OPEN template

Vplus

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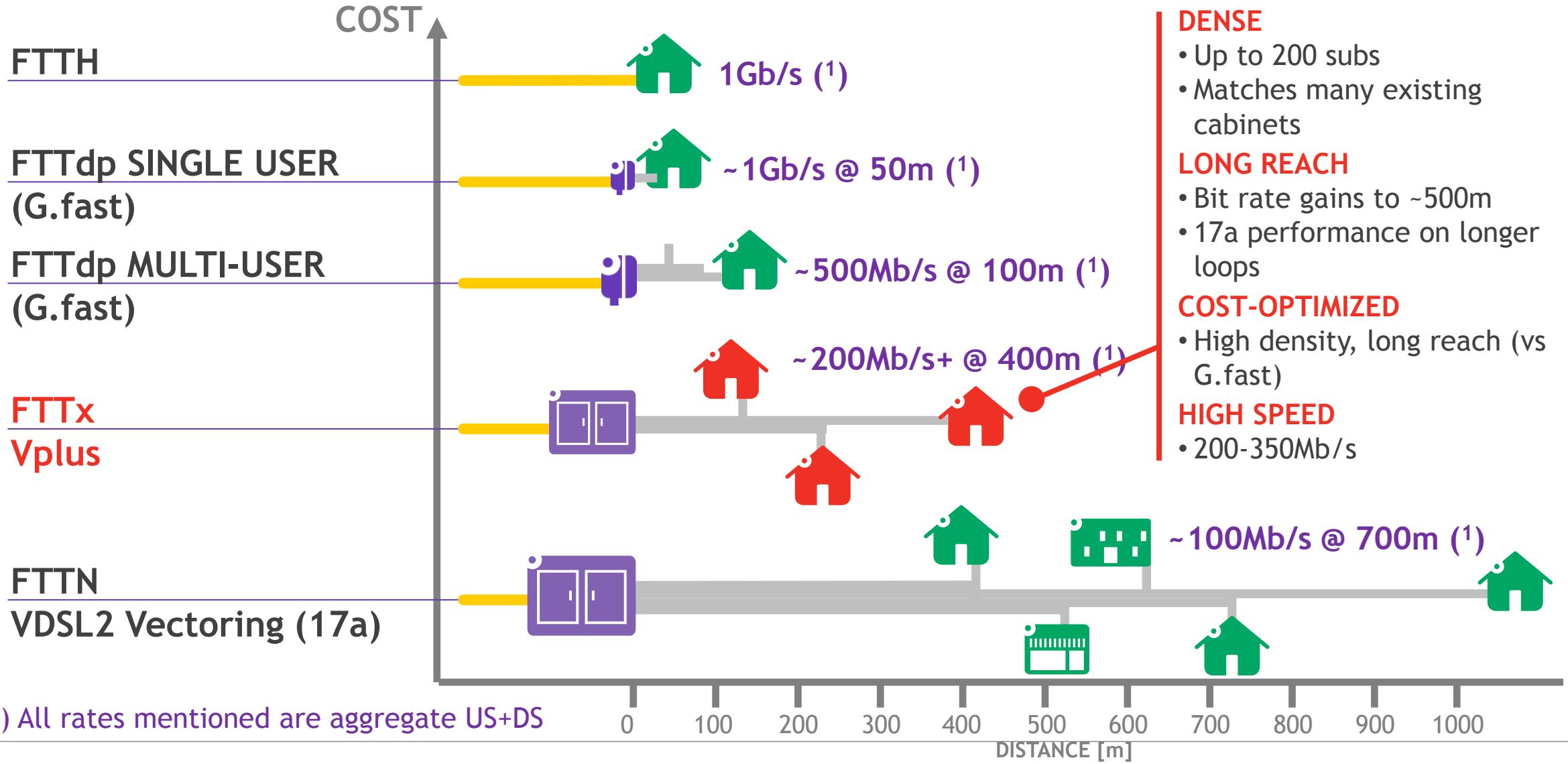
Ultra-broadband technology options – Vplus



DENSE
- Up to 200 subs
- Matches many existing cabinets

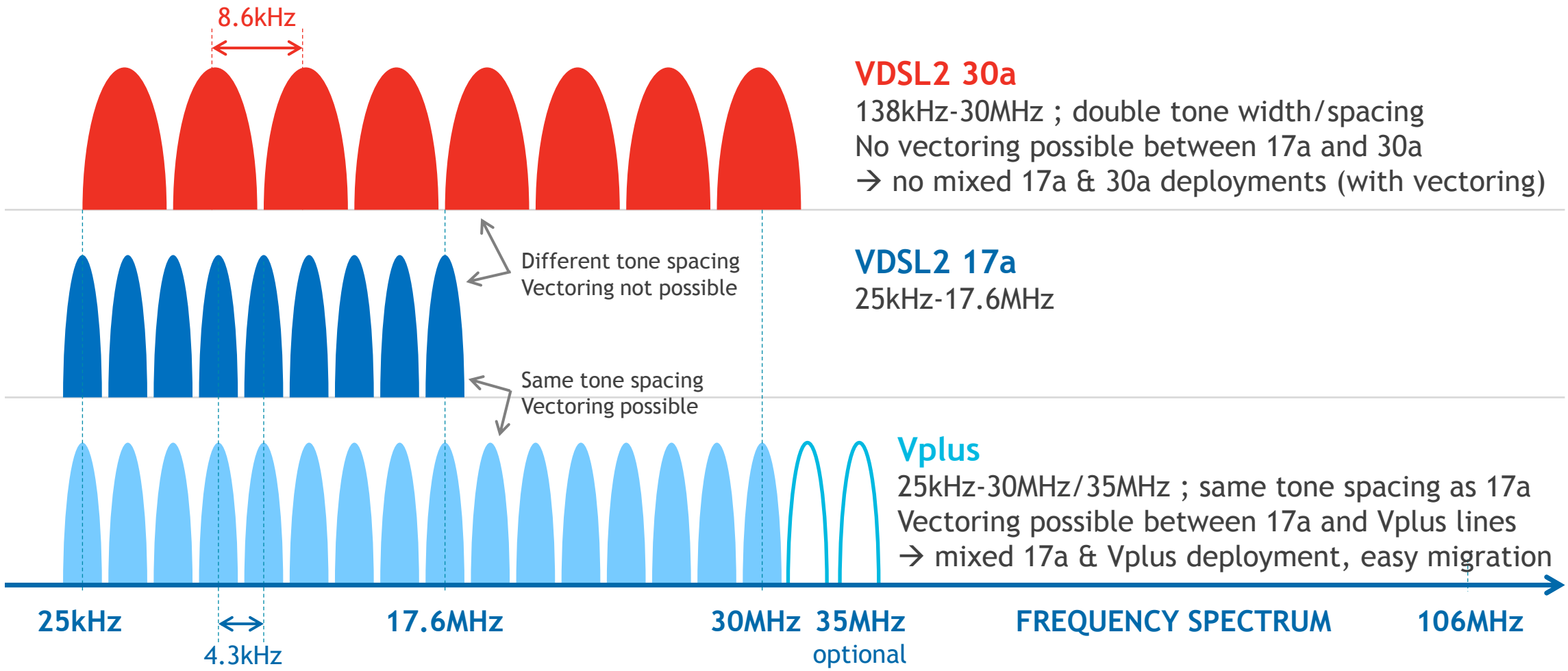
LONG REACH
- Bit rate gains to ~500m
- 17a performance on longer loops

COST-OPTIMIZED
- High density, long reach (vs G.fast)

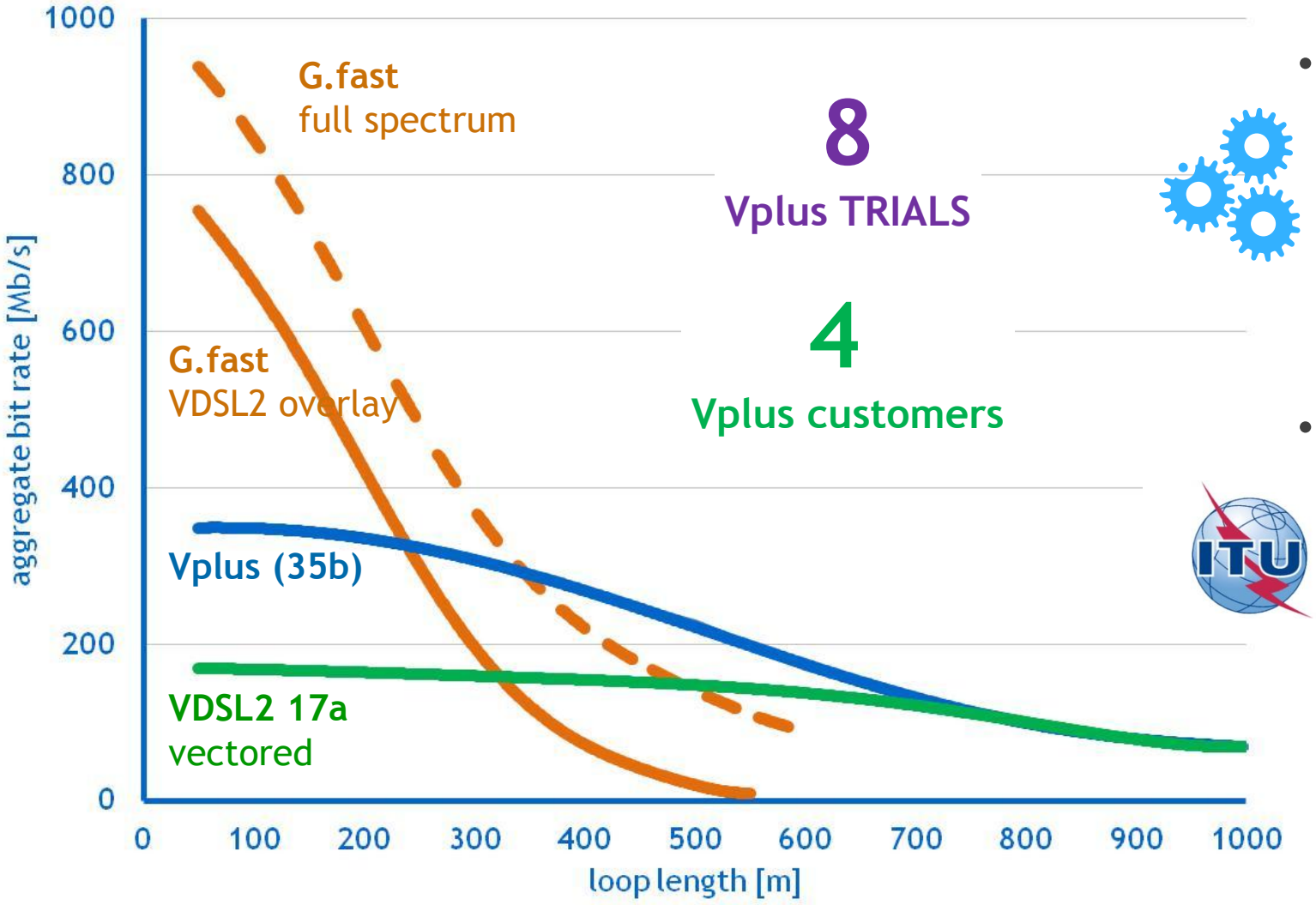
HIGH SPEED
- 200-350Mb/s

(1) All rates mentioned are aggregate US+DS

Vplus allows mixed vectoring with VDSL2 17a, VDSL2 30a does not



Vplus fills the gap between VDSL2 vectoring and G.fast



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Vplus TRIALS

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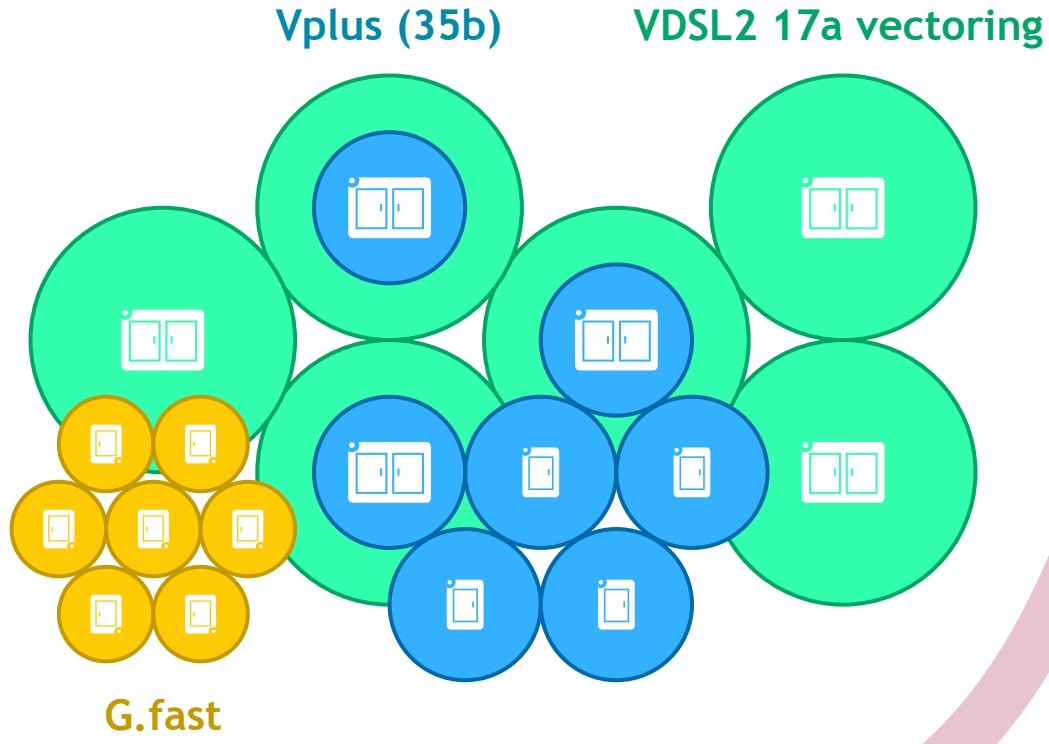
Vplus customers

- Vplus advantages
  - Can be mixed with existing VDSL2 17a vectoring deployment
  - Longer reach and higher density than G.fast
  - Cost optimized for FTTN/FTTcab
- Vplus standardization in final phase
  - Described in Annex Q of VDSL2 standard (G.993.2) as profile '35b'
  - G.993.2 Amd.1 reached consent in July
  - Amd.1 includes VDSL2 profile 35b (Vplus) and related changes to band plans and Limit PSD Masks (Annex B)
  - Approval expected in November 2015

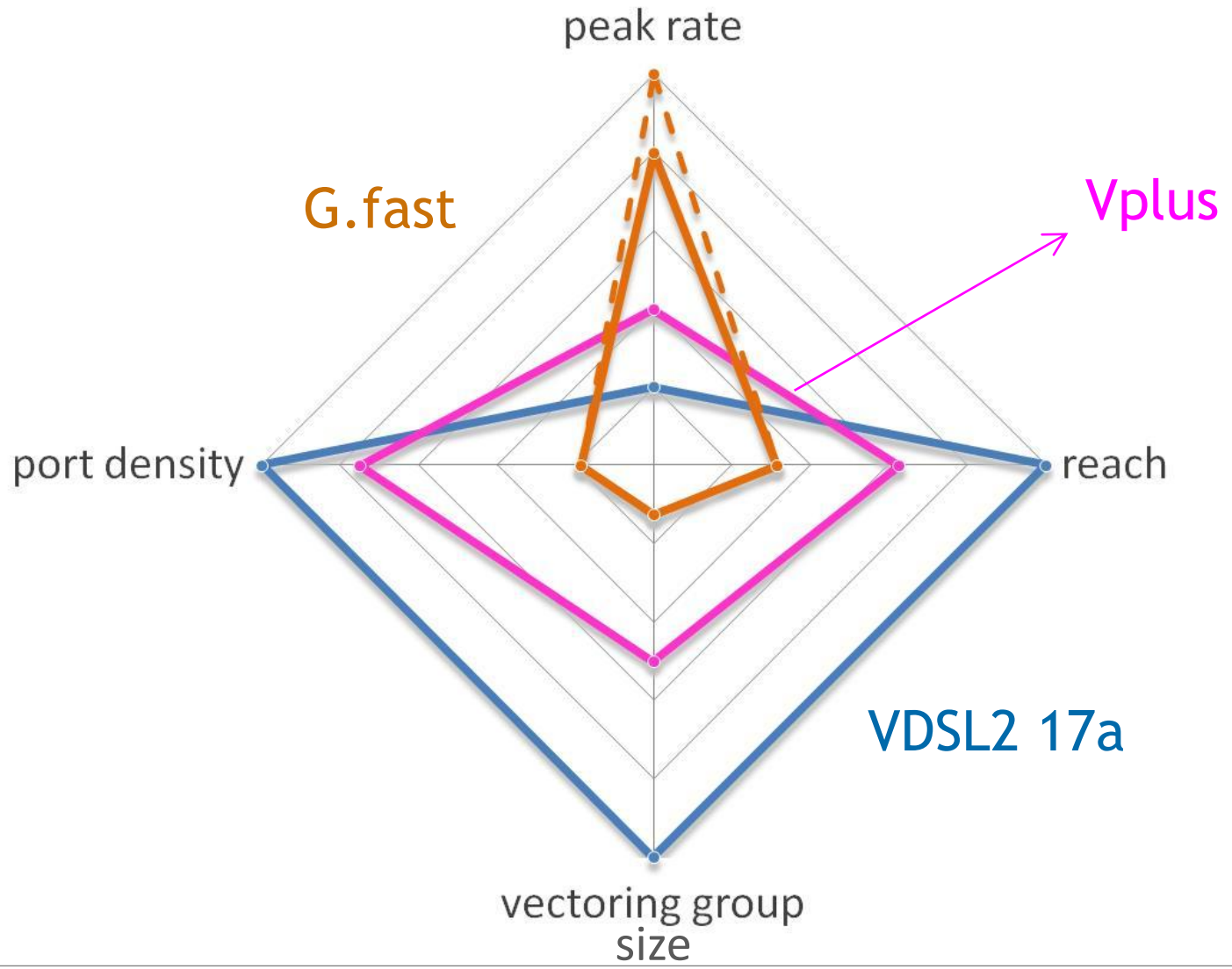
Choosing the right technology

	17a	Vplus	G.fast
Short loops (≤250m)	✔	✔✔	✔✔✔
Medium loops (≤500m)	✔✔	✔✔✔	
Long loops (>500m)	✔✔✔	✔✔✔	
Density (max subs)	400p	200p	16-48p
Outside plant costs	$	$$	$$$$
Standards	✔	consented (2)	✔(1)

(1) Amendment 1 (mandatory) consent reached in July 2015
(2) VDSL2 Annex Q (Vplus/35b) consent reached in July 2015



Choosing the right technology



Vplus standardization (ITU Q4/15)

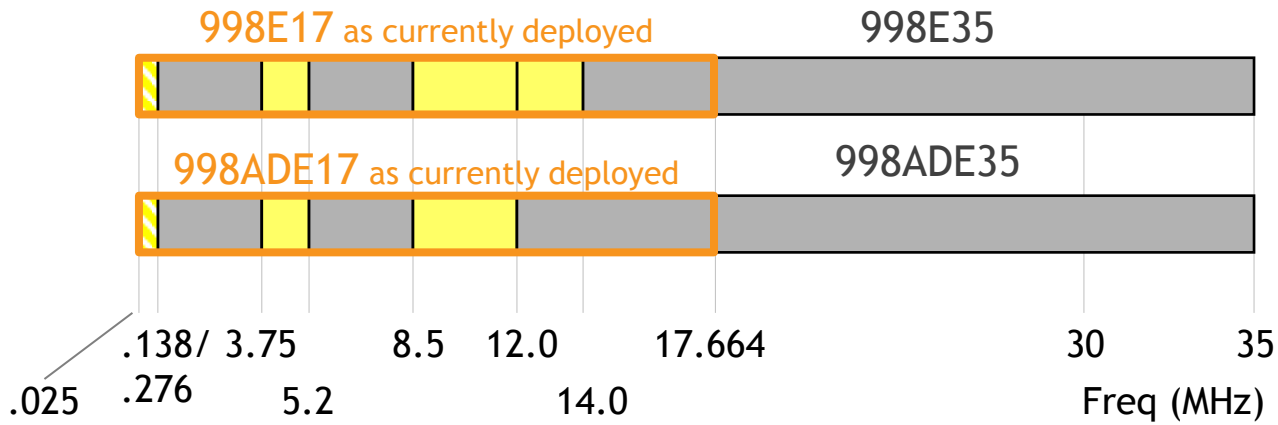
- VDSL2 35b
  - Described in Annex Q of VDSL2 standard (G.993.2)
  - As a new profile '35b'
- Main parameters
  - 4.3125kHz sub-carrier spacing (same as 17a)
  - 35.328 MHz bandwidth (8K tones)
  - Max Aggregate Achievable NDR of at least 355 Mb/s
  - Max ATP: 17dBm
- Status
  - G.993.2 Amd.1 reached consent on July 3
  - Note: ITU had set as goal to consent new Annex by Feb 2016
  - Includes VDSL2 profile 35b and related changes to band plans and PSD masks (Annex B)
  - Approval expected November 2015

Limit PSD masks

- At typical VDSL2 levels below 30 MHz
- Follows G.fast PSD mask (G.9700) above 30 MHz

Short name	Limit PSD mask (Long name)	Frequency	
		US0 type A/B/M (Note)	Highest used upstream or downstream frequency (kHz)
B8-17	998ADE17-M2x-M	M	17 664
B8-18	998E17-M2x-A	A	17 664
B8-19	998E35-M2x-A	A	35 328
B8-20	998ADE35-M2x-A	A	35 328
B8-21	998ADE35-M2x-B	B	35 328
B8-22	998ADE35-M2x-M	M	35 328

Band plans

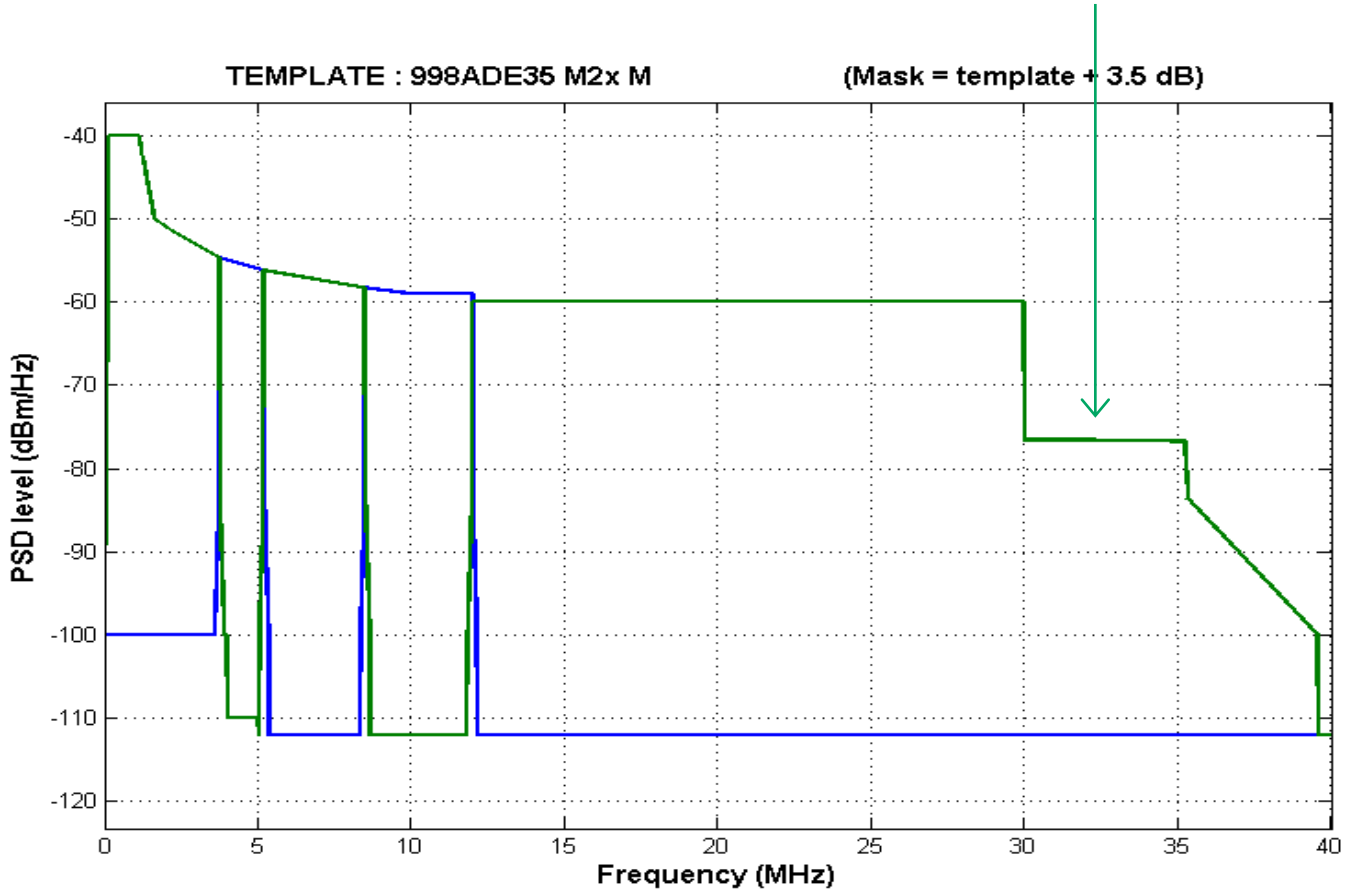


G.993.2 Amendment 1 covering VDSL2 35b

- G.993.2 Annex Q
  - Describes new profile 35b
  - Full ITU title: 'Enhanced data rate 35 MHz VDSL2 with 4.3125kHz sub-carrier spacing'
  - Doubles # carriers to 8192 (cf. 4096 for 17a)
  - Increased data rate requirements
  - Mandatory support of G.inp retransmission in downstream (Like Annex P)
- G.993.2 Annex B
  - Describes band plans and PSD masks for Region B (Europe)
  - Incl. new band plans and limit PSD masks for 35b
  - Added band plans: 998E35, 998ADE35
  - Added PSD masks: 998E35-M2x-A (B8-19), 998ADE35-M2x-A (B8-20), 998ADE35-M2x-B (B8-21), 998ADE35-M2x-M (B8-22)

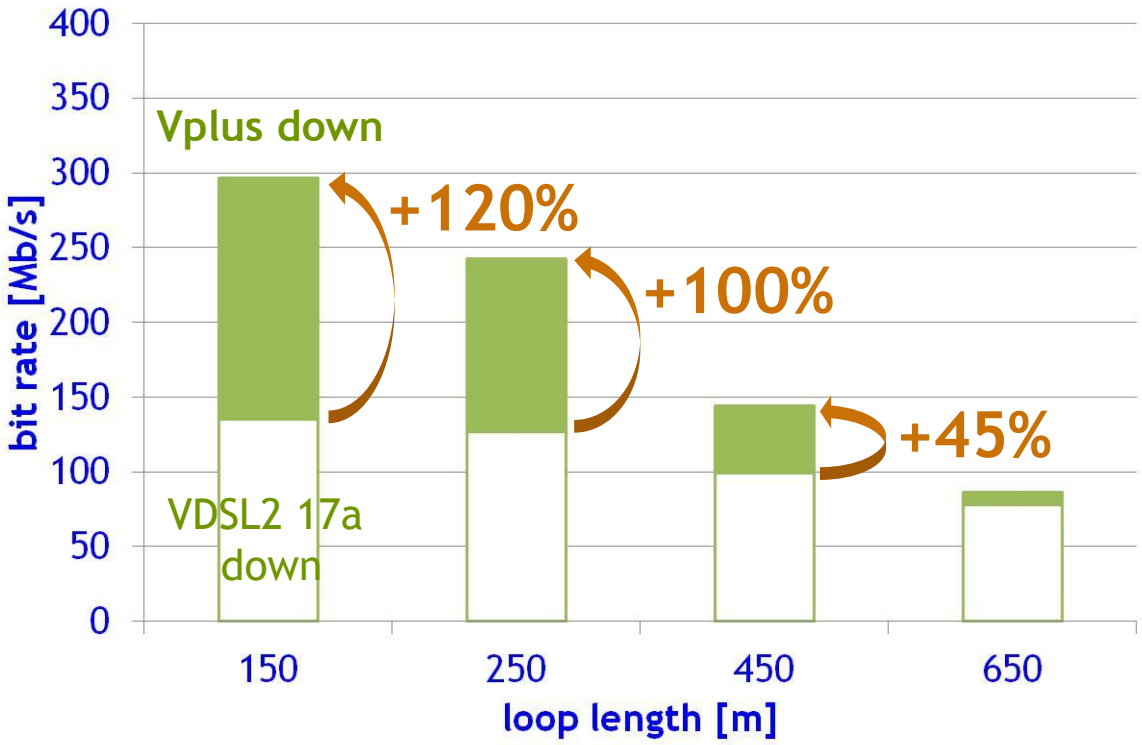
35b limit PSD mask
Example: 998ADE35-M2x-M

VDSL2 limit PSD mask = G.fast limit PSD mask = -73.0 dBm/Hz
VDSL2 PSD template = -76.5 dBm/Hz
G.fast template = G.fast limit PSD mask = -73.0 dBm/Hz

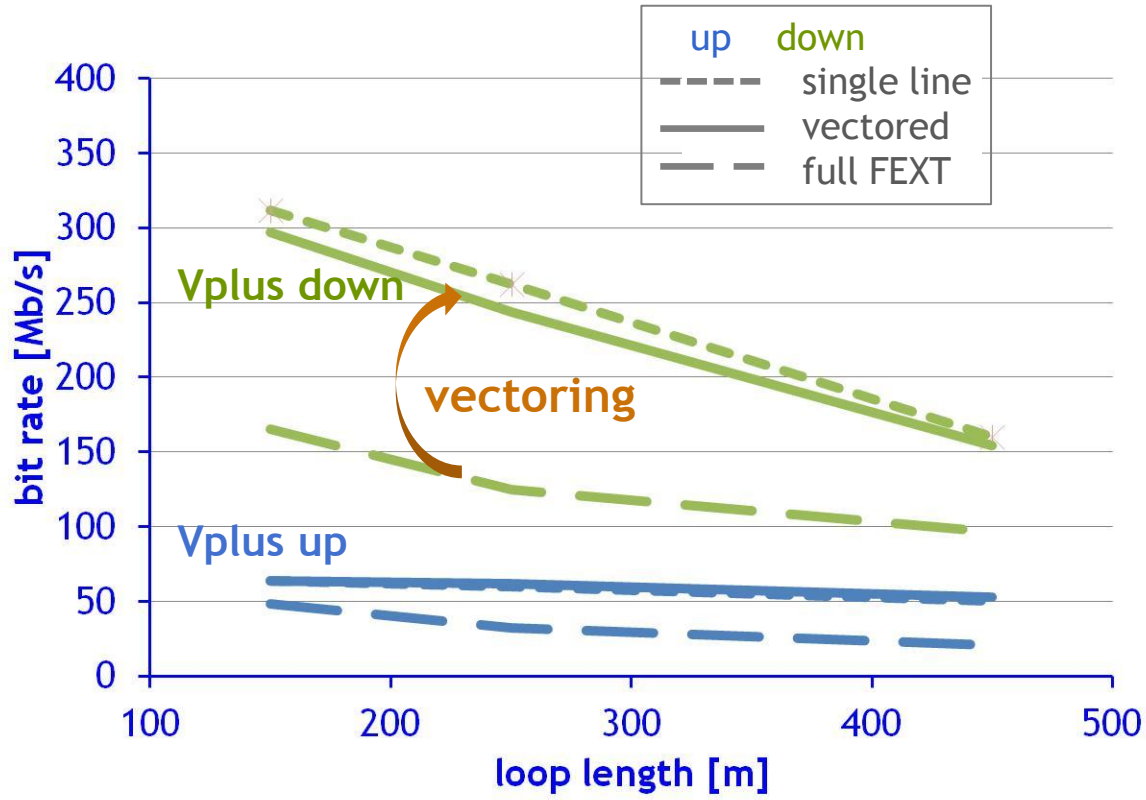


Vplus doubles rates on short lines

DOWNSTREAM RATES ON OPERATOR CABLE

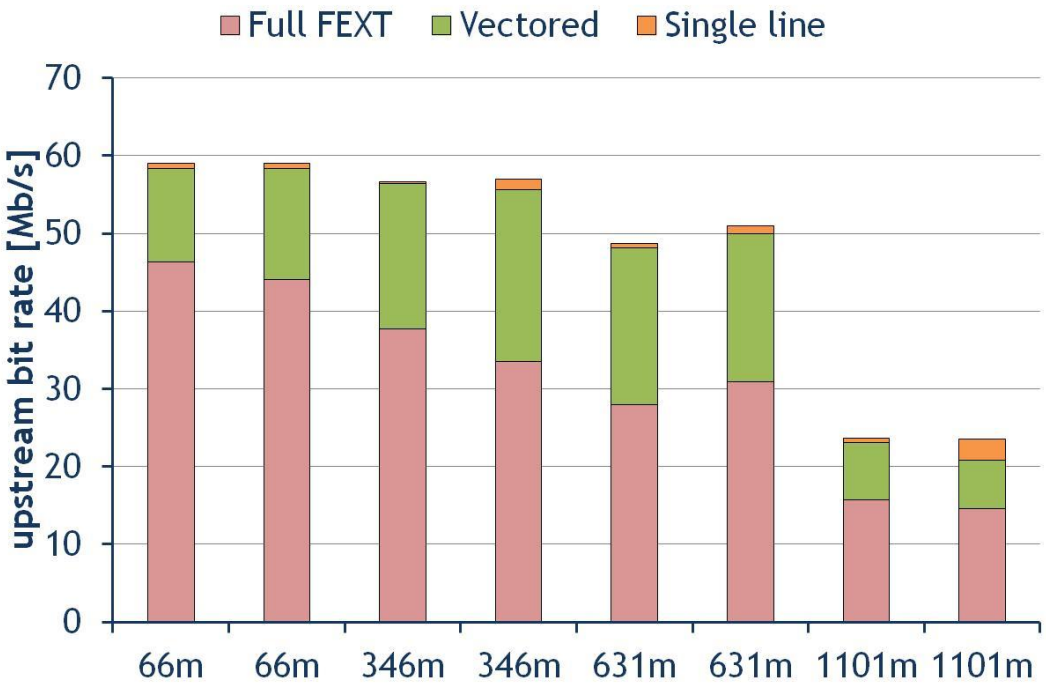


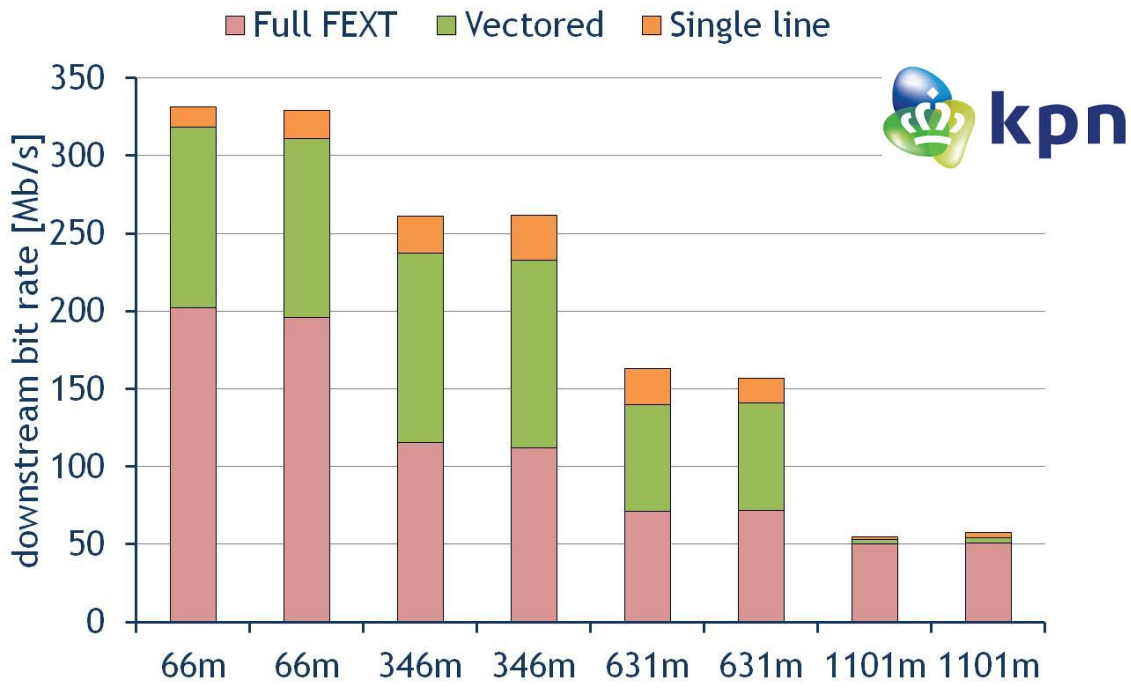
VECTORING CANCELS CROSSTALK BETWEEN Vplus AND 17a



Operator cable ; mix of VDSL2 17a and Vplus (35b) in same cable with distributed loop lengths
All rates shown are vectored over 12 active lines

Vplus tested in operator labs





Record copper in test environment with new technology

KPN during a successful pilot, along with Alcatel Lucent, with a new technology, a record speed on copper extracted from more than 230Mbit / s.

The pilot with the new technique, called Vplus, took place in a test center of KPN in The Hague. KPN has in recent years much progress has been made with high quality internet services. We invest in our networks and provide Internet that meets user demands speed, stability and security.

Every success has its network