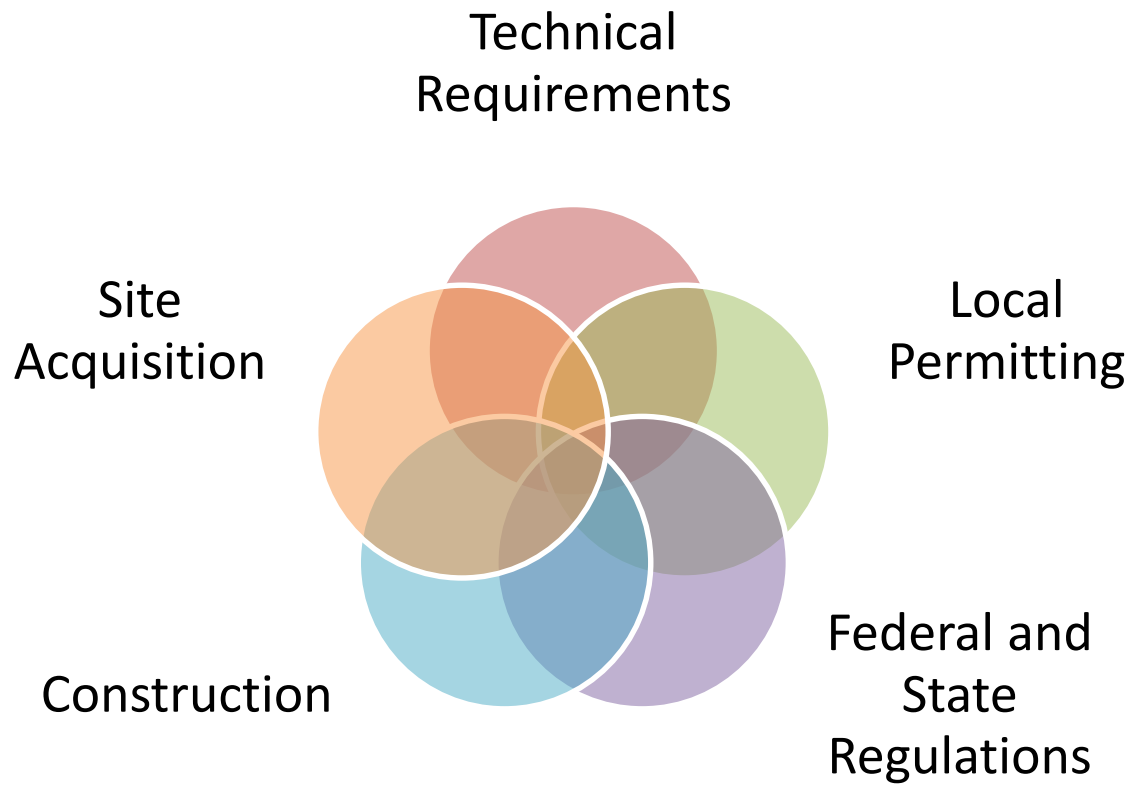
New Site Development

Site Identification and Evaluation – Due Diligence Report



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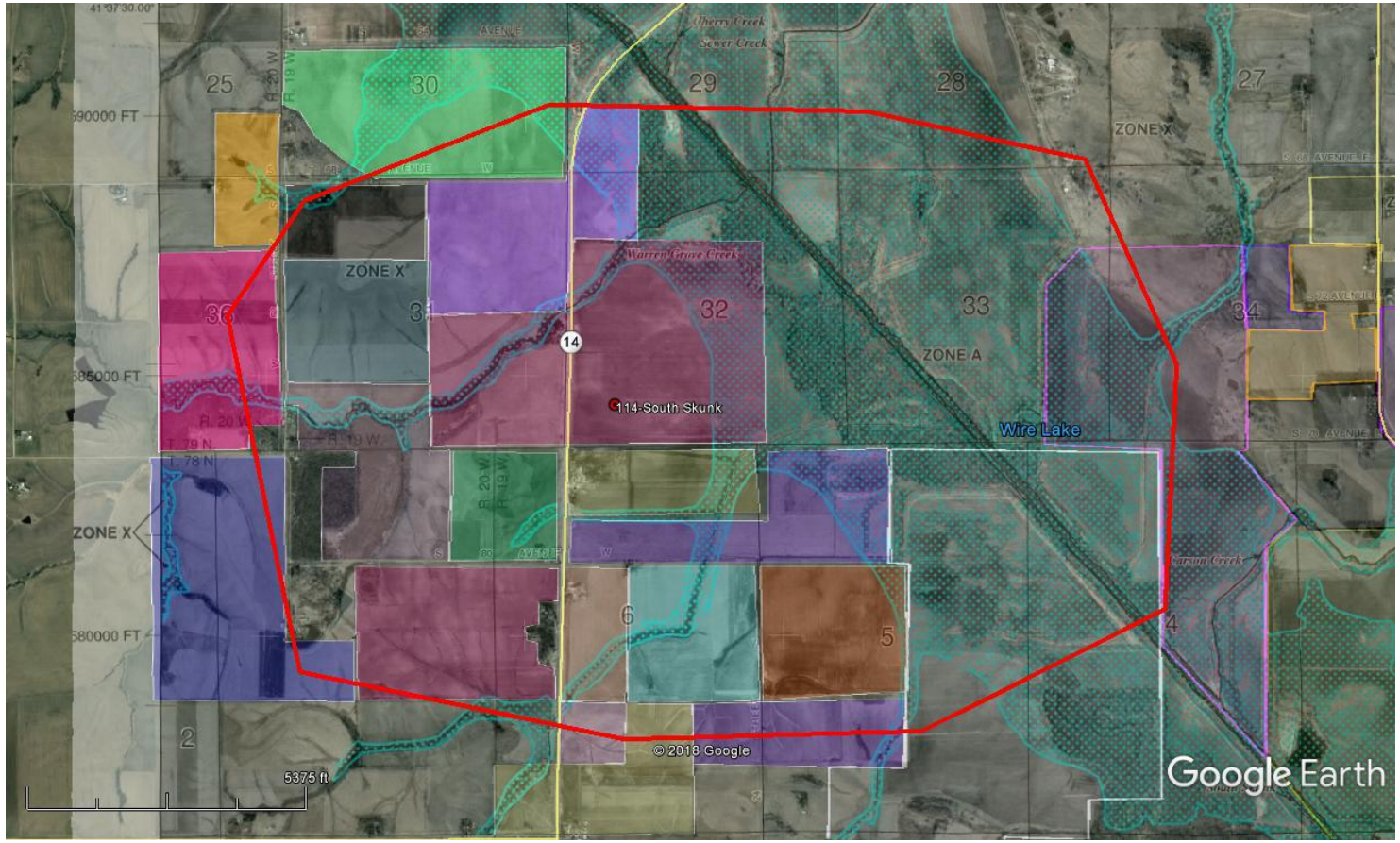
New Site Development

Site Identification and Qualification – Due Diligence Report



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New Site Development

Site Acquisition

- Lease vs Purchase
- Operational and administrative issues
- Legal – insurance, liability, title
- Business terms
  - Length of agreement
  - Rents – stable or declining last few years

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New Site Development

Local Permitting – Zoning

- Opposition waning but still pops up
  - Pick the right site to start
  - Follow code requirements
  - Leverage local relationships ahead of time

- Numerous new Federal and State laws and rulings
  - Varies by facility type
    - New tower
    - Co-location on existing tower
    - Small Cells
  - Purpose is to
    - Expedite deployment
    - Establish consistency/predictability
    - Narrow local review to land use issues

U.S. 2012 Middle Class Tax Relief Act

IA House File 655 (2015)

IA Senate File 431 (2017)

Various FCC Rules & Interpretations

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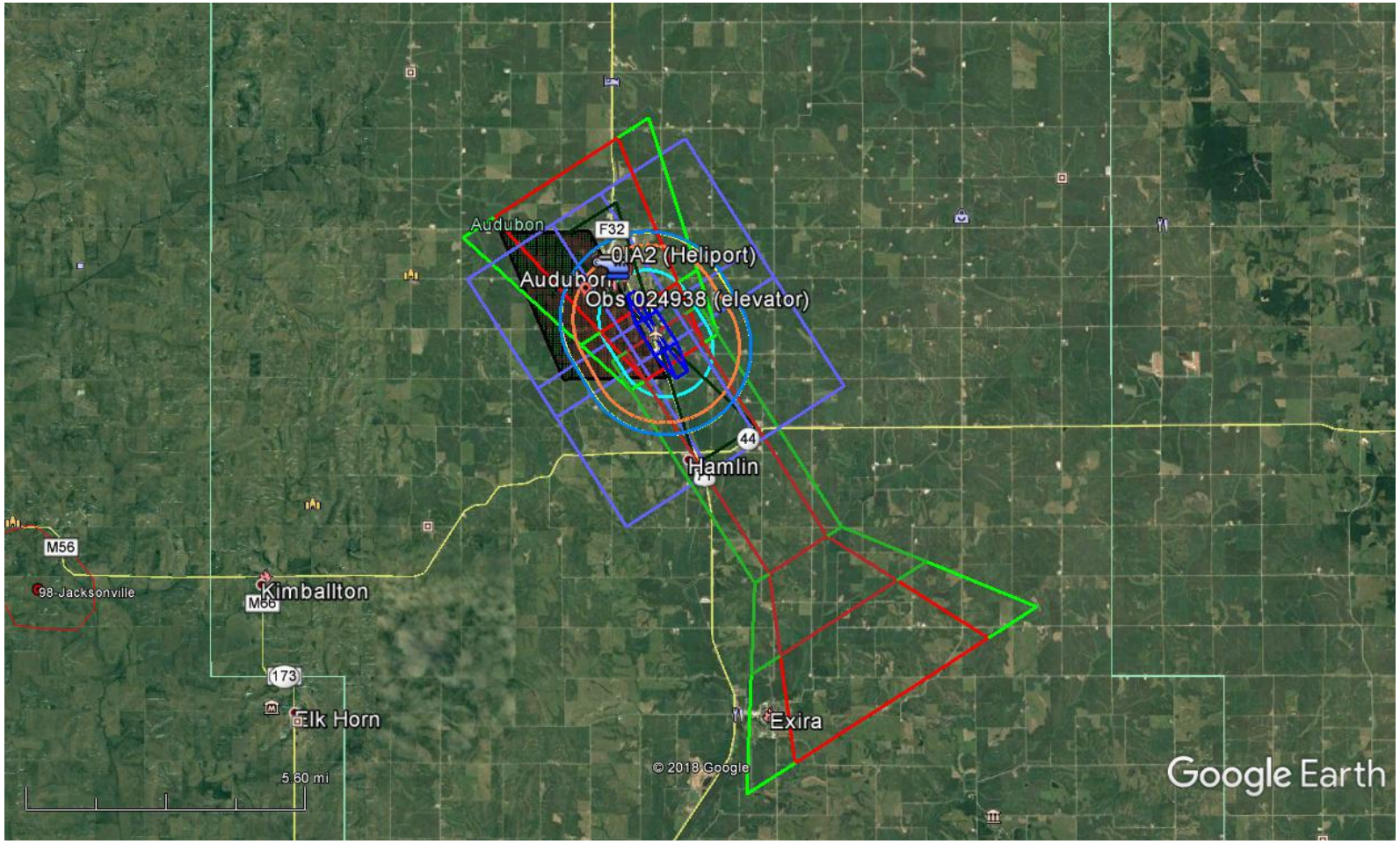
New Site Development



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New Site Development

Federal and State Regulations

- FAA Determinations
- FCC Regulations
- AM Interference
- NEPA / SHPO
- Environmental Site Assessments

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Tower Asset Management

Tower Ownership → Responsibilities

Administrative

Engineering / Compliance

- FAA Lighting
- Maintenance
- Periodic Inspections

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Tower Asset Management

Tower Ownership  Responsibilities and Opportunities

Tenants

- Who
- Benefits
- Creates More Responsibilities

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Tower Asset Management – New Tenants

No conflict with owner's facilities or use

Consistency with existing agreements

- Length
- Interference
- Access
- Insurance and liability
- Sublease requirements – notice / consent
- Protect rights of owner and existing tenants

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Tower Asset Management – New Tenants

No conflict with owner's facilities or use

Consistency with existing agreements

Financial Terms

- Rent
  - Local demand – population, land use
  - Availability of alternative locations
  - Proposed Loading
  - Time demands
- Escalator
- Capital contribution for tower modifications

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Tower Asset Management – New Tenants

No conflict with owner's facilities or use

Consistency with existing agreements

Financial Terms

Engineering and Design Review

- Limited physical space
- Structural capacity
- Consistency

Structure Usages

Structural Component	Controlling Usage	Pass/Fail
Legs	90%	Pass
Diagonals	81%	Pass
Horizontals	61%	Pass
Guys	104%	Pass

Foundations

Reaction Component	Analysis Reactions	% of Usage
Base Axial (kips)	229.0	56%
Anchor 1 Uplift (kips)	55.0	32%
Anchor 1 Shear (kips)	68.0	30%

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Tower Asset Management – New Tenants

No conflict with owner's facilities or use

Consistency with existing agreements

Financial Terms

Engineering and Design Review

Construction Oversight

- Protections
- Inspections

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Tower Asset Management – New Tenants

No conflict with owner's facilities or use

Consistency with existing agreements

Financial Terms

Engineering and Design Review

Construction

Record Keeping

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Tower Asset Management – Existing Tenants

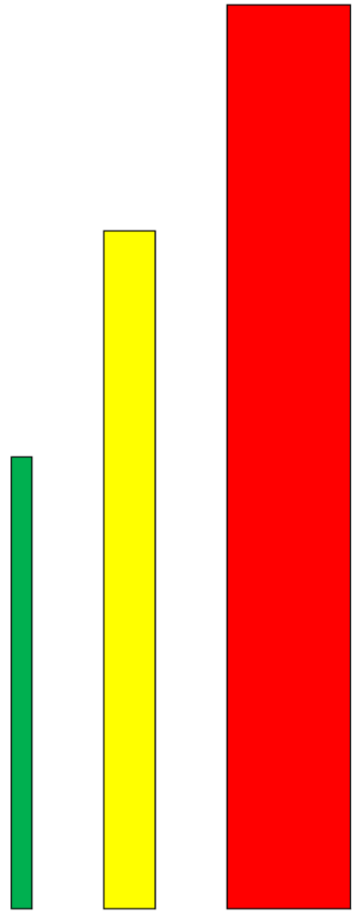
Equipment Changes

- Same leasing, operational and engineering issues as new tenants
- Tenant's push for notice or consent only – know your lease rights and obligations
- Today's antennas are not your father's antennas
- Opportunity to modify other terms

Multi-band antenna (24" x 96")
with 2 remote radios
Total weight: 250 lbs

4G antennas (6"-8" x72")
with 1 remote radio
Total weight 75 lbs

2G/3G Antenna (4"x48")
No remote radios
Total weight 15-25 lbs



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Tower Asset Management – Existing Tenants

Equipment Changes

Renewals

- Prime lease and tenant subleases
- Timing matters
- Opportunity to modify other terms

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Tower Asset Management – Existing Tenants

Equipment Changes

Renewals

Buy Outs

- Essentially a financial deal- in the long haul, buyer makes money
- Value of short term capital vs long term revenue

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Tower Asset Management – Existing Tenants

Equipment Changes

Renewals

Buy Outs

Rent Reduction Requests

- Generally a fishing expedition
- Tell them “No” four or five times, then call me.

Dear Landlord,

[redacted] is actively reviewing its portfolio of sites to determine ways to make its network more efficient and economical. Several factors will go into this review including coverage objectives, technology changes, design of our network, and the cost of operating the site (i.e., rent, taxes, and utilities).

We are in a very competitive space and we need to ensure that are costs are in line with that reality. [redacted] is reviewing its cell site portfolio to identify those locations that are in excess of the market for that real estate. [redacted] must significantly reduce expenses without sacrificing the quality of its service.

As a part of this review, [redacted] has implemented an optional Lease Optimization Program that will offer you the opportunity to strengthen your strategic relationship with [redacted] as well as providing you the opportunity to secure your cell site rent income.

Depending on your level of participation, [redacted] will propose rent guarantees that will provide security and stability for your cell site income. To help you understand this process, [redacted] has authorized [redacted] a wireless lease management and services company, to implement [redacted]s Lease Optimization Program.

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Recap

Site Development – Success dependent upon managing competing variables

Asset Management – Protect investment to maximize return

Trends

- Rents: stable to decreasing
- Equipment: load increasing
- Permitting: greater certainty

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