

“*STRAP ON YOUR BOOTS*” AND  
**SUCCEED WITH COPPER**

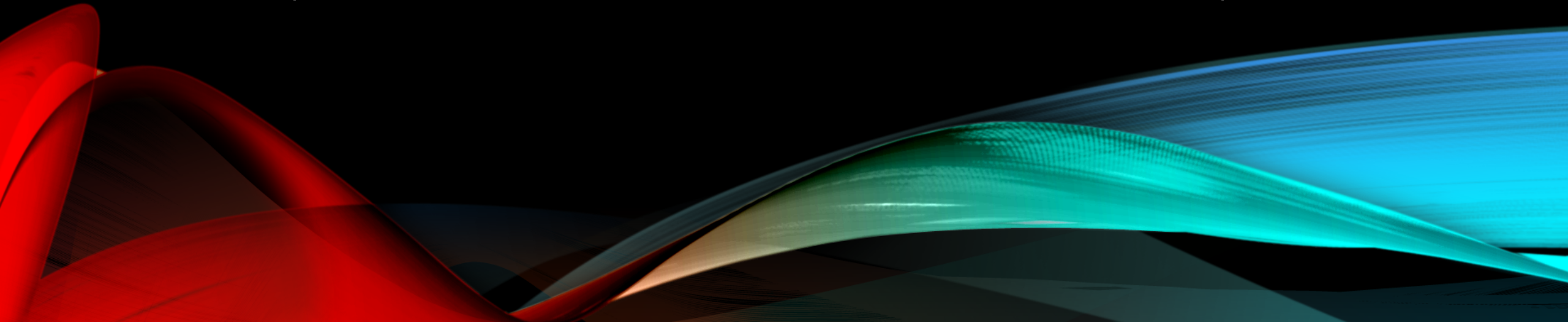
WTA Fall Conference

Wednesday, September 17<sup>th</sup>, 2014

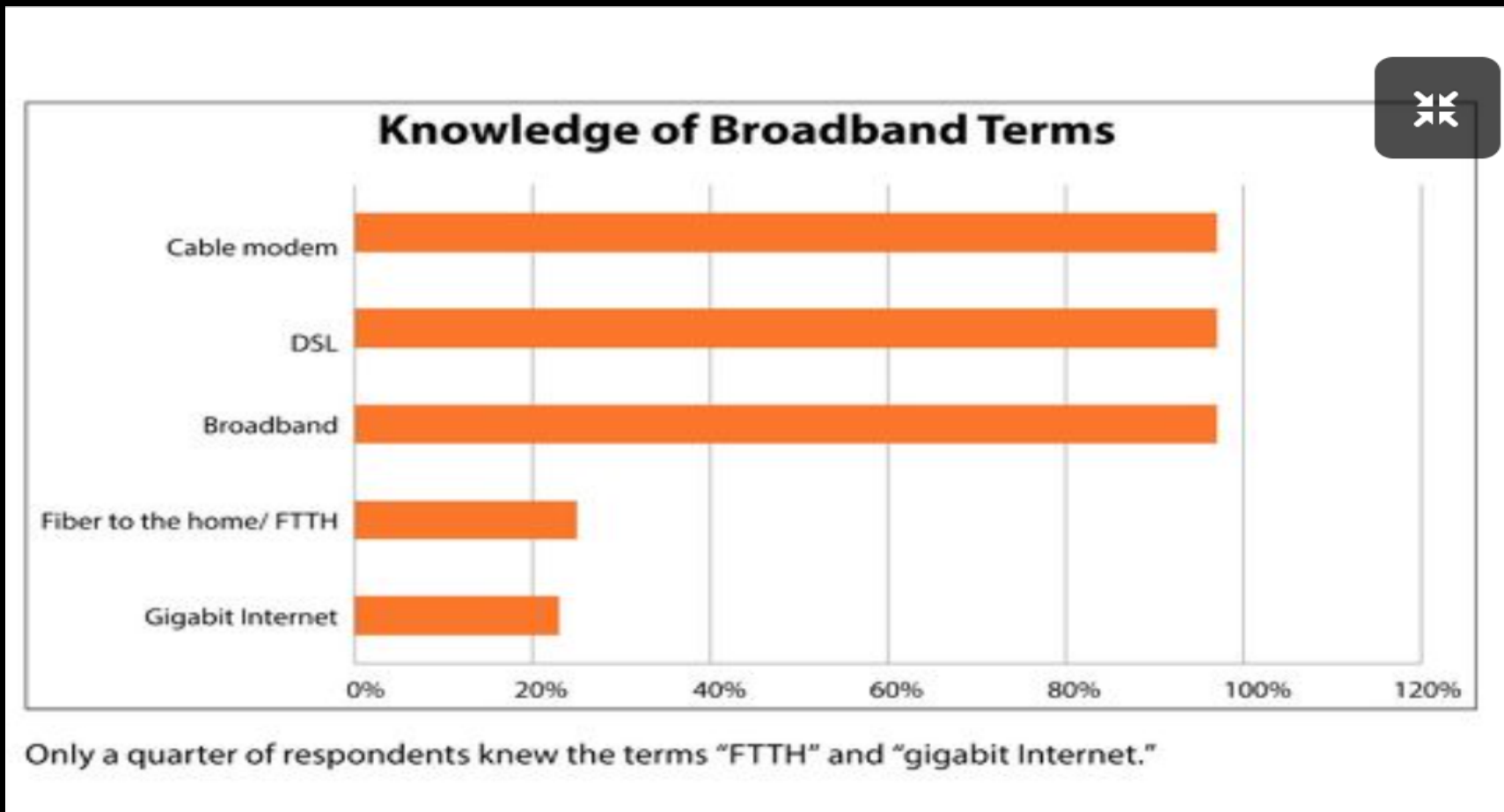
# WHAT DO CUSTOMERS THINK ABOUT COPPER?

ANSWER: THEY DON'T!

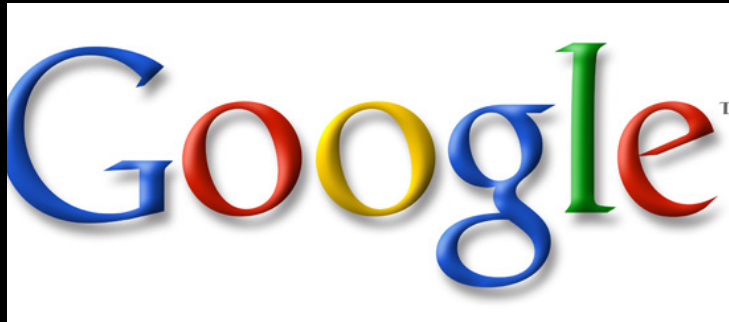
They think about how to connect to the internet and what they can do with it!



# BROADBAND VS. FIBER TO THE HOME



# TOP VISITED WEBSITES SEPT 2014

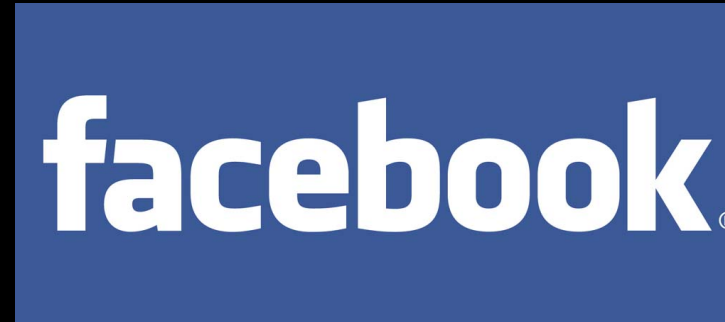


## Search

730,000,000 visits per day

23.5 pages per visit

18:56 minutes daily



## Social Media

630,000,000 visits per day

14.8 pages per visit

27:41 minutes daily



## Sharing Video

460,000,000 visits per day

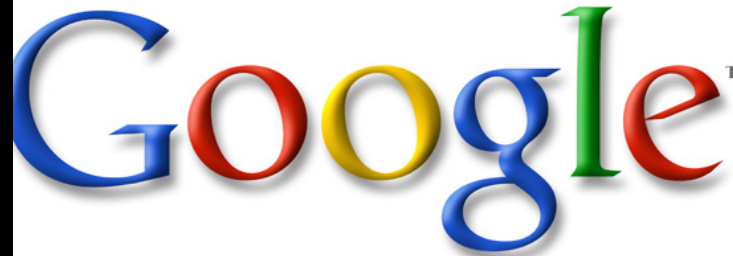
9.1 pages per visit

19:20 minutes daily

# US PEAK INTERNET TRAFFIC GENERATORS FEBRUARY 2014

The Netflix logo is displayed in a bold, white, sans-serif font with a slight 3D effect, set against a solid red rectangular background.

Watch Movies  
32% of all traffic

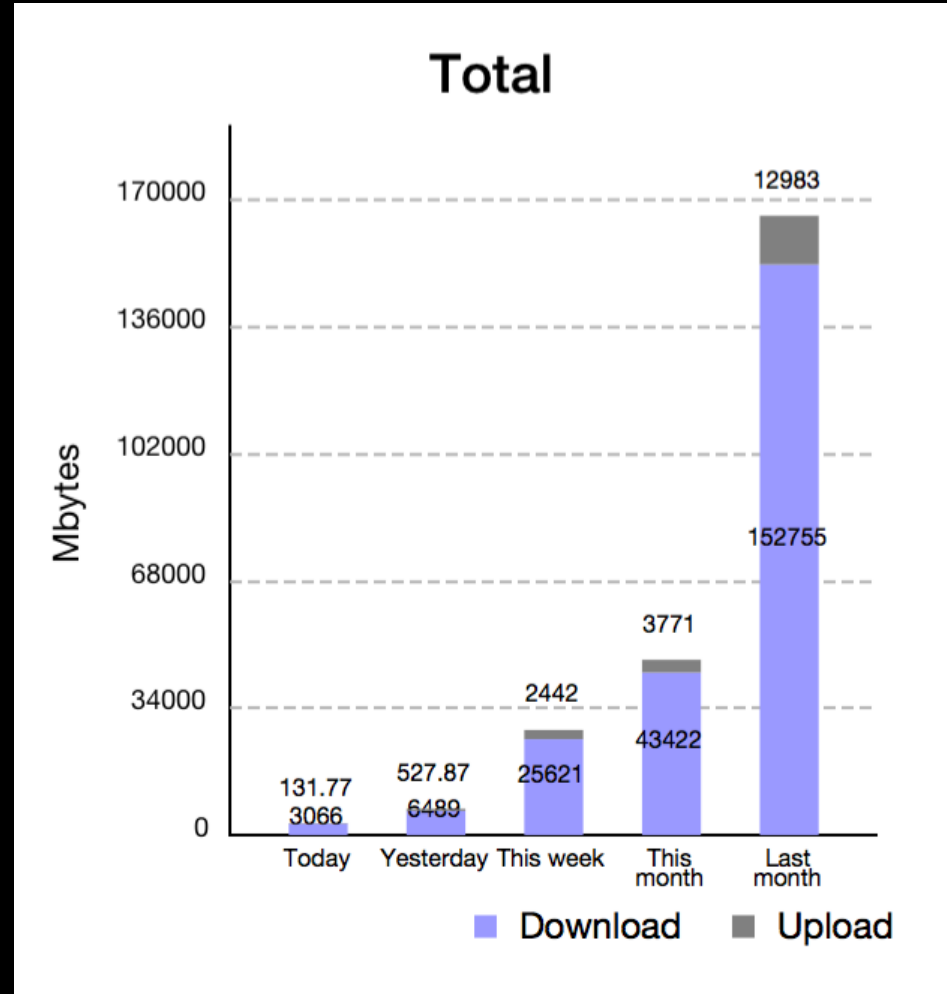
The Google logo is shown in its classic multi-colored font (blue, red, yellow, green, red) with a slight shadow effect, centered on a white rectangular background.

Search for Stuff  
22% of all traffic



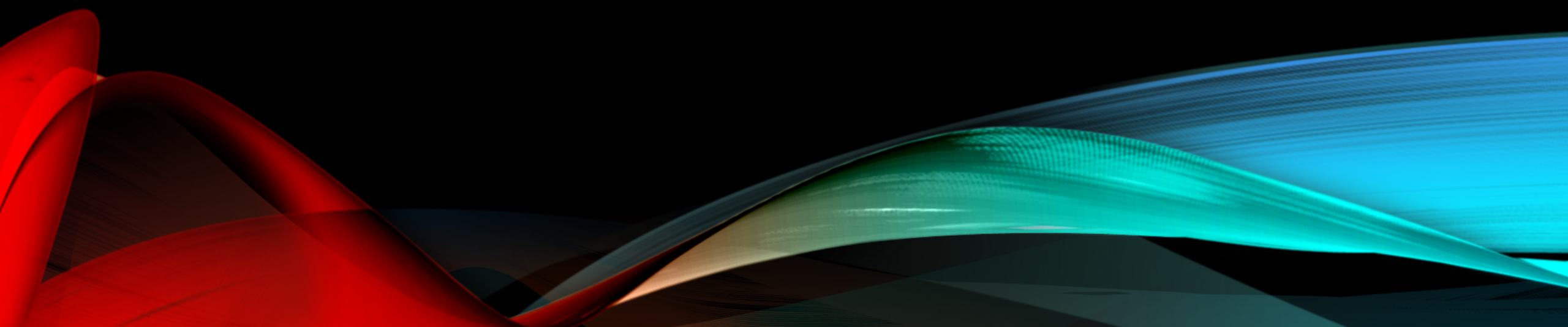
Shop for Apps/Ask Siri  
4.3% of all traffic

# ASYNCHRONOUS STILL DELIVERS!



# BRIEF PRIMER ON ADSL2+ AND VDSL2

Key Facts about using these DSL technologies



# 2004 STANDARDS (ALPHABET SOUP)

## ITU 991.1 and 991.2

- HDSL
- SHDSL

## ITU 992.1 thru 992.5

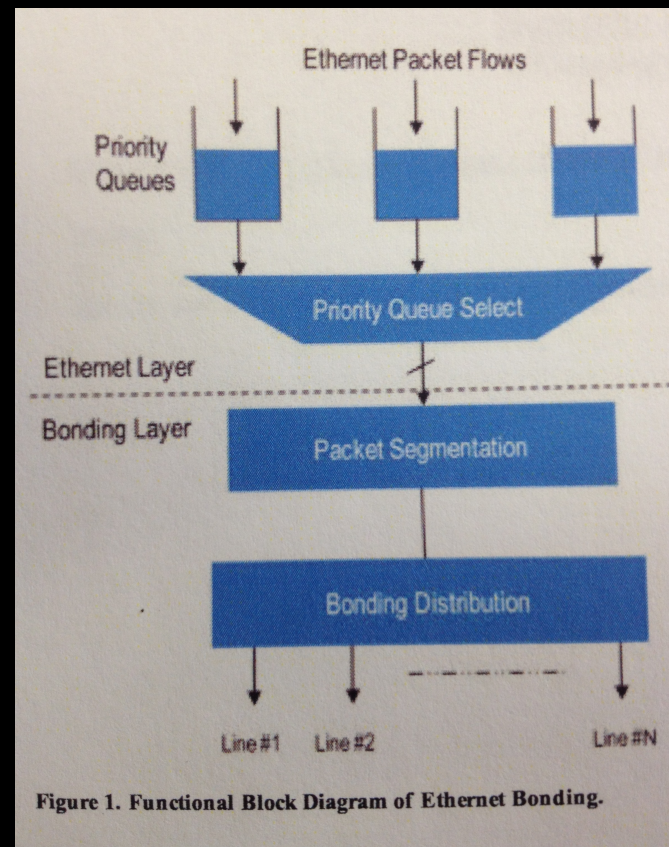
- ADSL (G.dmt)
- ADSL (G.lite)
- ADSL 2 (G.dmt.bis)
  - Bonding  
Introduced
- ADSL 2 (G.lite.bis)
- ADSL 2+

## ITU 993.1 and 993.2

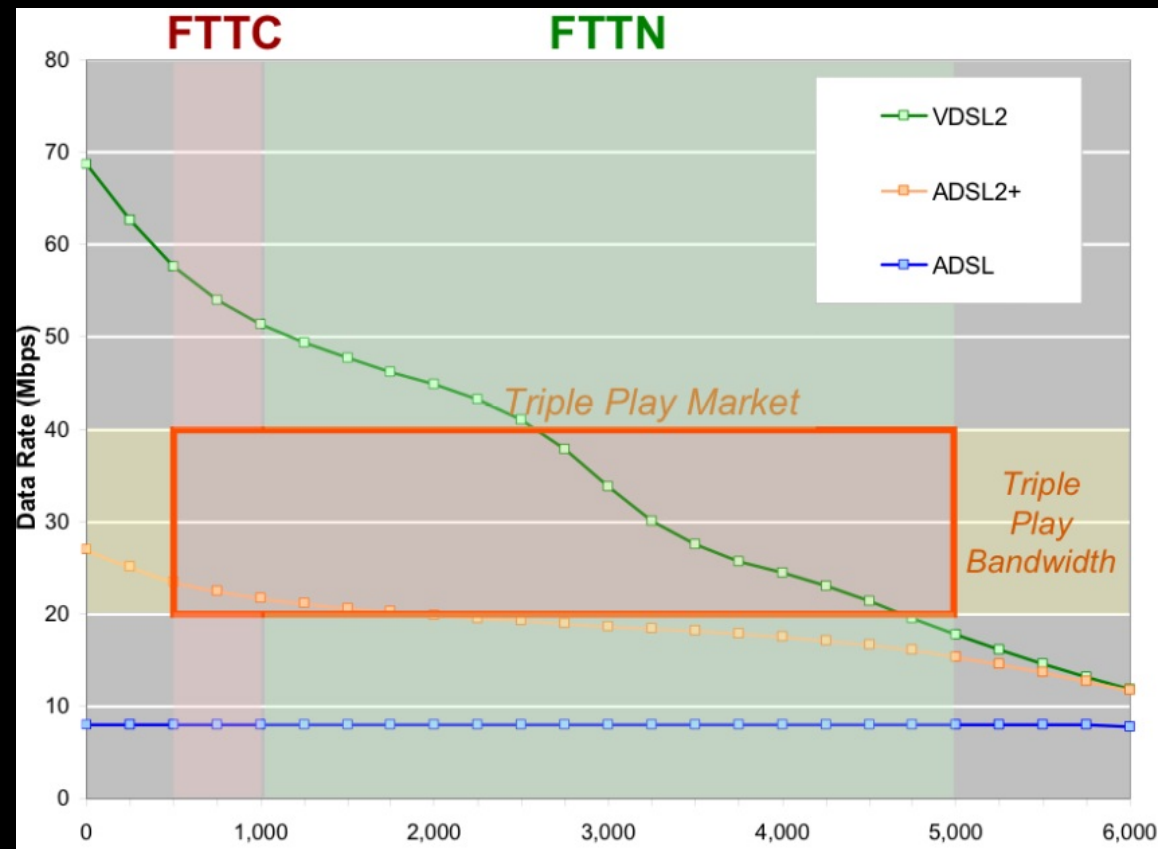
- VDSL
- VDSL 2



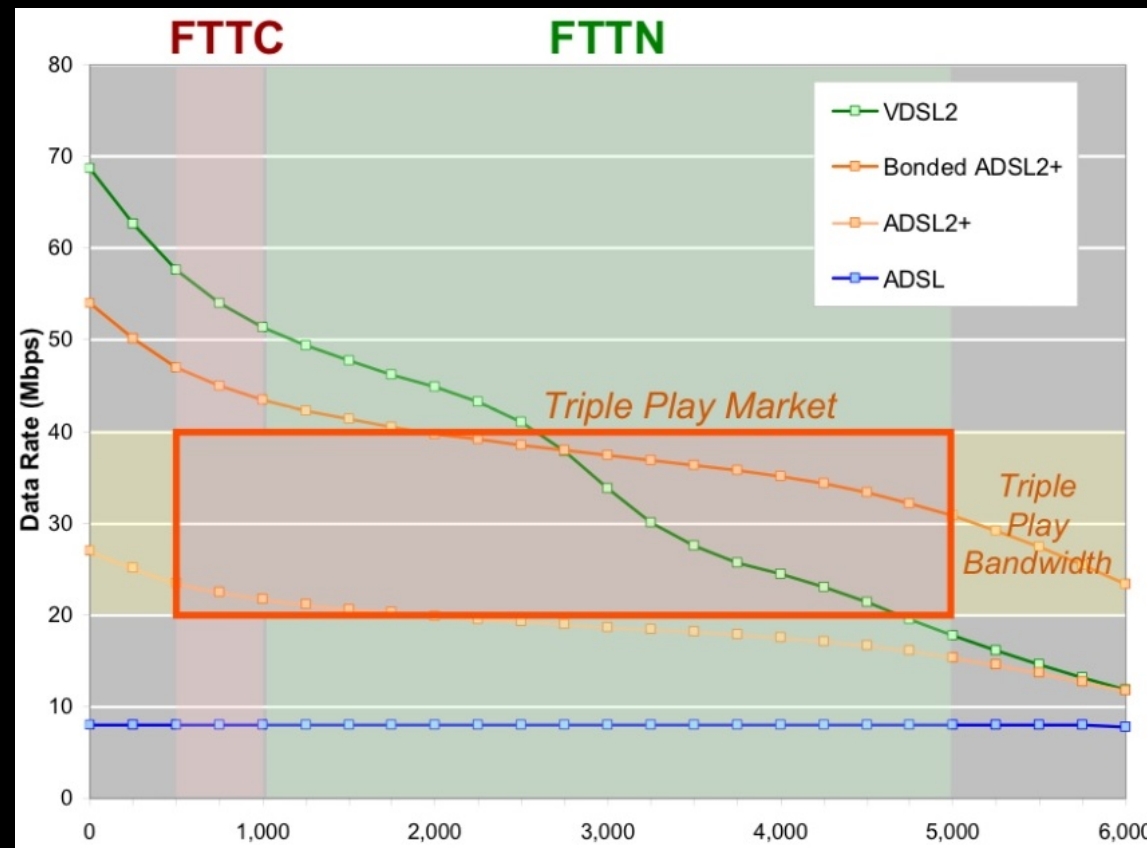
# 2005 ITU INTRODUCES G.998.2 ETHERNET BASED MULTIPAIR BONDING



# START WITH VDSL2 REVIEW



# ADSL2+ WITH BONDING BRINGS OLDER DSL INTO THE VIDEO PICTURE

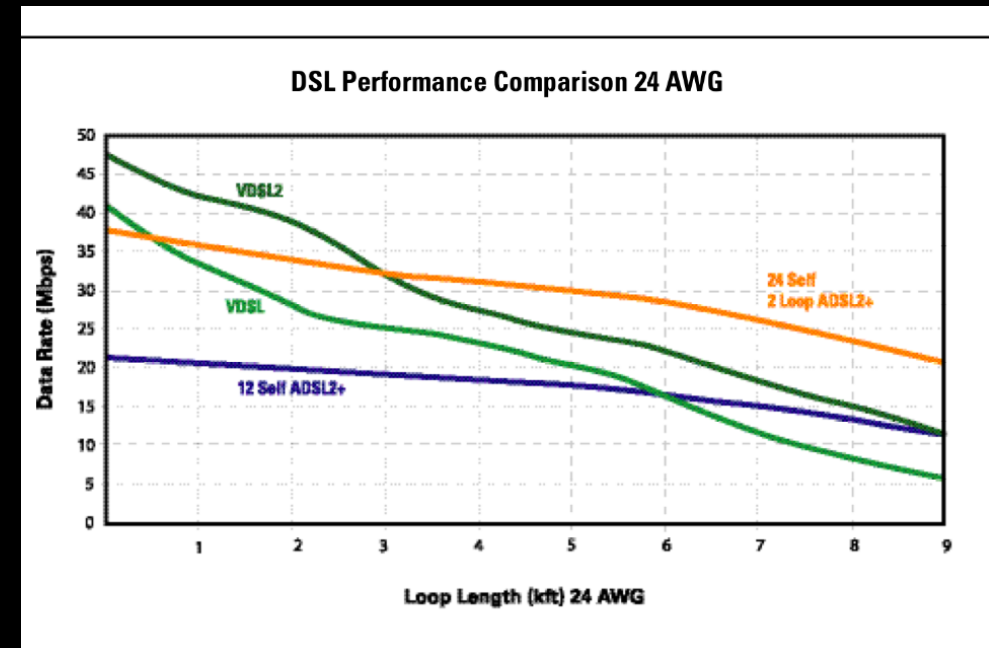
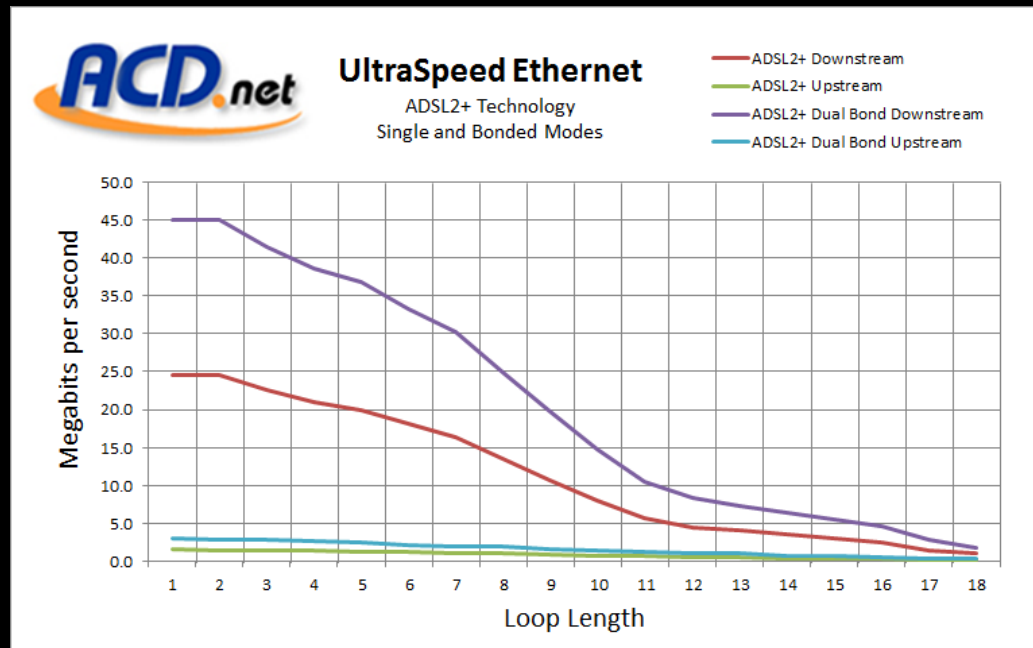




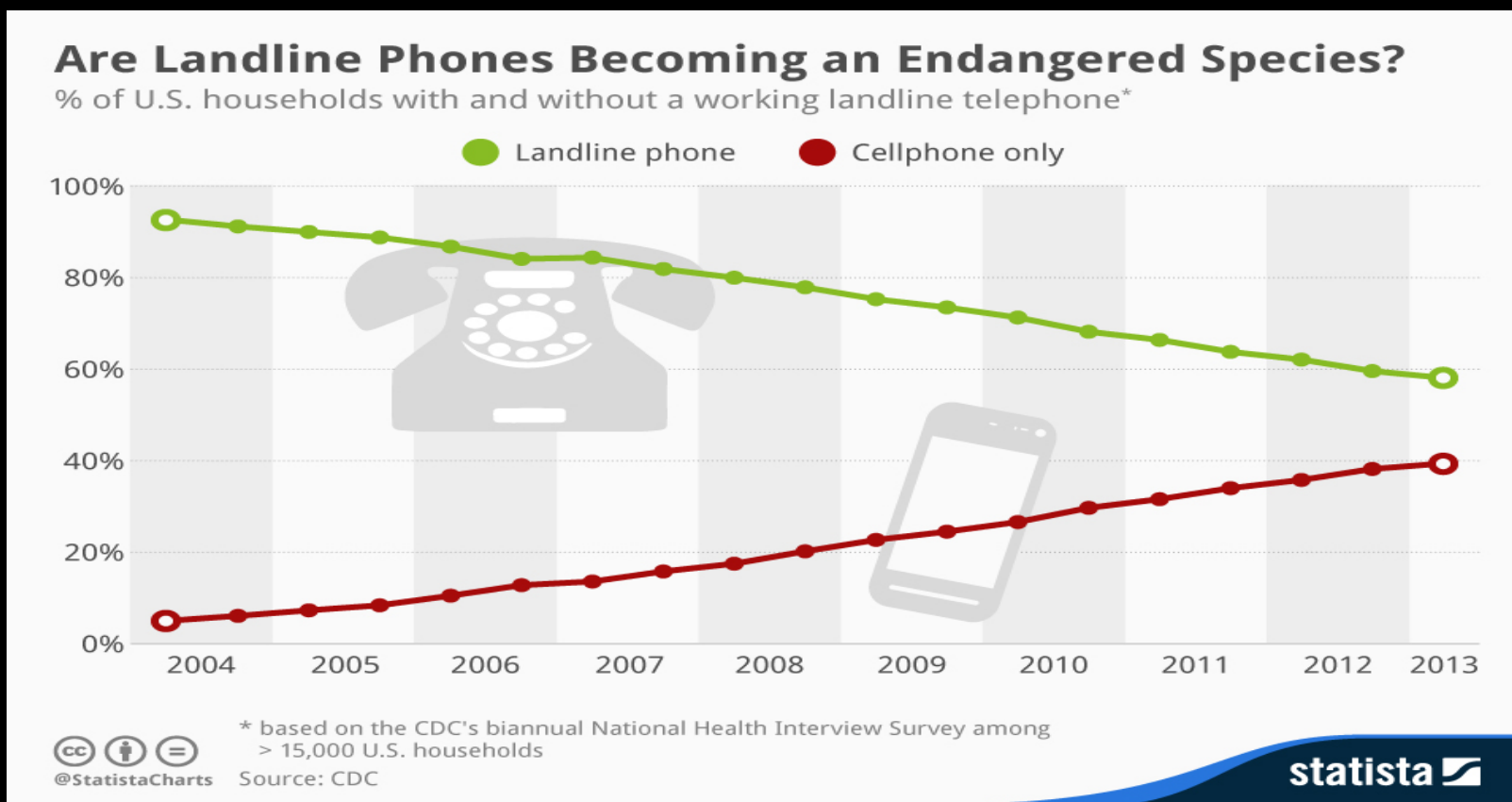
# IMPACT OF GAUGE

## 26 Gauge

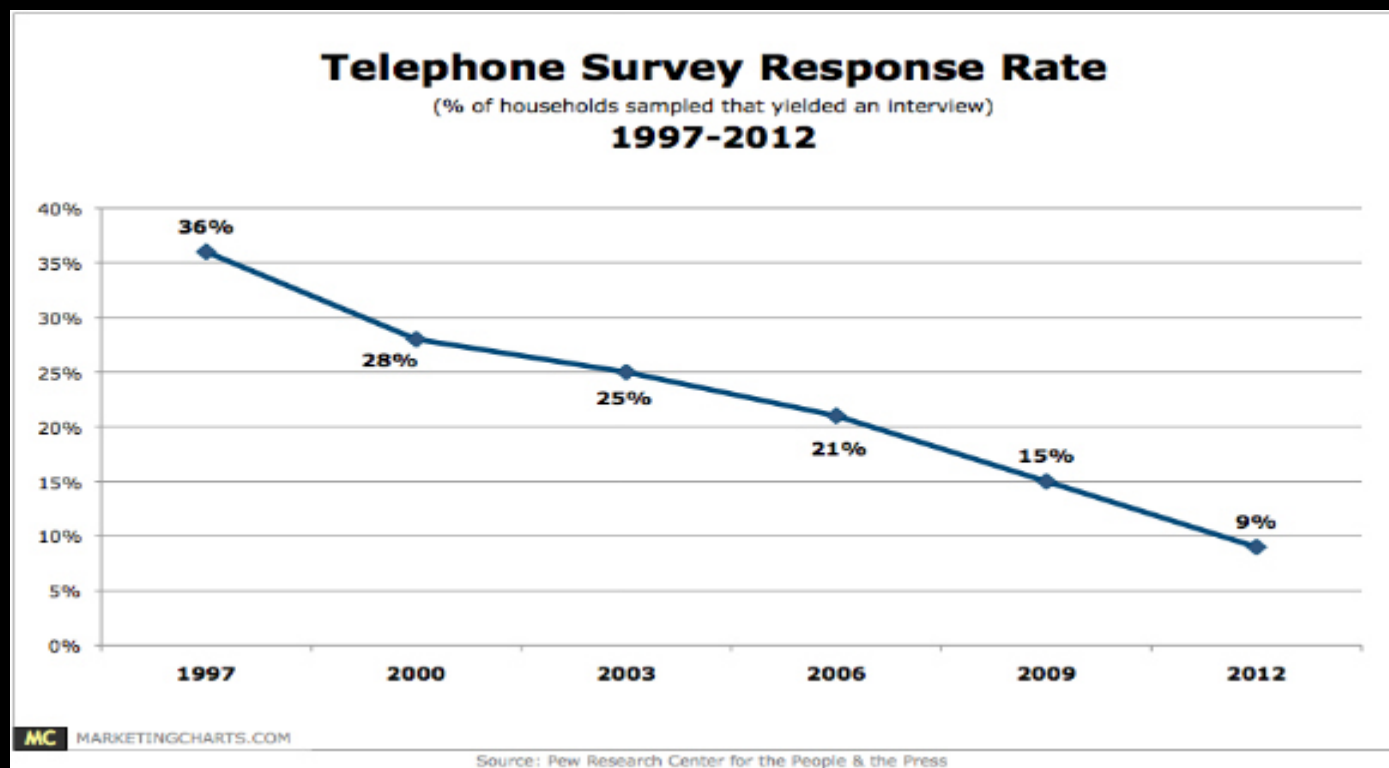
## 24 Gauge



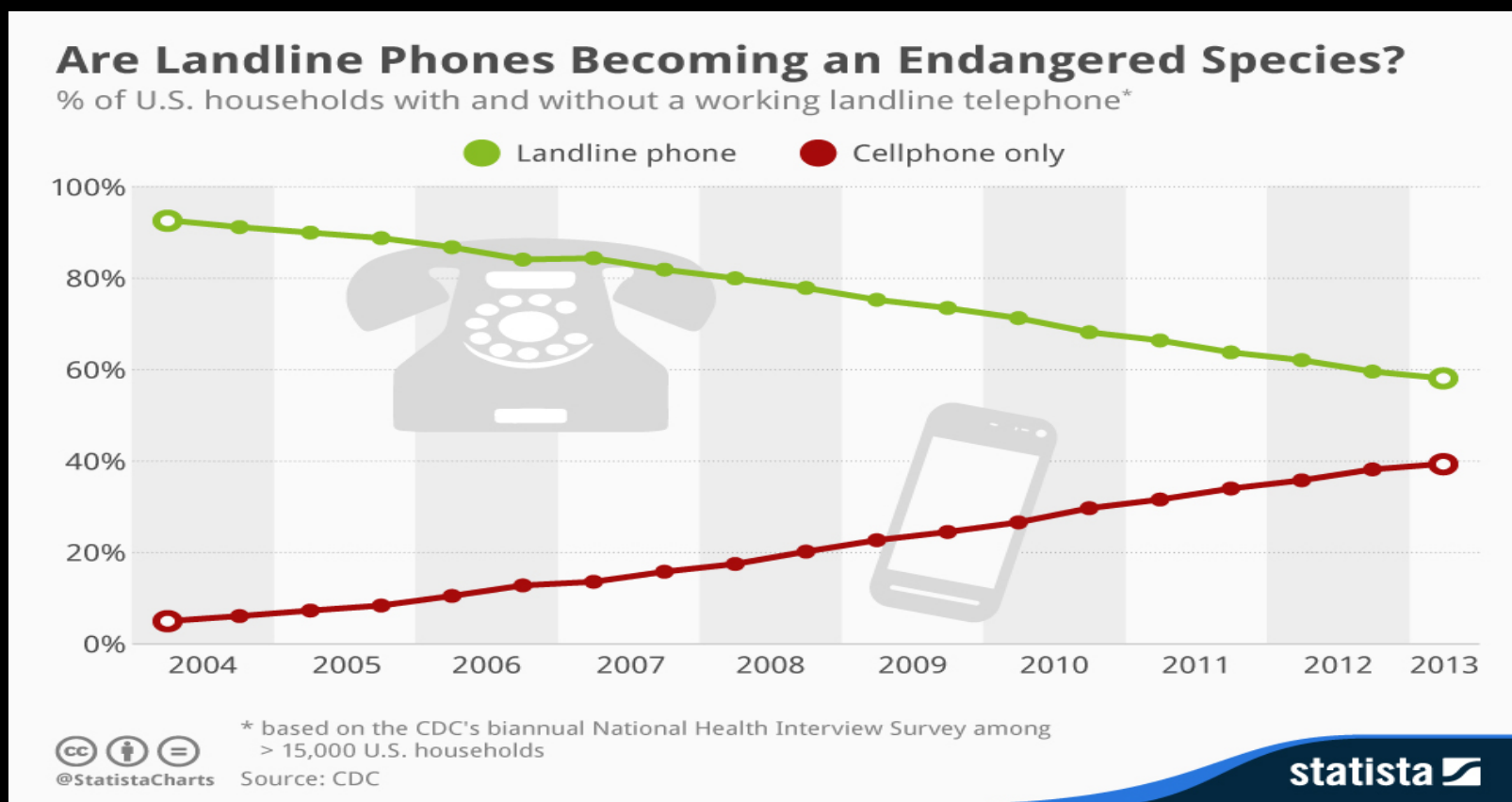
# POTS DECLINE = REVENUE CHALLENGE



# SIDE BENEFIT (LESS SURVEY CALLS)



# POTS DECLINE = SPARE PAIRS FOR BONDING!



# IMPACT OF CABLE SIZE

## 25 pair (or less)

- No 25-pair binder group separation
- A second pair bonded to the first produces a 25% higher bandwidth

## 50 pair (or more)

- Each pair in a different binder group
- A second pair bonded to the first produces 100% higher bandwidth, doubling the speed





# BUYING 2 ADSL LINES IS NOT BONDING!

## Bundling

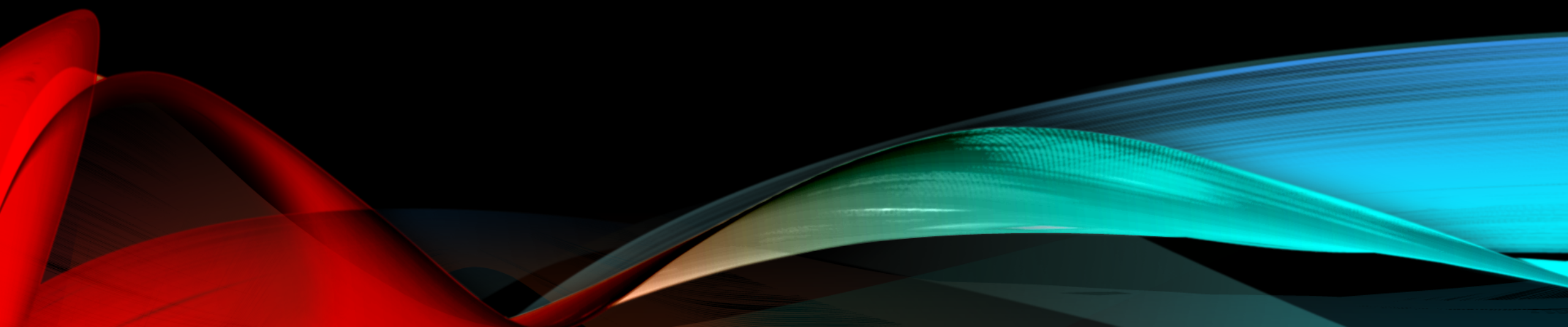
- Shares and load balances two or more connections among many users or applications
- Does not transform 2 – 3 Mb circuits into 1 6 Mb circuit
- Multiple IP addresses cause certain applications to stop working

## Bonding

- Allows multiple users or applications to access a single data stream at the full throughput
- Single IP address
- Bonding handles being at or near full load better than single connections (flooded link)

# VENDOR AND TELCO EXPERIENCE

What is happening in the “Real World”?



## ADTRAN

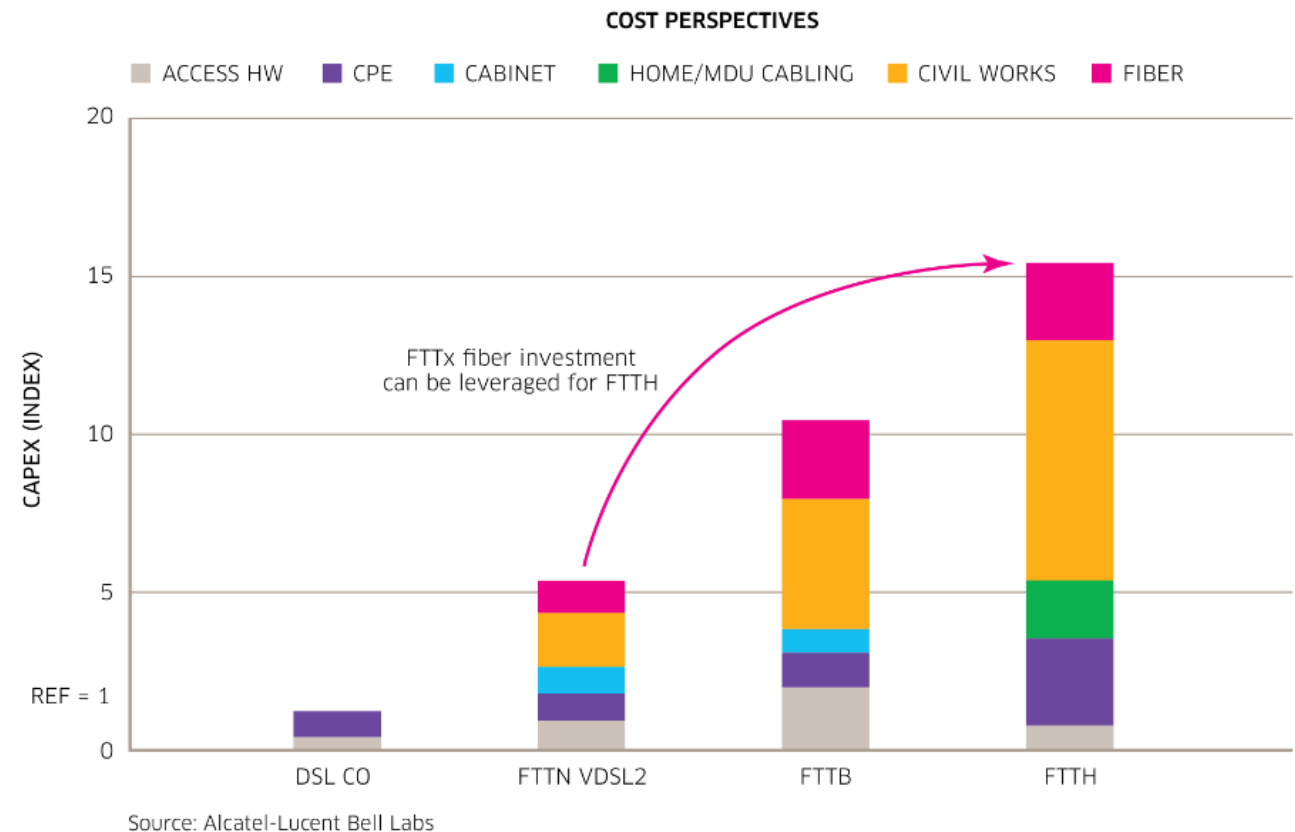
- Like most vendors, started with ATM bonded ADSL2+ on the TA3000
- Now, most customers have evolved to the Ethernet based TA5000 for Bonded ADSL2+/VDSL2/SHDSL/HDSL4/DS-1 type technologies.
- These are used for IPTV type delivery as well as business and residential.
- Main customer use is ADSL2+, VDSL2 and SHDSL.



## ALCATEL LUCENT

- Focuses on FTTN VDSL2 solutions
- Has research showing use of bonded VDSL is about 3 times less expensive
- Hosted by 7330 ISAM FTTN equipment
- Have xDSL modules that support ADSL2+ (ATM) 2 pair bonding or VDSL2 8 pair bonding

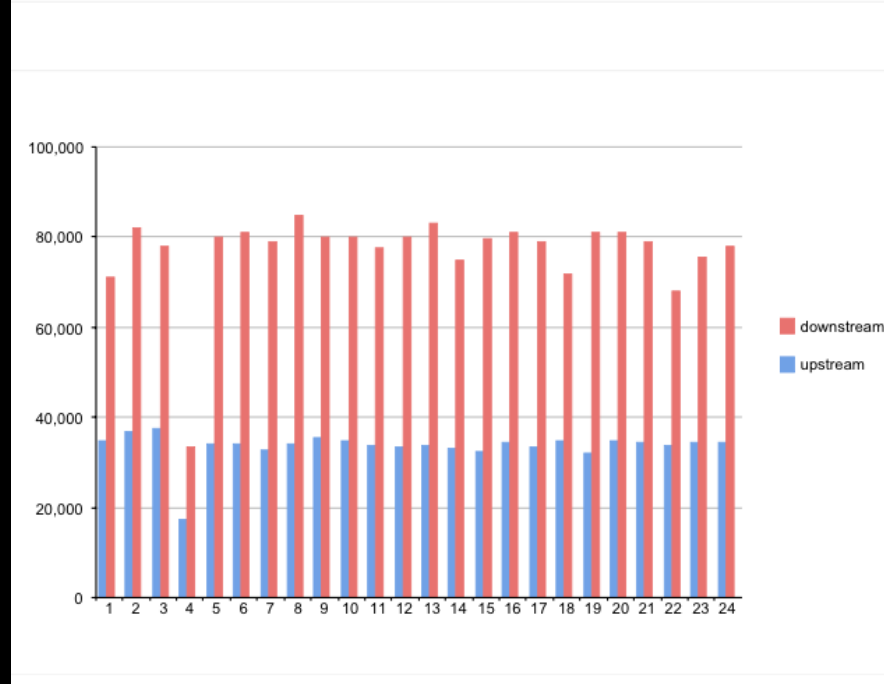
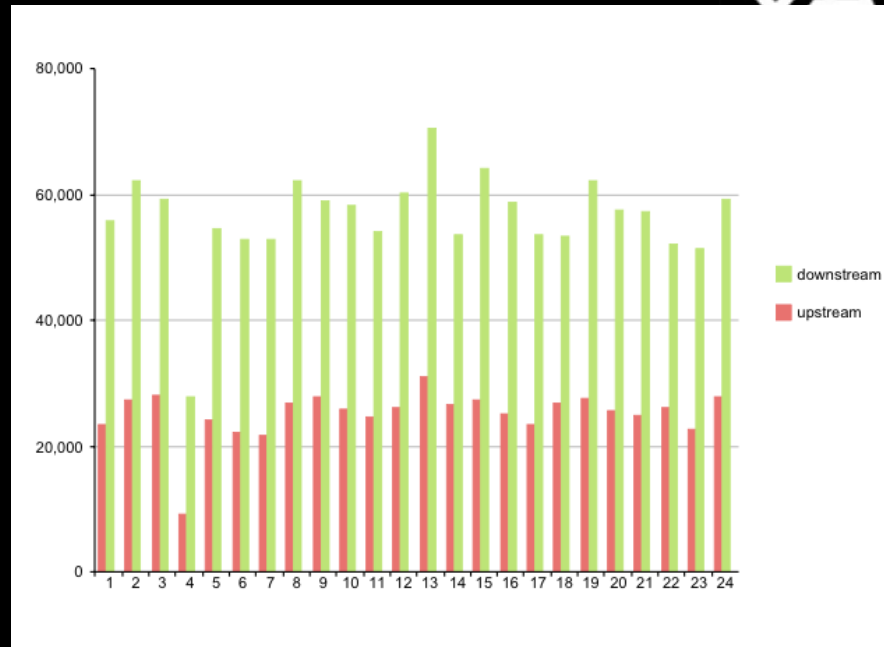
Figure 2. VDSL2 FTTN deployments are much less expensive than FTTH deployments



# CALIX

- Focus is on all IP services over Ethernet to include the large internet over copper subscriber base.
- Bonded ADSL2+ is available over the C and E series of equipment
- Port-for-Port VDSL2 cards can replace ADSL2+ with ADSL 2+ fallback on the C7 platform.
- Real world testing this year with VDSL2 Noise Cancellation technology called Vectoring
- VDSL with Vectoring boosts throughput!

Vectoring Data provided by Jerome Day, Calix



## HUAWEI

- DSLAMS support bonding
- MA5600 – four –pair G.SHDSL.bis
- MA5662 – any of the 48 ports can be bonded together
- MA5603U – The VSDL2/ADSL2+ interfaces supports bonding
- Migration strategy to G.Fast (1Gb over copper)



# ZHONE

- Their IP platform is the MXK
- Their customers have renewed interest in looking into ways to shorten loops and provide higher bandwidth via VDSL and/or bonded solutions.
- Zhone features single rack unit DSLAM products for bonding applications.
- Zhone offers both the bonding line cards as well as the modem.

6728-W1 CPE											
VDSL2 AA8d Profile Interleaved Channel (Noise per TR-114)											
Loop Length	Down Rate (Actual)			Down Margin		Up Rate (Actual)			Up Margin		Noise profile
	Port 1	Port 2	Total	Port 1	Port 2	Port 1	Port 2	Total	Port 1	Port 2	Loop length (ft)
250	46307	40404	86711	6	6	7667	6749	14416	6.1	6.3	300
500	46335	41267	87602	5.9	6.1	7357	6015	13372	6.1	6.2	500
1000	46363	36255	82618	5.9	6.0	7420	6449	13869	6.1	6.1	900
1250	45890	36255	82145	6	6.0	6980	6231	13211	6.3	6.3	1200
1500	45946	37397	83343	5.9	6.0	7203	6342	13545	6.0	6.3	1600
2000	45416	34779	80195	5.9	6.0	6704	5970	12674	6.1	6.3	2000
2500	43773	30575	74348	6	6.1	6756	6225	12981	6.1	6.2	2400
2750	40710	31354	72064	6	6.0	6795	6179	12974	6.3	6.1	2800
3250	32329	24552	56881	5.9	5.9	5038	4323	9361	6.4	6.3	3200
3500	29962	24246	54208	5.8	5.9	4350	3609	7959	6.5	6.3	3600
4000	25307	20120	45427	6.4	5.9	2095	1736	3831	6.5	6.3	4000
4500	24775	18111	42886	6.1	6.1	957	934	1891	6.0	6.0	4500
5500	18114	12424	30538	6.1	6.0	952	839	1791	6.2	6.3	5500
6500	14208	9357	23565	5.9	6.9	878	849	1727	5.9	6.1	6500
7500	13319	9776	23095	5.5	8.0	762	911	1673	5.9	6.2	7500
8500	10547	7380	17927	6	7.6	907	1096	2003	6.4	6.3	8500

Interleaved Channel									
Loop Length	Down Rate						Down Margin		
	Max Attainable			Actual			Port 23		Port 24
	Port 23	Port 24	Total	Port 23	Port 24	Total			
100	24304	24396	48700	20730	20789	41519	9.6	9.1	
400	23740	24240	47980	20263	20716	40979	10.1	9.4	
1000	23912	24372	48284	20263	20782	41045	9.9	8.9	
2000	23680	23792	47472	20263	20263	40526	8.9	9.2	
3000	22632	24832	47464	19413	19349	38762	10.1	8.8	
4000	22080	21488	43568	19095	18562	37657	9.4	8.5	
5000	21352	19532	40884	18269	17082	35351	8.8	7.8	
6000	19752	17528	37280	16850	15546	32396	8.2	6.8	
7000	17496	15120	32616	15427	13373	28800	7.4	6.5	
8000	15160	12052	27212	13516	10714	24230	7.0	6.2	

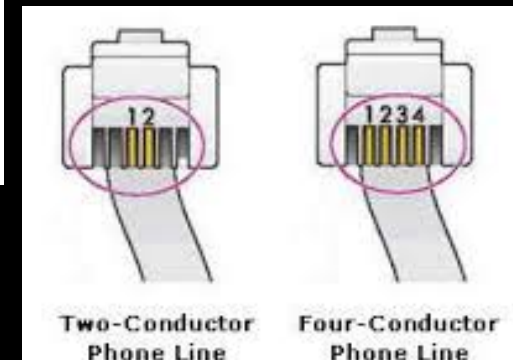


# BONDED NETWORK IS SIMPLE FOR THE CUSTOMER

Install and test second line  
from the CO or RT DSLAM



Bonding Modem Customer  
Premise





## COMPANY #1

A Rural Telephone Cooperative in Ky  
2,300 customers on ADSL 2+ bonded  
video

307 customers on ADSL 2+ bonded 15/2  
Internet

- Longest copper loop 11,000 feet
- All 24 Gauge
- TV Service
  - HD requires 8 Meg
  - SD requires 3 Meg
  - 15% overhead expected
- Formula = over 5,000' and > 10 MEG required  
BOND 2 PAIRS Same Binder Group
- Have Comtrend, Zytel and VisionNet Bonded  
ADSL Modems in their network.

## COMPANY #2

One wire-center company in Indiana  
700 access lines

- Adding 12 cabinets to reduce footprint to 6000 ft loops
- Using all VDSL2 in their network
- Using bonding to pick up customers that fall outside that radius
- Spending less than if they did FTTH for 70 (10%) of their customers

## COMPANY #3

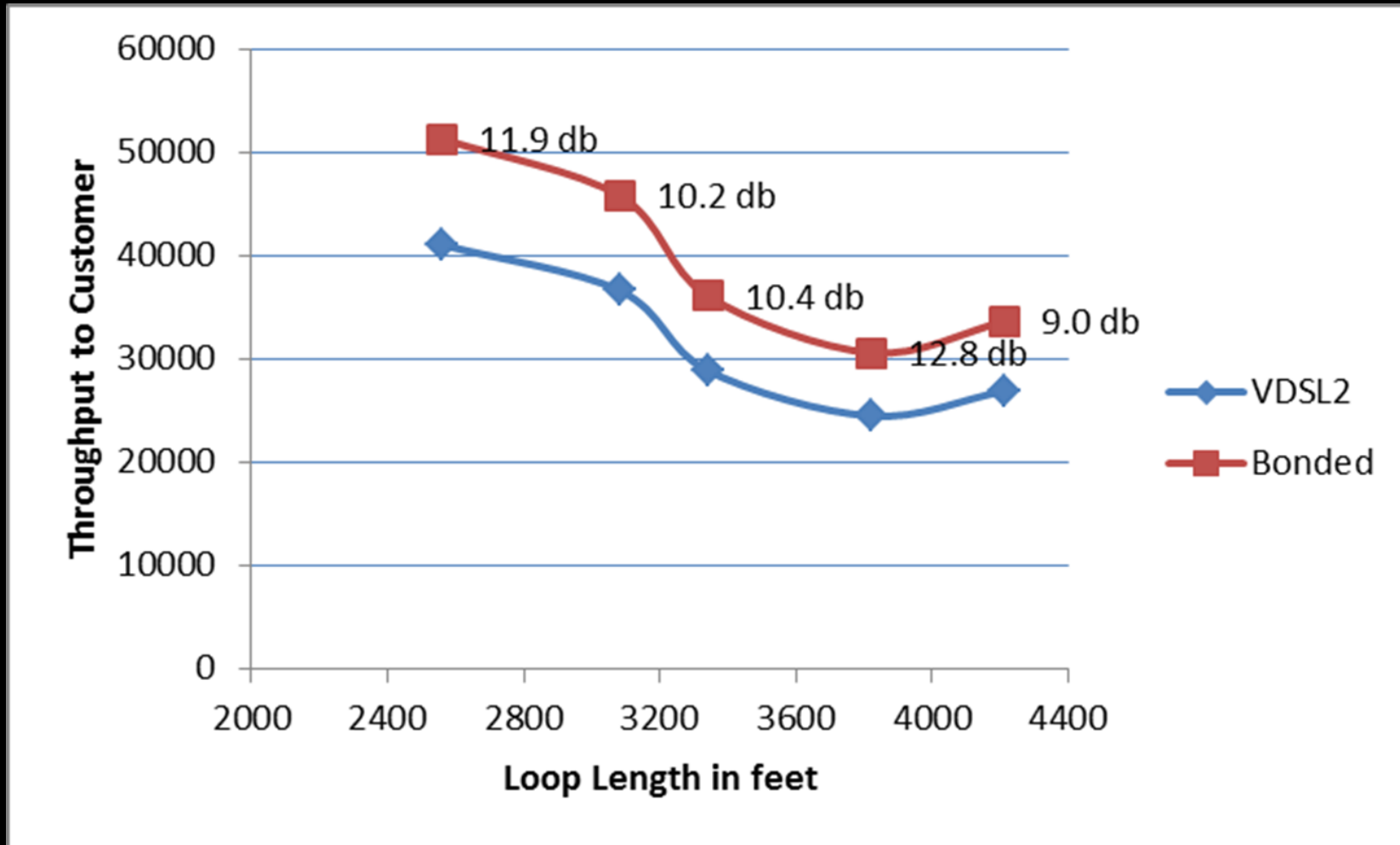
Family owned Illinois Company

Network:

- First 1 to 3Kft is 26 Gauge pressurized air core, and rest is 24 Gauge filled.
- Deployed over 1000 lines with ADSL, then migrated to VDSL2 for short loops, and bonded ADSL2+ for longer loops.

- Longest Bonded ADSL 2+ loop is 14Kft, throughput delivered to customer is 9.3M down.
- Bonded pairs are in same binder group.
- Measurement data shows “line rate” at 8.8 M each line (7.5 M with overhead), with 4.65 M usable each line.
- Use a 9 db Minimum standard
- 40 of 400 video customers are bonded ADSL2+
- Average throughput delivered to customers at 4000’ on 5 tested lines.

# VDSL2 BONDING PERFORMANCE



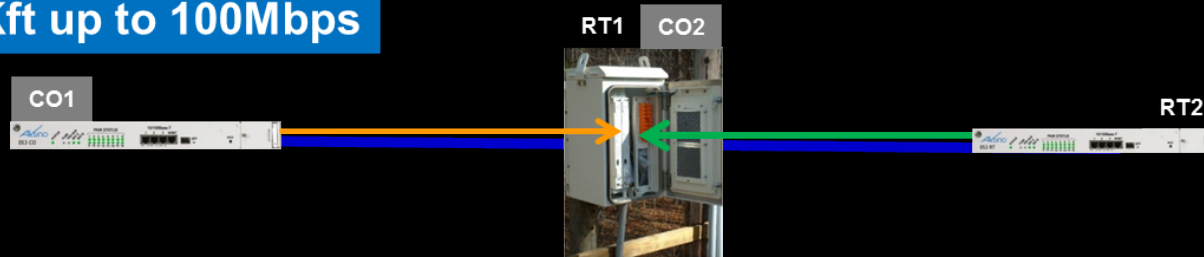
## UK/AUSTRALIA

- Evolving Networks
- Fusion
- Published testing completed in April of 2014
- Advertise Bonded ADSL 2+ services
- If the cable pair is properly deployed, the technology delivers as promised!



# BONDING ON THE CO SIDE UP TO 16 PAIRS

8Km / 26Kft up to 100Mbps



14.7Km / 47Kft up to 100Mbps



# SUMMARY OF BONDING

- Take advantage of vacated, high-gauge copper in your distribution network
- Get with your equipment vendor and review their bonding solutions for your remote cabinets.
- Don't forget to investigate pair bonding to increase speeds back to the Central Office as well.
- Talk to Telcos that have deployed bonding successfully with your equipment vendor.
- Test every pair and expect results to vary across a route or office.
- Selling bonded ADSL services over IP increases revenue on your embedded network to help you fund fiber build out.
- Train and Educate your customers on the Services you offer not the access method!

# YATES

ENGINEERING SERVICES LLC

Bart Bretsch, President  
2536 W Industrial Park Dr, Suite #1  
Bloomington, IN 47403

Phone 812-333-7335  
Cell 812-219-6366

Thank you for your time and attention!!

