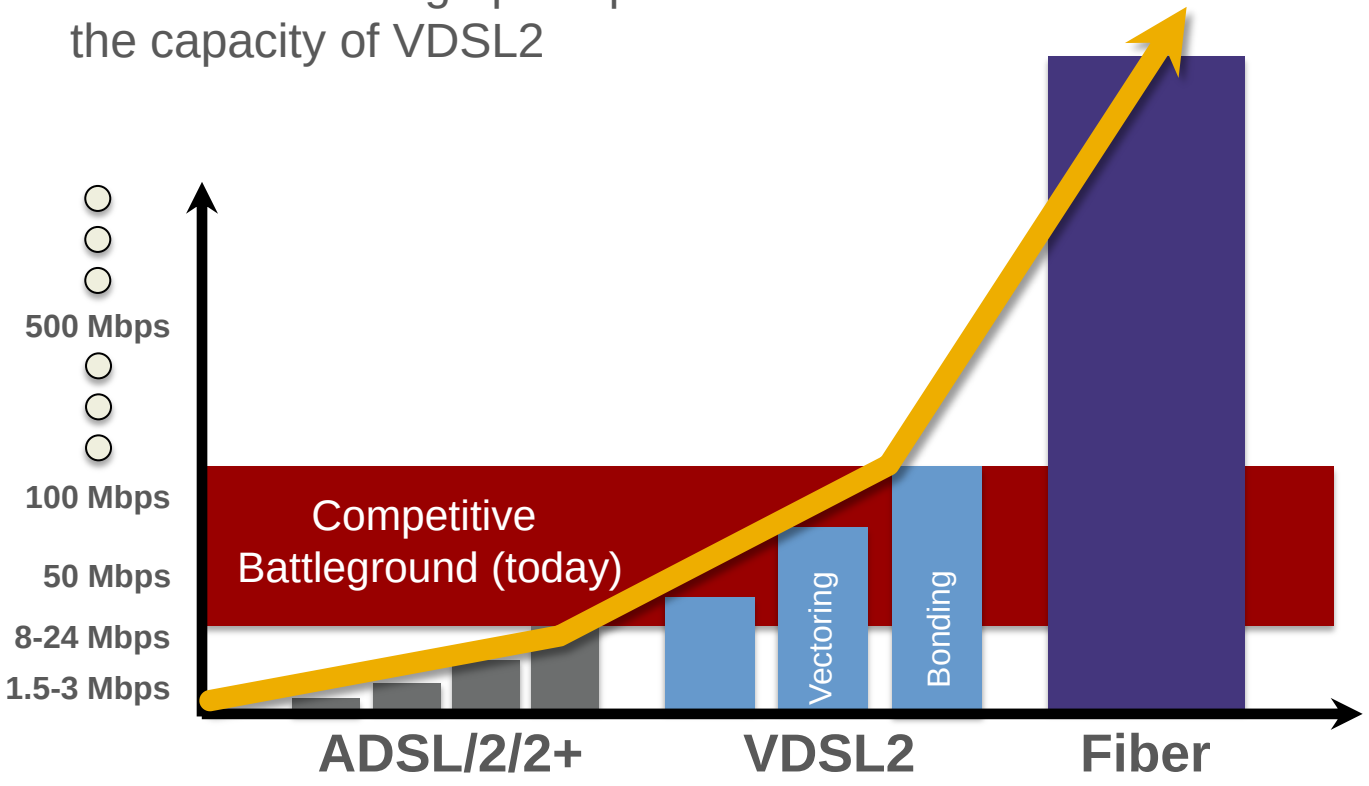
FCC Technology Transitions Policy Task Force Workshop, March 18, 2013

VDSL2: A Transition Technology

- VDSL2 provides a short term solution for bandwidth needs
- After 2020 average peak period consumer bandwidths will exceed the capacity of VDSL2



Defining Five Key Technologies

- ADSL2+-DSL technology commonly used in the U.S. today
- VDSL2-Next generation DSL technology in the process of being deployed in much of the U.S. VDSL2 products automatically fall back to ADSL2+ when that technology has superior performance
- Bonding-Utilizing 2 or more pairs of copper to increase bandwidth or the loop length of a given bandwidth. Bonding can be done on both ADSL2+ and VDSL2 technologies
- Vectoring-A signal processing technology that reduces the impact of noise in VDSL2 system
- FTTH-Fiber-to-the-Home utilizes either passive (PON) or active (Pt-to-pt Gigabit Ethernet) to bring bandwidth directly to the customer premises

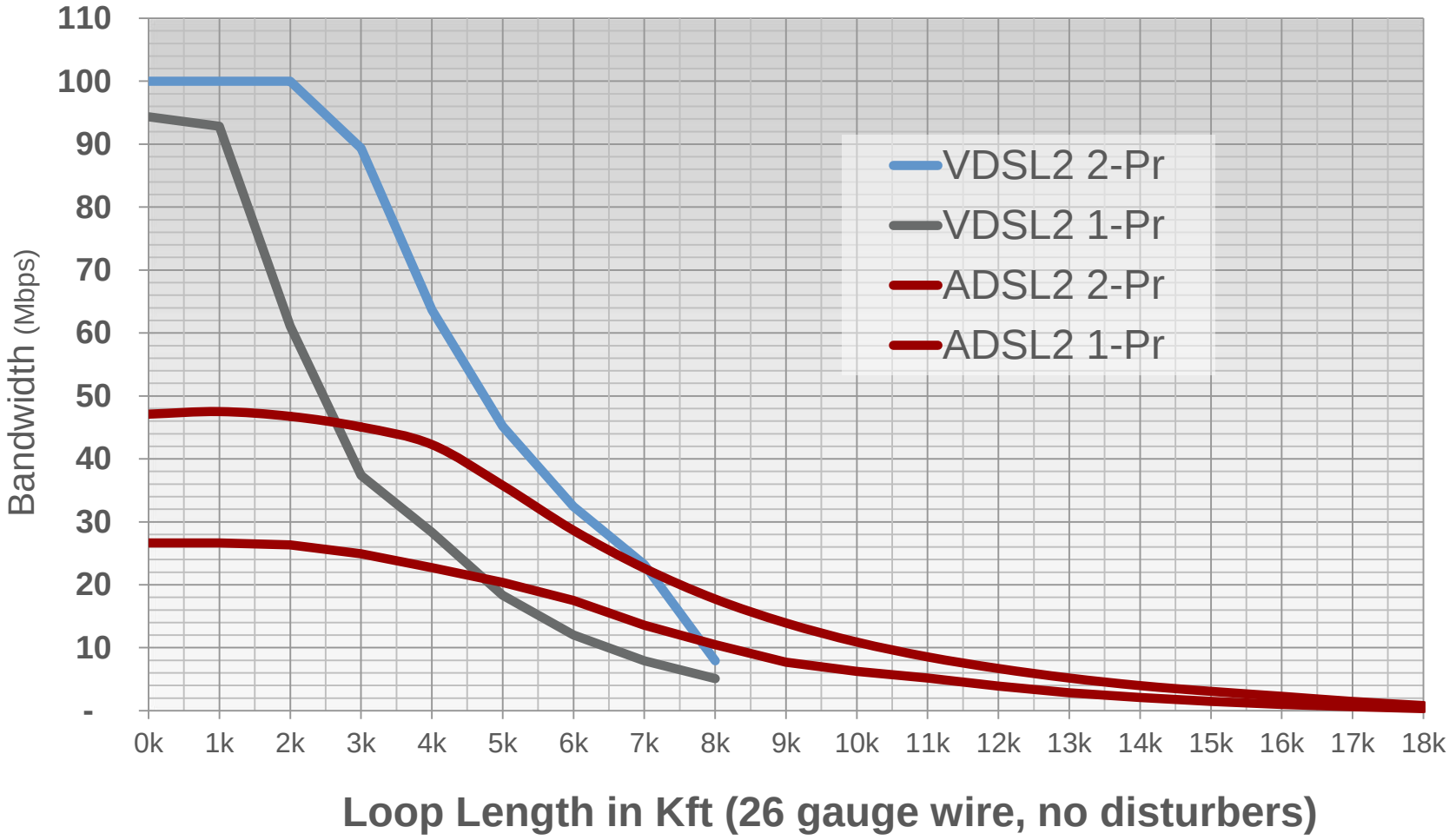
VDSL2 Profiles for Different Applications

VDSL2 differs dramatically from ADSL2+ with the use of profiles

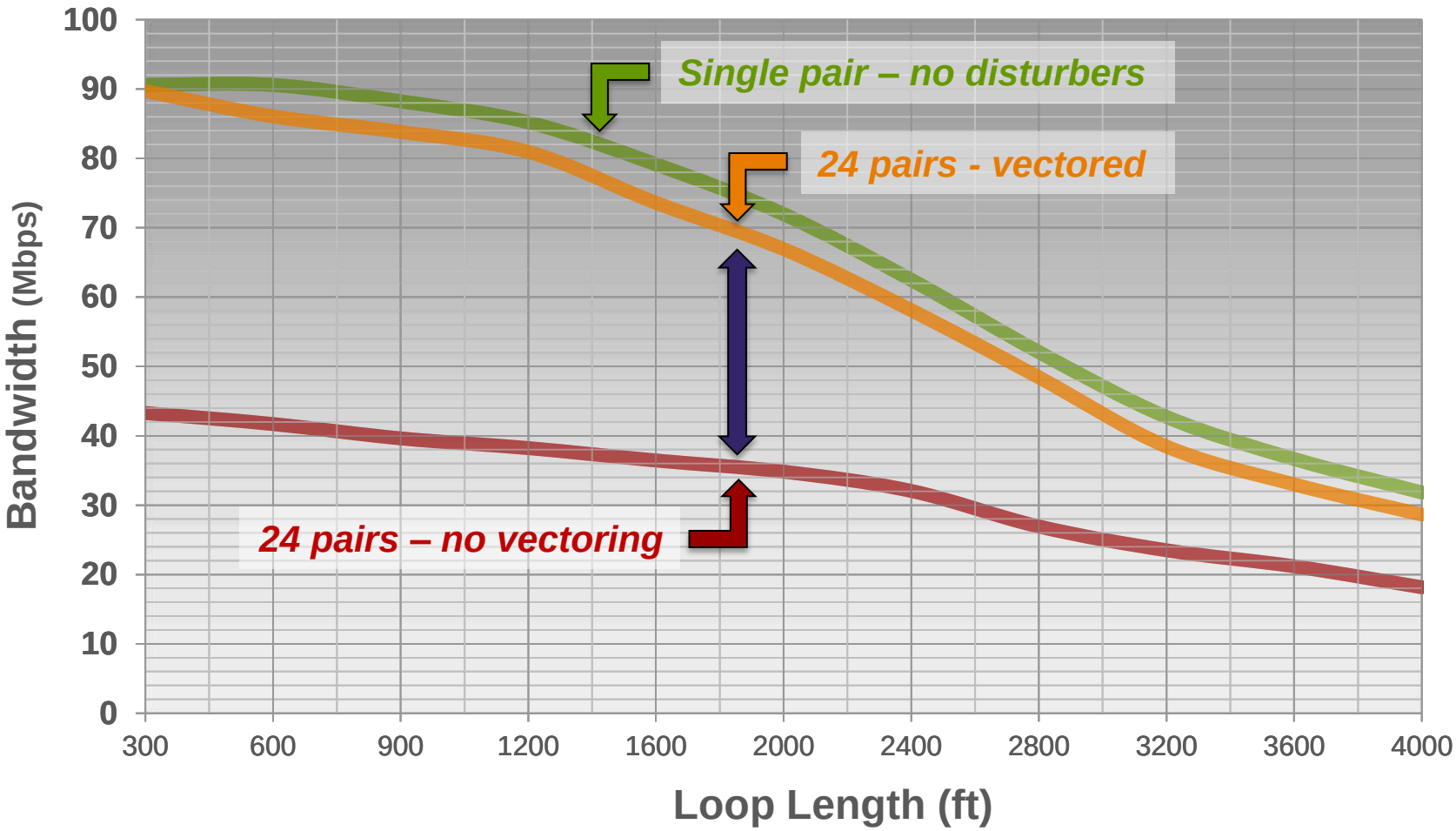
- Profiles differ dramatically in their performance over distance

	Max. DS Power	Max. Freq.	**Bandwidth** (Max Downstream)	**Bandwidth** (Max Upstream)	Typical Application
Profile 8b	20.5 dBm	8.5 MHz	**90 Mbps**	**20 Mbps**	CO
Profile 8a	17.5 dBm	8.5 MHz	**90 Mbps**	**20 Mbps**	CO
Profile 8d	14.5 dBm	8.5 MHz	**90 Mbps**	**20 Mbps**	RT
Profile 8c	11.5 dBm	8.5 MHz	**90 Mbps**	**20 Mbps**	RT
Profile 12a	14.5 dBm	12 MHz	**90 Mbps**	**60 Mbps**	Node
Profile 12b	14.5 dBm	12 MHz	**90 Mbps**	**60 Mbps**	Node
Profile 17a	14.5 dBm	17.7 MHz	**100 Mbps**	**60 Mbps**	MDU
Profile 30a	14.5 dBm	Not Generally Supported in North America			MDU

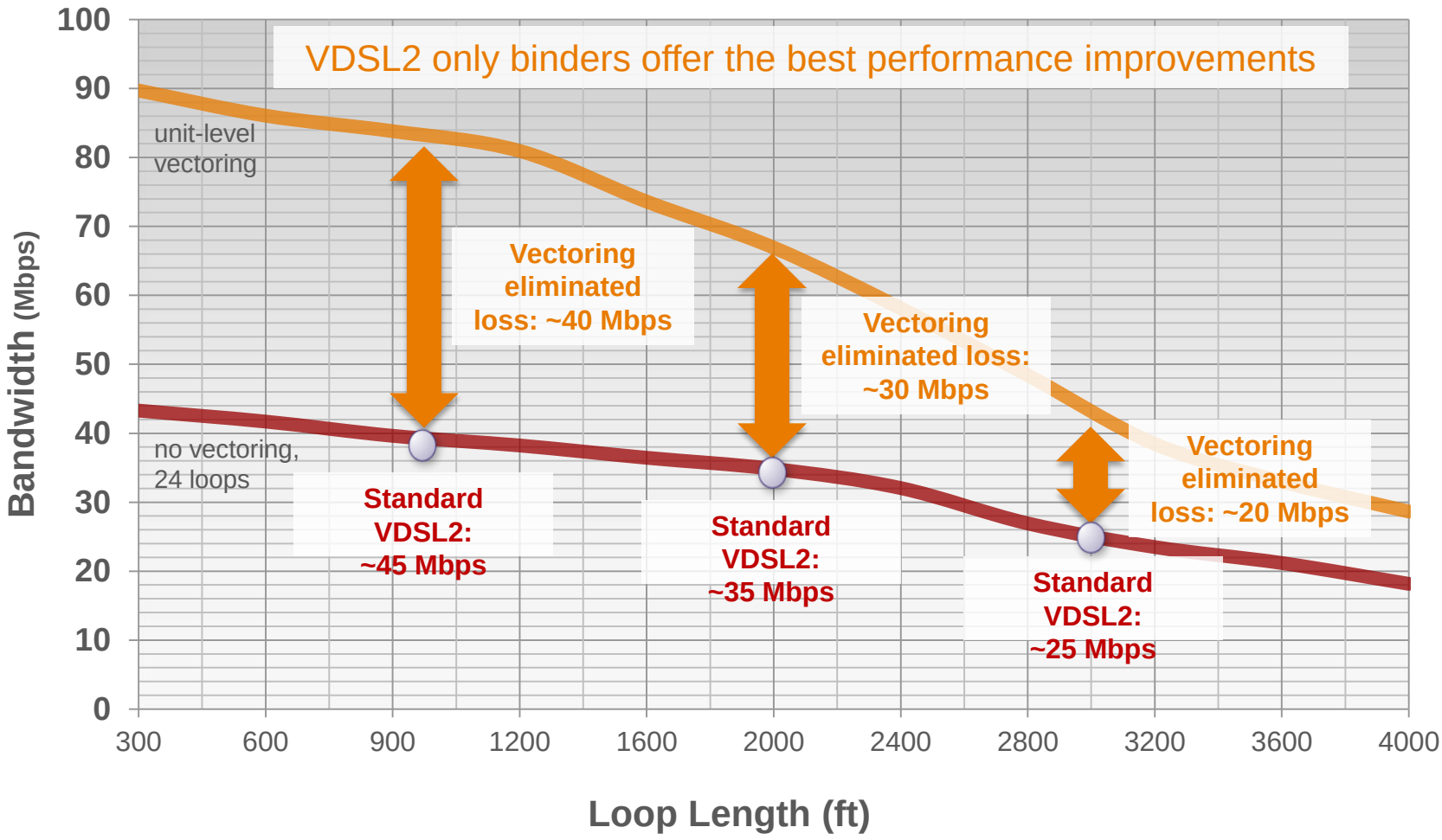
DSL Performance and Bonding



VDSL2 Performance

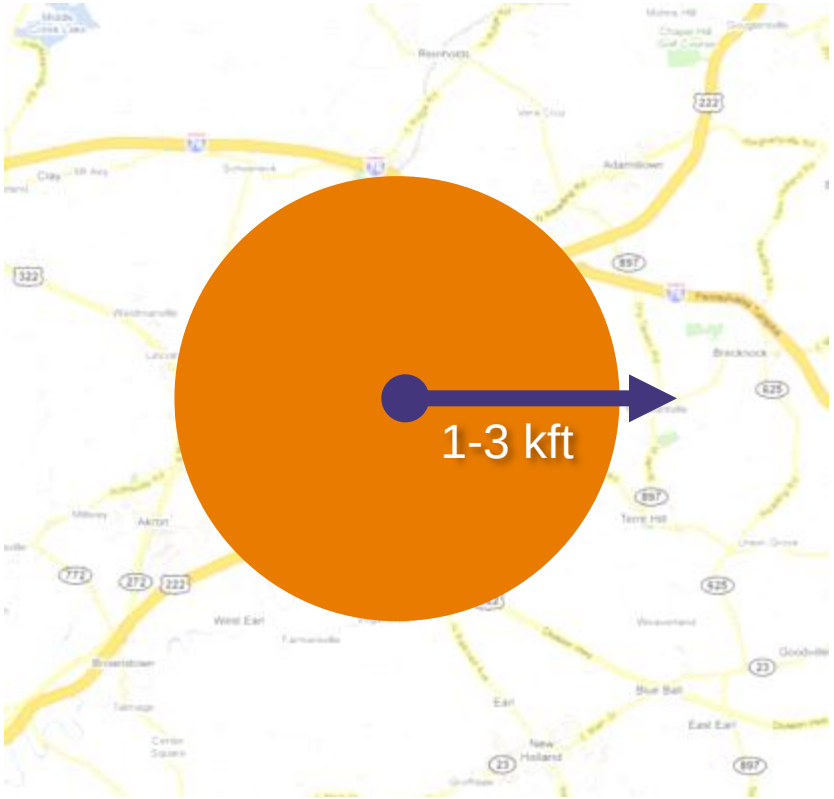


VDSL2 Take Rate Impact on Vectoring



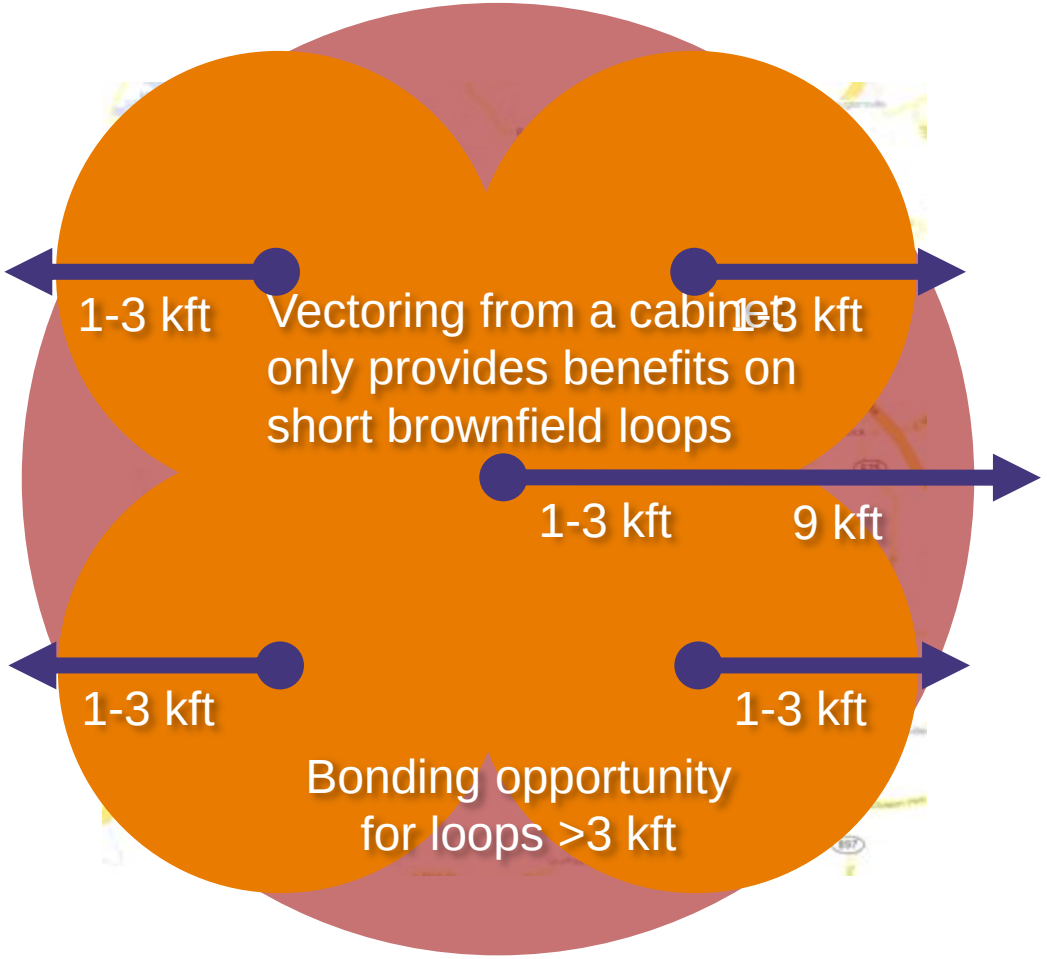
VDSL2 Applications

- **Greenfield** (1-3 kft)
  - New deployments…but these can justify FTTH
  - Short copper loops so bandwidth is optimized
  - Vectoring good to ~3kft



VDSL2 Applications

- **Brownfield** (up to 7 kft)
  - Deployments often served from existing cabinets
  - Density designed to serve high subscriber counts, or subscribers geographically dispersed (multiple binders)
  - Mix of short and long loops
  - Vectoring of no benefit between 3-9 kft
- **Opportunities to improve bandwidth**
  - Bonding on loops longer than 3Kft
  - Shorten copper loops by extending fiber



VDSL2 Deployment Challenges

VDSL2 is a beneficial technology…but faces real-world deployment challenges

- Age of copper plant – may require maintenance upgrade
  - Old splices, bad pairs, water, etc.
- Interferers and ADSL2+ loops reduce benefit of vectoring
  - May require labor intensive binder grooming, plant and record management
- Little benefit on longer loops
  - Bandwidths fall to ADSL2+ and below levels
- Bonding yields rate and reach benefits if pairs are available
  - Pairs are not plentiful enough in many areas to allow for wide use of bonding

Optimal Technology 2013-2018

- VDSL2 short loop lengths (up to 9 kft) satisfy denser areas
- FTTH loop lengths of over 20 miles are optimal for less dense areas
- Wireless and satellite become optimal as housing densities make FTTH less viable economically

	Urban	Suburban/ Rural Towns	Rural 10-100 subs per sq/mile	Rural 2-10 subs per sq/mile	Rural Less than 2 subs per sq/mile
Greenfield or Rebuild	FTTH or VDSL2 w/vectoring	FTTH or VDSL2 w/vectoring	FTTH	Wireless	Satellite
Brownfield	VDSL2	VDSL2	ADSL2+	Wireless	Satellite

Birds Eye View of Example Service Area