

The logo features the text "SCKiPIO" in a bold, white, sans-serif font. A dark blue, stylized wave graphic is positioned above the letter "i", starting from the top of the letter and extending to the right, ending above the letter "P".

SCKiPIO



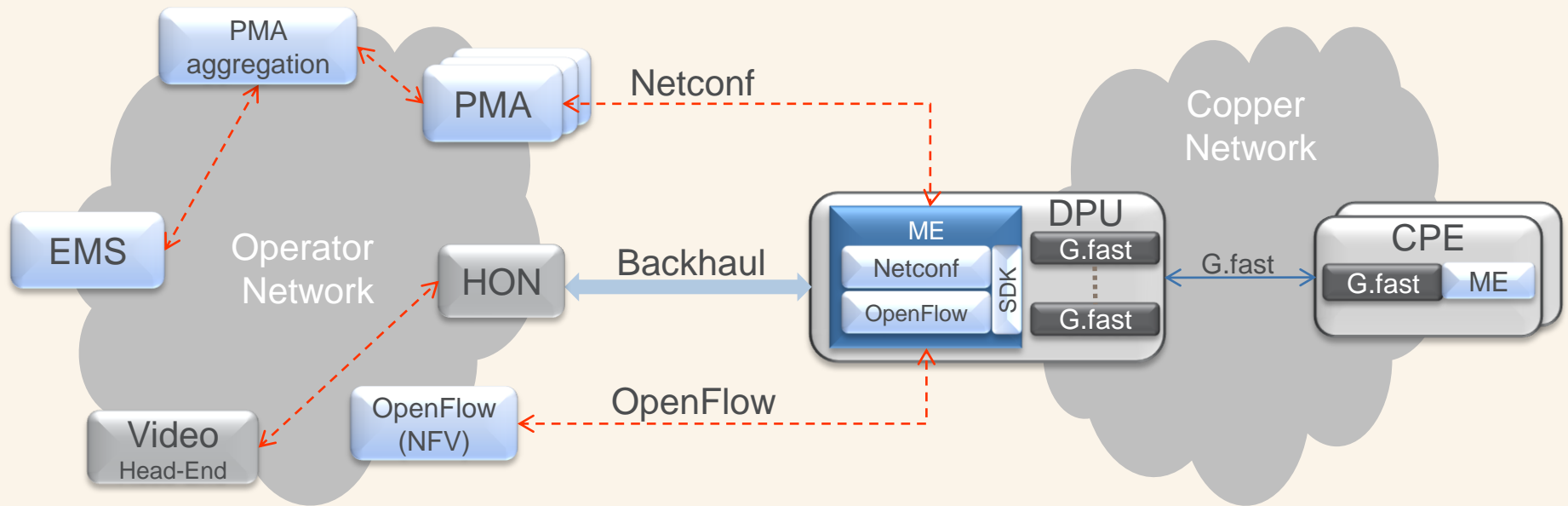
Connecting The Pieces

Putting the pieces together and some insight on the evolution of G.fast

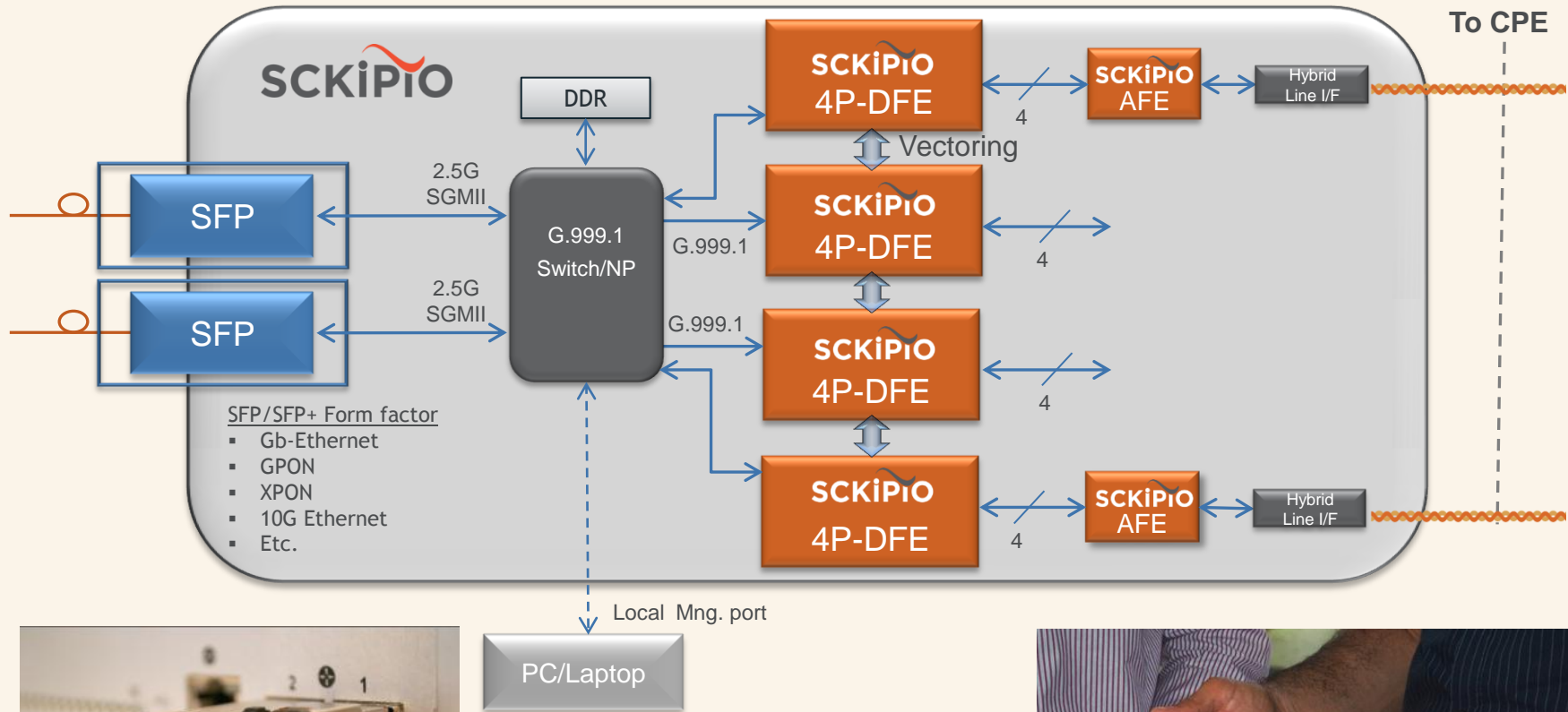
Agenda

- Putting the pieces together
 - DP elements
 - GPON, RPF, VDSL coexistence/dual mode, management
 - GW elements
- What's next...
 - Market evolution
 - Next generation G.fast
 - G.fast vs. VDSL 35b

The End To End Solution



16 ports DPU



Different scenario examples

Indoor: P-Series 870 MDU

- ▶ 16 Port G.Fast indoor model
- ▶ Integrated GPON/AE Optics
- ▶ Rack Mount / Wall Mount
- ▶ AC Power
- ▶ Passive cooling



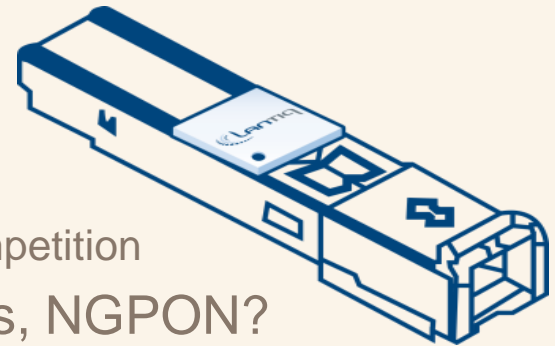
Outdoor: E3 Sealed ESAN Family

- ▶ 16 Port G.Fast outdoor model
- ▶ Integrated GPON/AE Optics
- ▶ Pole, Wall, Manhole, Pedestal
- ▶ Line, Local DC, Reverse power
- ▶ Passive cooling



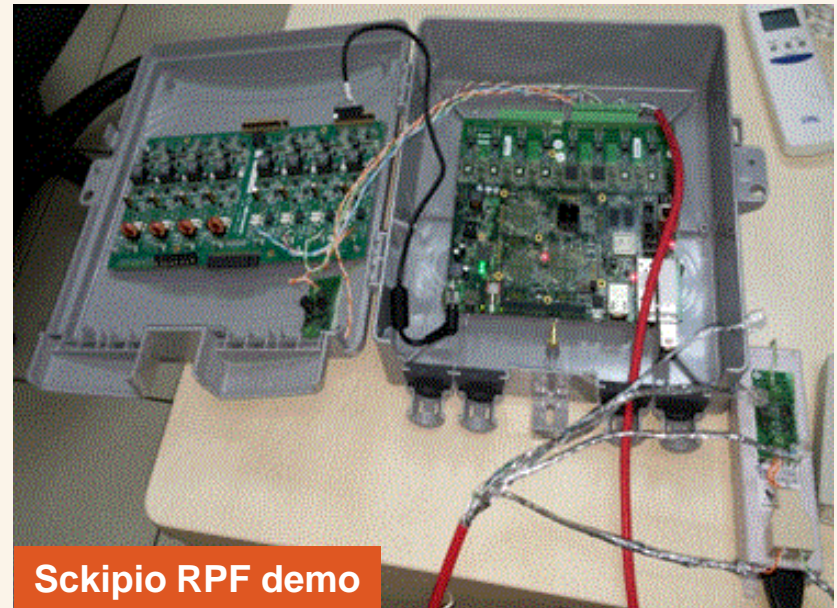
Why Using GPON SFP

- Decoupling the ONT from the DPU
 - Keeping the DPU simple
 - Lower cost
 - Opens the market to more vendor, i.e., more competition
 - Easy migration to new optical technologies, NGPON?
- No lock up to a specific GPON vendor
 - The history of GPON interoperability...
- Note – GPON SFP is gaining momentum also in the GW market, volume is ramping up



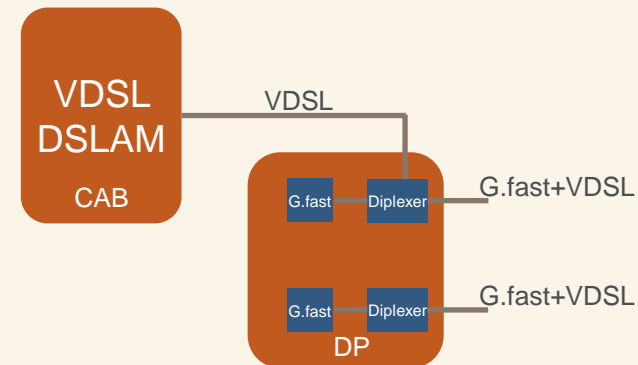
Reverse Power Feeding (RPF)

- 4 ports DPU with RPF was demonstrated in January 2015
- Requirements and challenges
- Power
 - Run one port with $<12\text{w}$
 - NP's are power hungry
 - GPON power consumption
 - Special care to avoid peaks
- Noise injection from RPF
 - Special care for long loops



Dual Mode DPU (G.fast + VDSL)

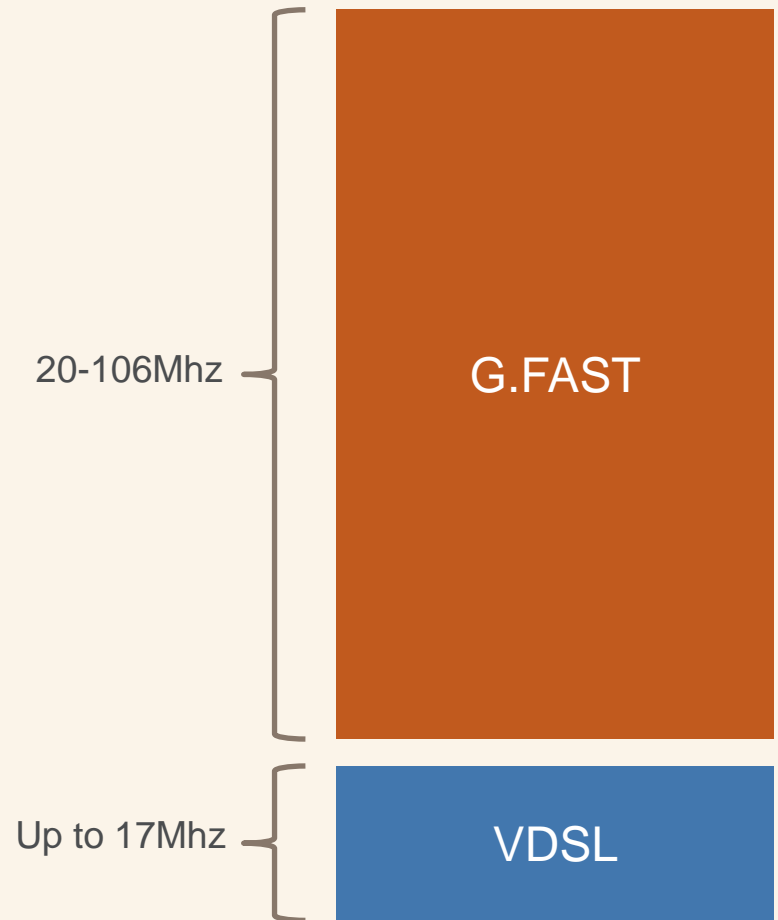
- Very few customers are looking for a dual mode DPU
 - Makes no sense for CAB deployment
- Main issue is cost
 - Two AFE's: one for VDSL and one for G.fast
 - Two line interfaces
 - How to couple (or select) the two signals without a loss:
 - Diplexer or a relay
 - One DSP may be used for both but what about the ratio between the number of ports per mode
 - If you optimize for VDSL, G.fast is going to be quite expansive...



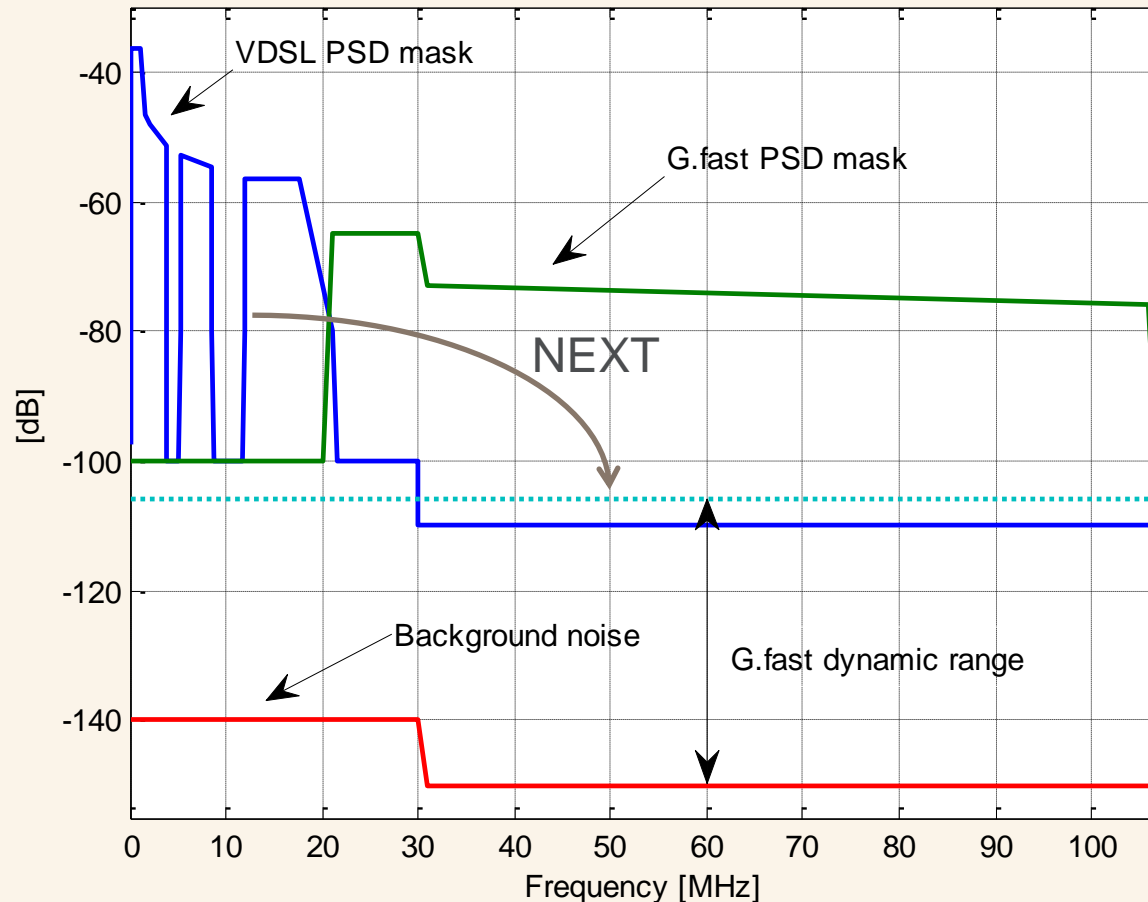
- And the alternative is quite simple

VDSL coexistence

- Issues in both directions
 - Spectral overlapping is not allowed
 - G.fast may start from 20-23MHz
- G.fast -> VDSL
 - Spectral overlapping is not allowed
 - G.fast may start from 20-23MHz
- VDSL -> G.fast
 - VDSL in-band NEXT into G.fast
- Some filtering may be needed

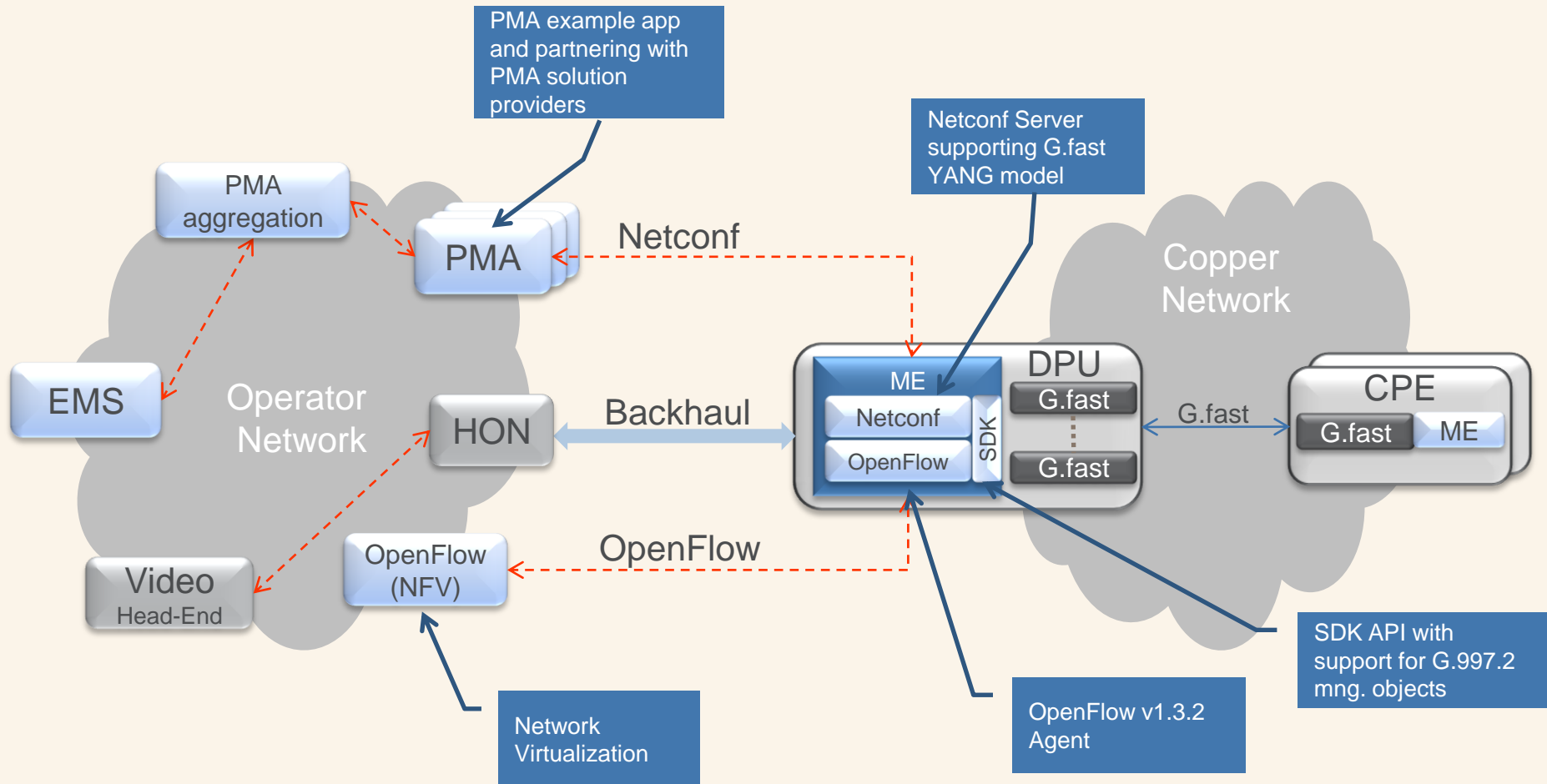


VDSL-G.fast coexistence

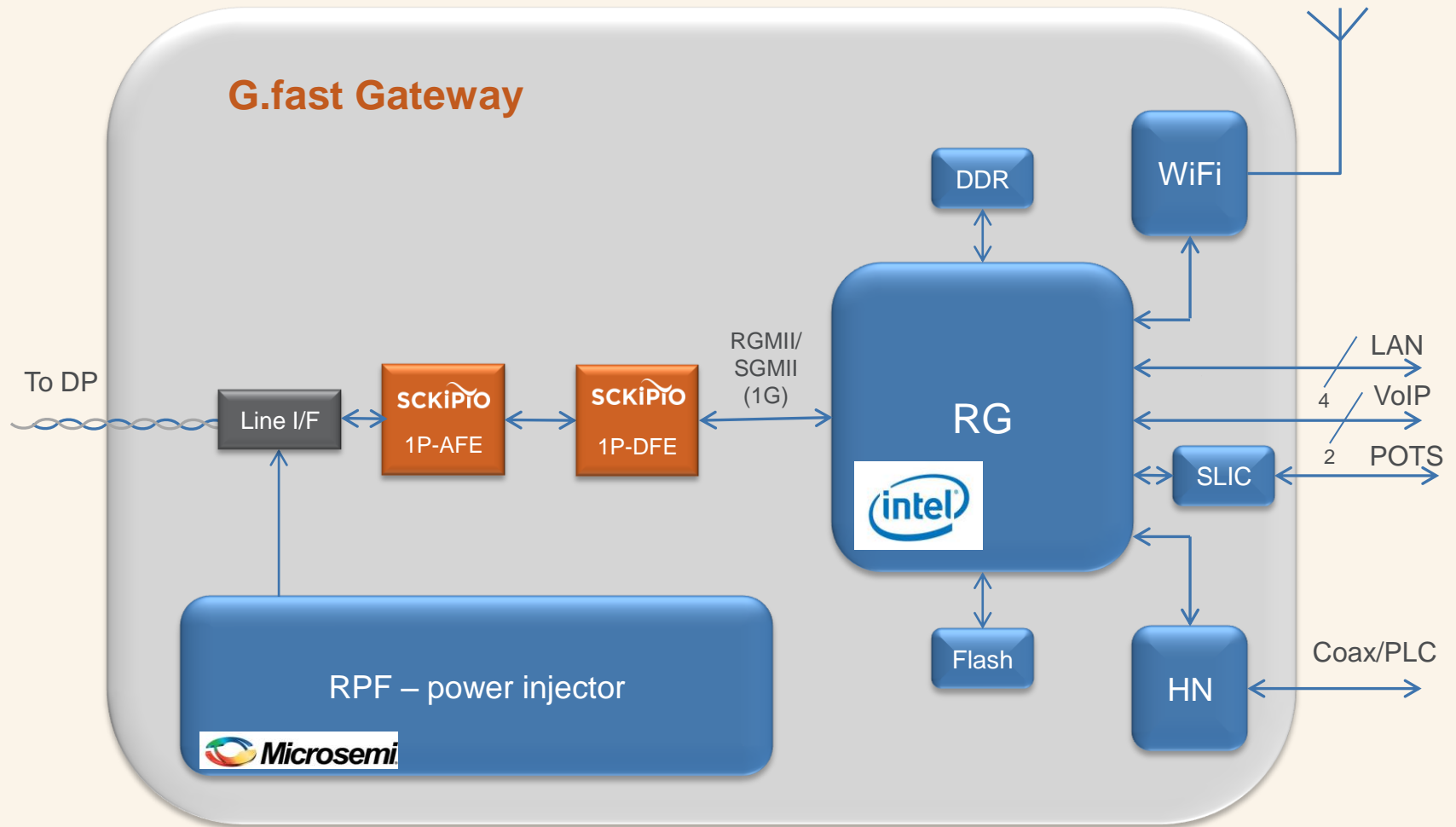


- VDSL in-band signal may couple into G.fast receiver via NEXT and limit its dynamic range (higher noise floor)

Data, Management and Control Plane



G.fast Integrated Gateway (CPE)



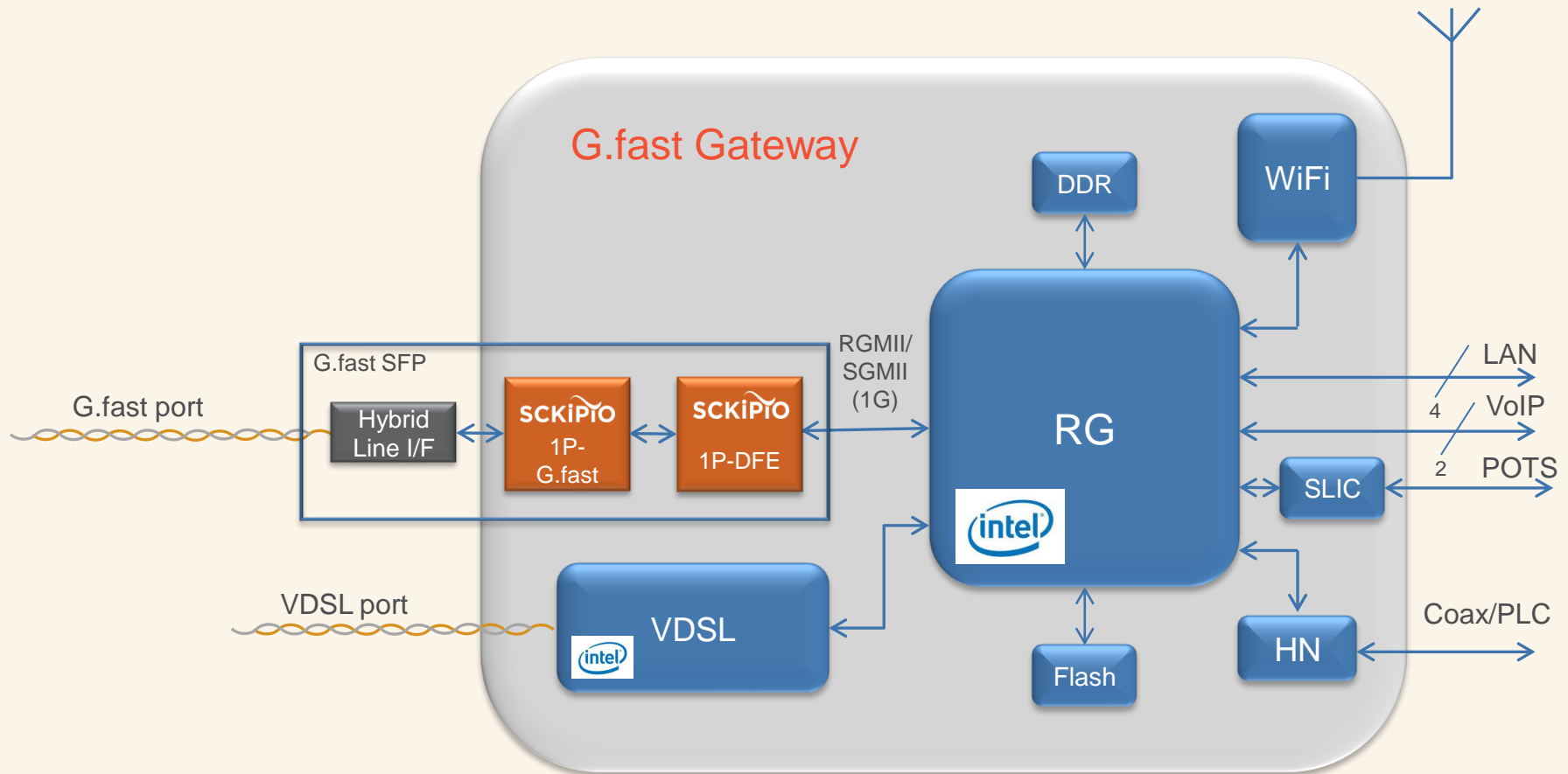
CPE Example

Calix 844F GigaCenter with G.Fast WAN

- ▶ Carrier Class 802.11ac Wi-Fi for IPTV and high speed internet access
- ▶ 4 GE LAN ports
- ▶ BBF TR-124 compliant for IPv4/v6 residential gateway device
- ▶ 2 POTS ports (VoIP)
- ▶ UPS alarm telemetry
- ▶ Complemented by **Calix Consumer Connect** software for complete experience visibility and management

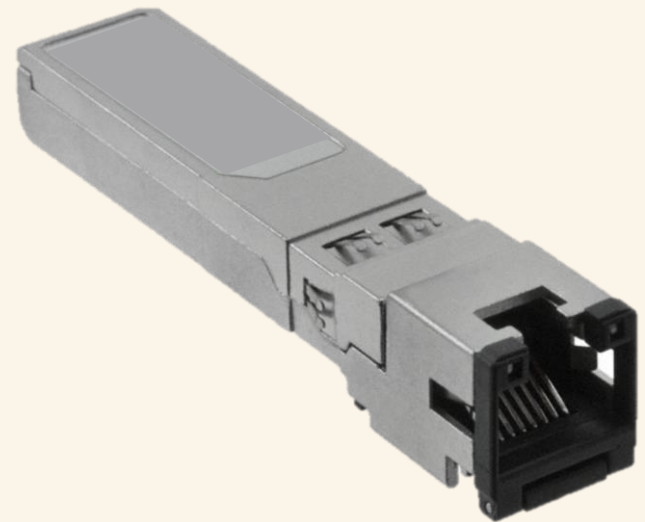


SFP based G.fast Gateway



Why G.fast SFP

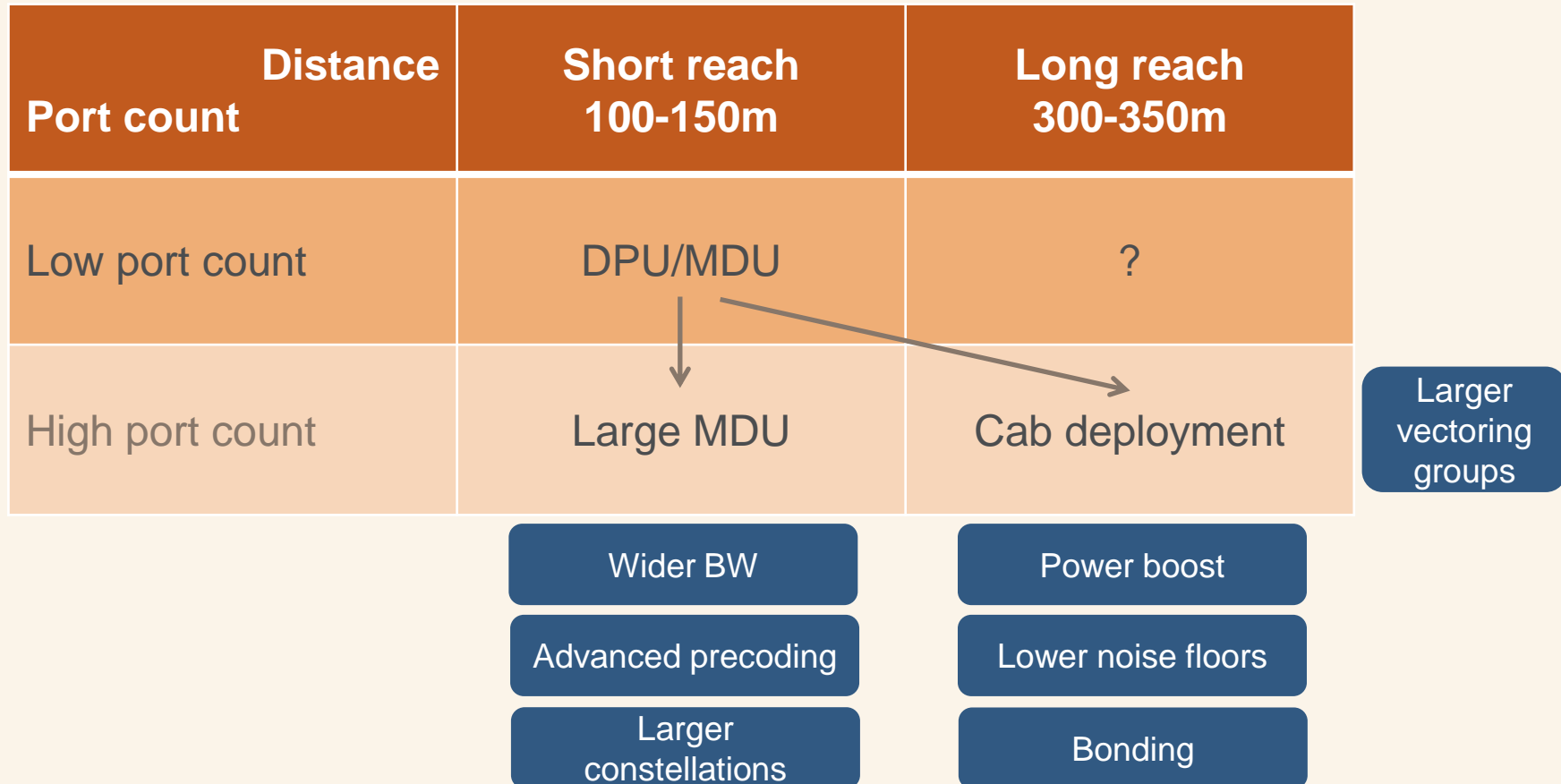
- Migration strategy from VDSL to G.fast become easy
- Reuse existing VDSL GW
- Future proof
 - G.fast issue 2?
 - Interop. fixes
- Multi-mode GW
 - G.fast
 - GPON
 - 1G Eth.
- Reduce risk of interoperability



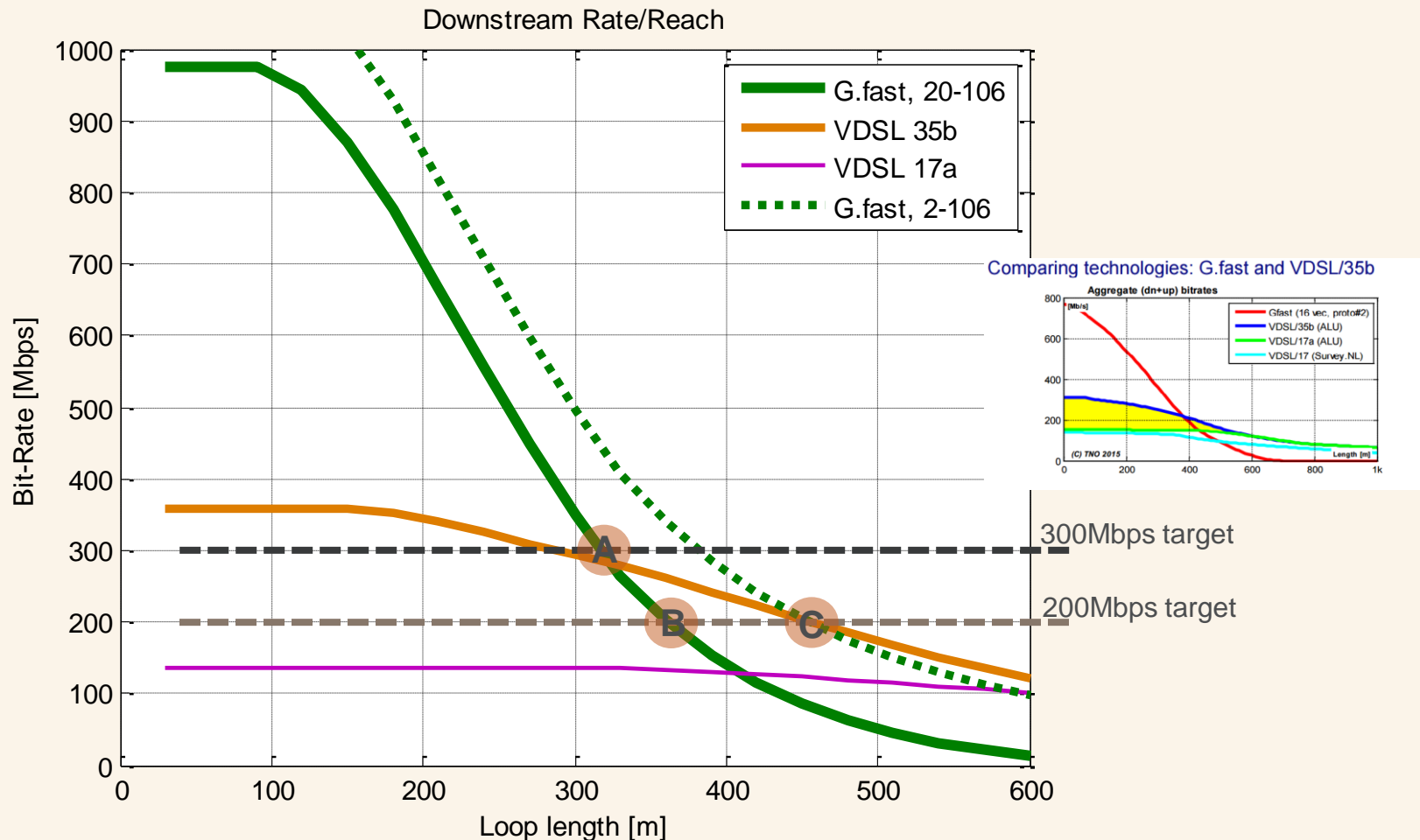
What's next with G.fast

G.fast technology going forward

G.fast is evolving - more features to be added...



G.fast vs. VDSL 35b, downstream



- Huge advantage for G.fast for short lines. Similar performance if the target rate is 300Mbps. Advantage to VDSL+ if the min rate target is 200Mbps (100m). No real advantage for VDSL+ if G.fast can start from 2MHz.

V+ (35b) vs. G.fast Comparison

Parameter	G.FAST	VPLUS (35b)
Bandwidth	2-106MHz, 2-212MHz (future)	2-35Mhz
Max Rate	Up to 1Gbps with path to even faster future G.fast performance	Up to 400Mbps for 0m loops, no path to higher speeds
Down/Up ratio	Configurable: 90:10 to 30:70	Fixed ratio
Complexity	2K Carriers (more efficient)	8K Carriers (results in 4x more memory required for vectoring)
Vectoring	Designed to cope with the high FEXT level in the G.fast band	Designed for the low 17MHz VDSL frequencies. Significant performance loss when FEXT is high.
Customer Self Install	Likely – the huge rates leave margin for handling tough in-home networks	Unlikely – performance may drop under 17a rates
Openness	7 silicon vendors participate in the G.fast interop. event (Plugfest)	Single vendor? No BBF certification plan

Summary

- We have all the elements in place
 - Ready to start the evaluation of the complete solution
- New deployment strategies are developed for G.fast
 - G.fast technology is evolving to align with the new requirements



Thank You