



Standardization of xDSL and MGfast in ITU-T SG15

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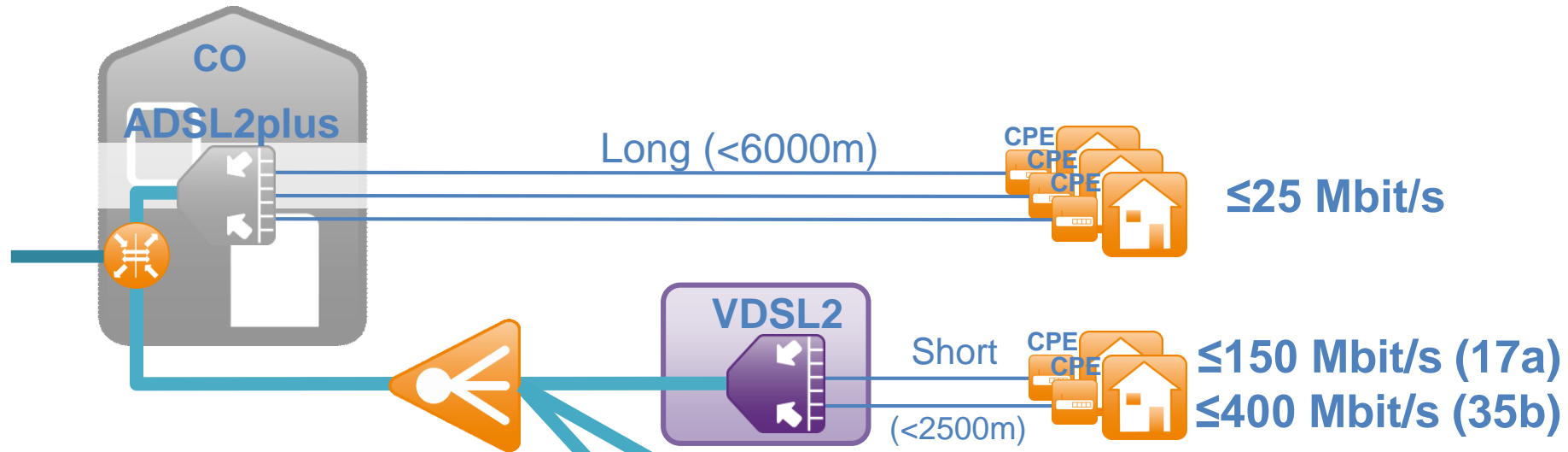
Overview

- About ITU-T SG15 Q4
- xDSL, G.fast and MGfast access solutions
- VDSL2 : recent/ongoing enhancements
- G.fast : recent/ongoing/future enhancements
- MGfast : emerging new technology

About ITU-T SG15 Q4

- SG15: Networks, Technologies and Infrastructures for Transport, Access and Home
- Q4: Broadband access over metallic conductors
- Covers all aspects of transceivers operating over metallic conductors in the access part of the network
- Projects: G.xdsl, G.fast, G.mgfast, G.lt (testing), G.ploam (management)
- Main liaisons: ITU-R, ETSI and Broadband Forum
- Meets face to face about 6 weeks per year

Overview Access Network Solutions



G.fast and MGfast fill an access technology gap

- Huge gap 100 Mbit/s → multi Gbit/s
- Fiber may not always be possible into the home/apartment
- G.fast and G.mgfast support FTTdp and FTTB architectures.

G.fast

CPE

≤ 1..2 Gbit/s

Very short TP or coax (<400m)

MGfast

CPE

≤ 5..10 Gbit/s

No drilling
No digging (<100m TP or coax)

Fiber

Copper

VDSL2

- **What is in the Recommendations (G.993.2/5, G.993.5, G.998.4)**
 - Aggregate data rates up to 150 Mbit/s (17a), 250 Mbit/s (30a), 400 Mbit/s (35b)
 - Operates over loops up to 2500m of 0.4mm copper
 - PHY layer retransmission and crosstalk cancellation (vectoring)
 - Down/up asymmetry ratio depends on band plan used (997 / 998 types)
 - Low power mode (reduced data rate and spectrum when user traffic is low)
- **Ongoing work (consented in June 2017 – under approval process)**
 - New Annex on mitigation of strong FEXT (operation in high crosstalk cables)
 - Defines a TIGAV procedure to adapt TX PSD under varying high FEXT levels
 - Long Reach VDSL2 (targets 10 Mbit/s over 4km of 0.5mm copper)
 - Defines a line probing during initialization to adapt TX power/PSD to the loop length
 - Adds ADSL2plus techniques for best performance on longest loops

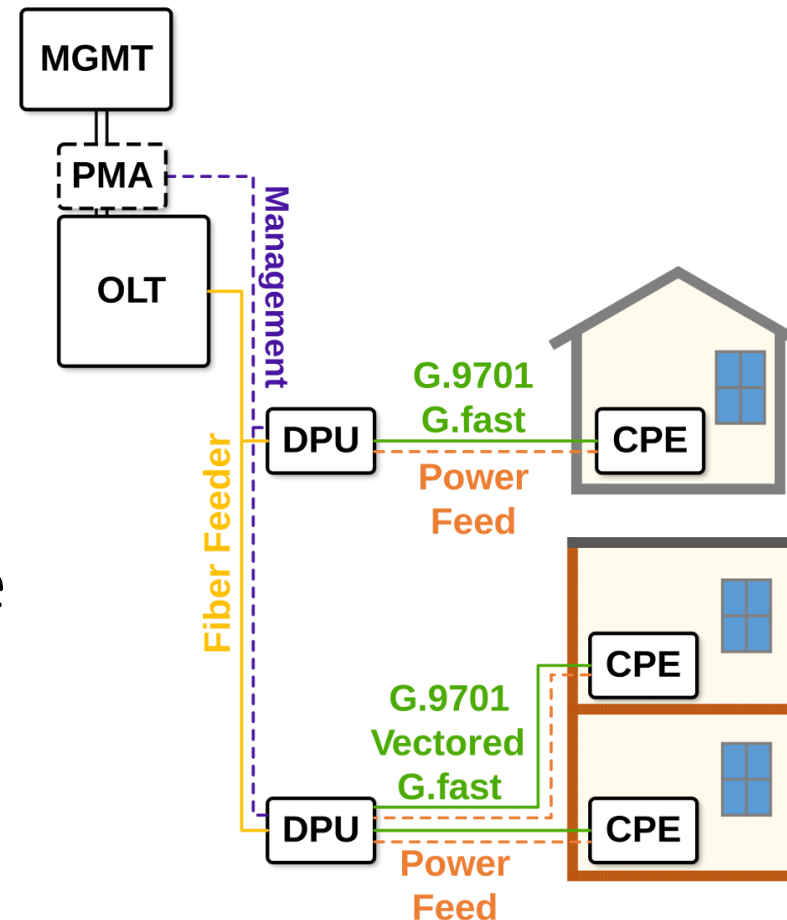
Key Aspects of G.fast

- **Aggregate service rate** (up+down) targets (over 0.5mm copper)
 - 1 Gbit/s at 50m
 - 900 Mbit/s at 100m
 - 600 Mbit/s at 200m
 - 300 Mbit/s at 300m
 - Operates up to 400m
- Operates over twisted pair, quad cables, and also coax.
- Customer **Self-Installable** CPE
- **Low power consumption modes** and **reverse power feeding**
- **Robust** with high immunity to disturbers
- **Crosstalk cancellation** for operation in multi-pair cable
- Down/up **asymmetry ratio** is static configuration of TDD split
- **NTR** and **Time-of-Day** support (expected accuracy < 50ns)

Far exceeding initial
ITU-T performance targets

Key aspects of FTTdp

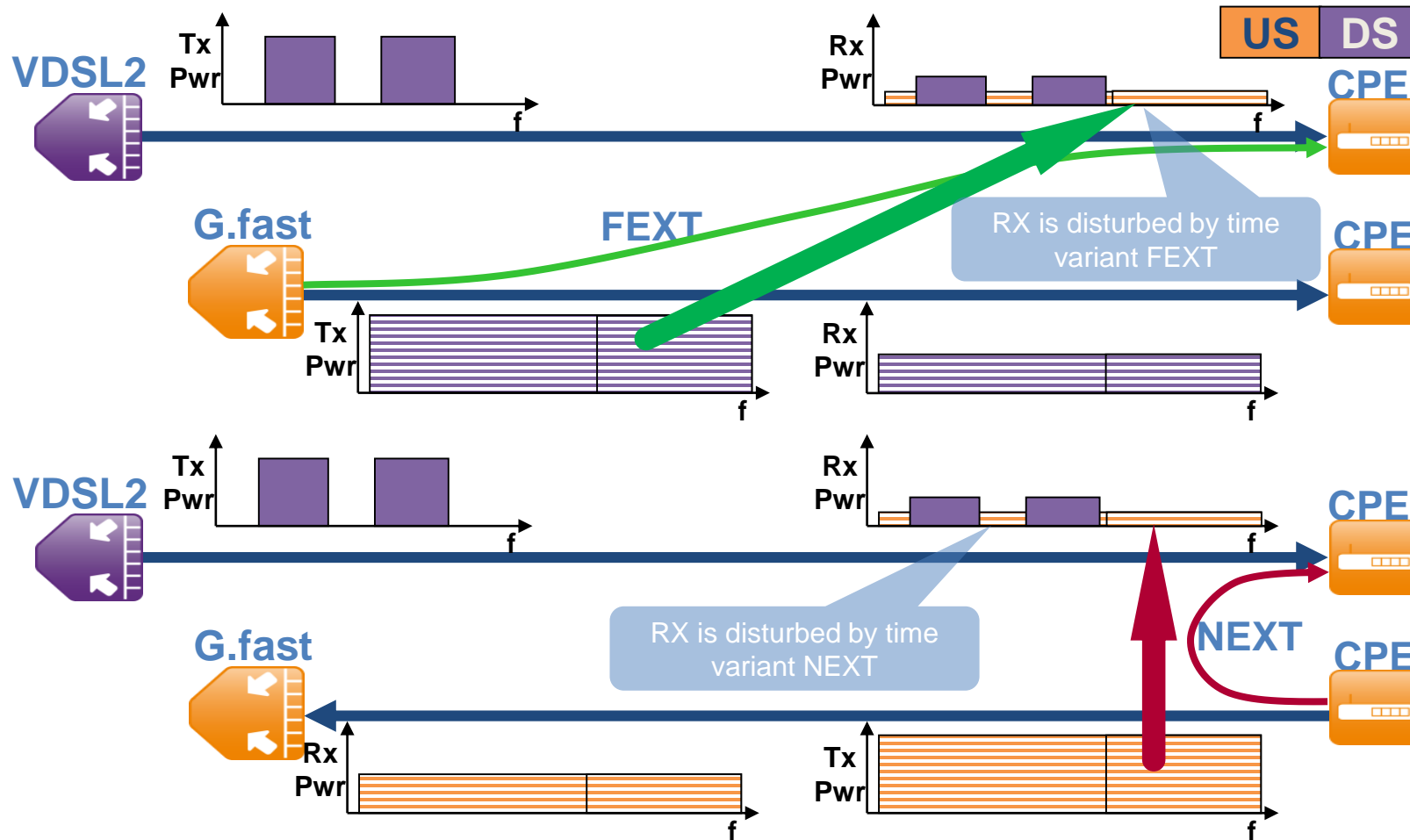
- Reverse power feeding (RPF) the DPU from the user premises.
- Persistent Management Agent (PMA) acts as management proxy in the event the DPU loses power.



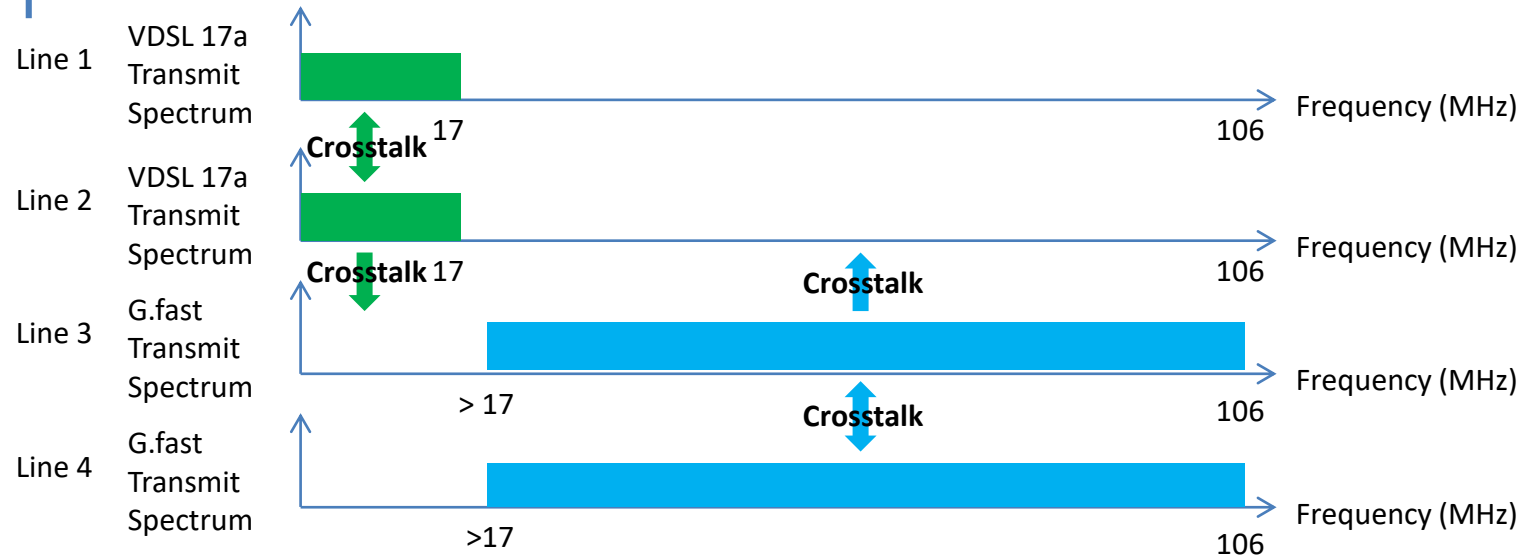
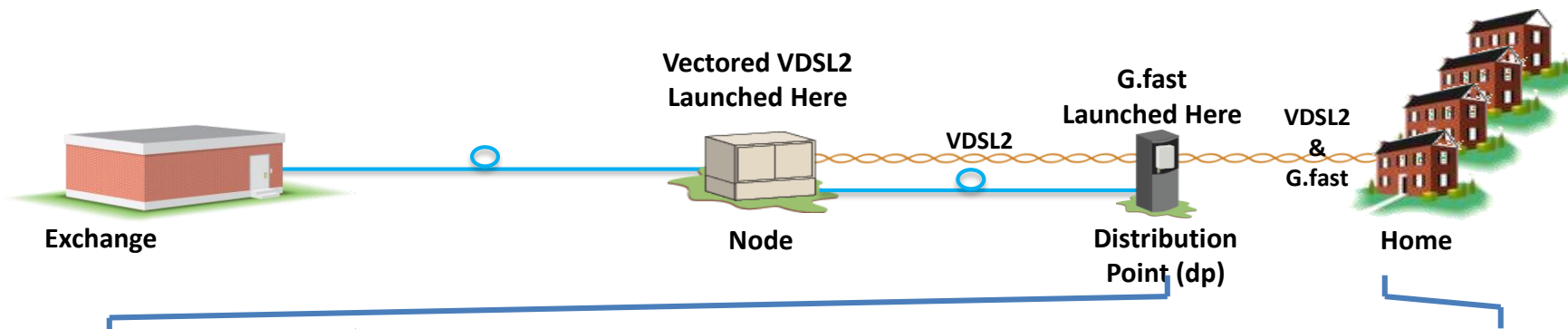
G.fast Characteristics

	G.fast	VDSL2
Modulation	DMT (up to 14 bits/sub-carrier)	DMT (up to 15 bits/sub-carrier)
Bandwidth (MHz)	106, 212	8, 12, 17, 30, 35
Max Transmit Power (dBm)	2 (coax) and 4 - 8 (TP)	11.5 - 20.5 (TP)
Duplexing	TDD	FDD
Distance	< 250m (400m) TP	< 1000m (2500m) TP
Bit Rate (up+dn) (Mbit/s)	< 1000 (106), <2000 (212)	< 400(35b), < 150(17a)
One way latency	< 1 ms	< 10 ms
Vectoring	Yes	Optional
Up/Down Rate Ratio	Provisioned, dynamic	Fixed by bandplan
Retransmission	Yes	Optional
Coding	Interleaved RS/Trellis	Interleaved RS/Trellis
Full init time (single line)	20 seconds (typical)	120 seconds (typical)

Coexistence Issue with ADSL/VDSL



Spectral Compatibility

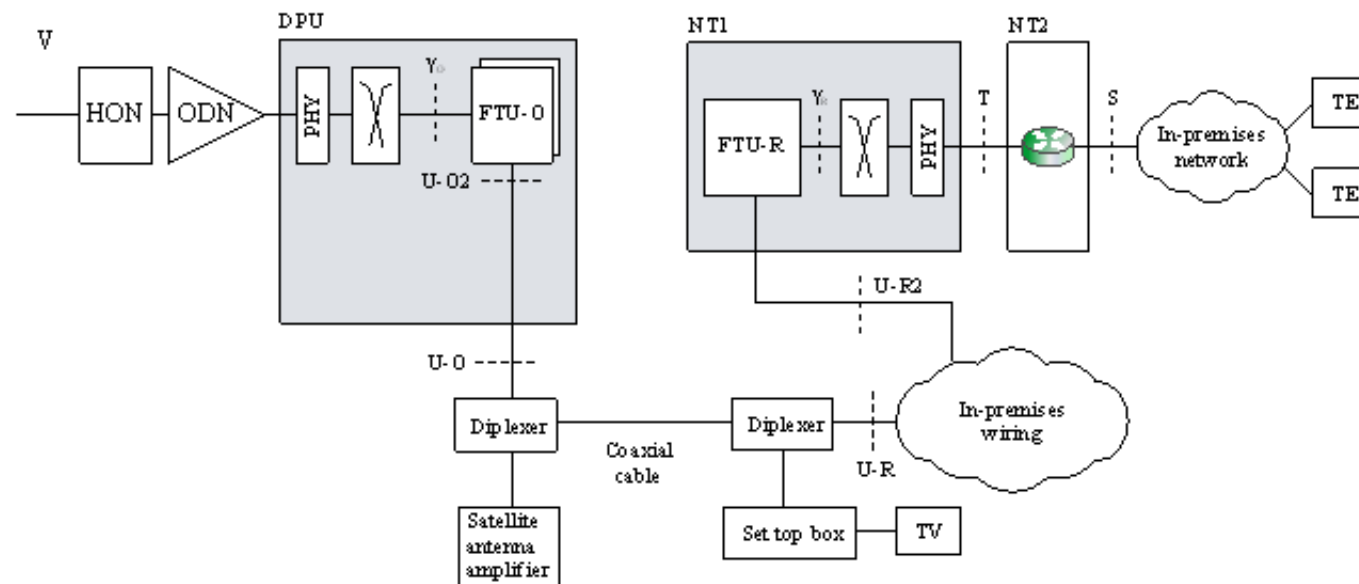


Collaboration with Broadband Forum

- Long standing collaboration with the Broadband Forum
 - BBF test plans have followed up with the ITU-T DSL standards evolutions on ADSL, ADSL2, ADSL2plus, and VDSL2
- Broadband Forum has been recognized by the ITU-T SG15 as a partner in improving the DSL Recommendations
 - Multi-vendor plugfests (sandbox testing) identify shortcomings
- Broadband Forum certification program
 - Detailed testing of the G.fast technology / functionality
 - Based on ITU-T G.fast specifications G.9700/9701
- Broadband Forum YANG development
 - Interoperability at the VDSL2 and G.fast management interface
 - Based on ITU-T Physical Layer OAM specifications G.997.1/2
- Co-branded ITU-BBF G.fast interop event in the BBF pavilion of BBWF2017

Operation over coax

- Approved April 2017 as part of G.9701 Annex X
 - Operation without coordination across lines
 - 106 and 212 MHz profiles with 2 dBm max TX power
- Use case:
 - G.fast overlay on existing in-building SAT TV coax distribution



Dynamic Time Assignment (i-DTA)

- Approved April 2017 as part of G.9701 Annex T/X
 - Operation without coordination across lines (i-DTA)
- Concepts:
 - AN/DPU system monitors up/down throughput needs
 - Requests FTU-O to change the TDD up/down ratio
 - FTU-O and FTU-R implement the change synchronously and seamlessly
 - Up/down ratio between 5/30 and 30/5 with default 7/28
- Use case:
 - Improve end user experience (QoE) by dynamically allocating the aggregate capacity to the direction that best serves the instantaneous needs of the user's applications.

NT Software Download

- Approved April 2017 as G.9701 Annex S
 - Software download from DPU over the G.9701 eoc to NT
- Concepts:
 - NT software image gets downloaded to the AN/DPU
 - DPU forwards the NT software image to the NT over the G.9701 eoc
 - Typical software image takes 1-2 sec to send over eoc
 - Protocol based on the G-PON OMCI ONU software download
 - Managed objects defined in support of YANG data model (TBD in BBF)
- Use case:
 - NT is simple device (SFP or PHY adapter without IP address)

Future G.fast work

- Impulse noise monitoring (consented in June 2017 - under approval process)
 - To facilitate characterization and source identification
- Metrics for service rate estimation (consented in June 2017 - under approval process)
 - Attainable throughput estimation (ANDEFTR) under current noise conditions
- Improved UPBO
 - Frequency dependent UPBO, more advanced mechanisms
- Coordinated DTA
 - Dynamic change of up/down split over the vectored group
- Line reconfiguration without retrain
 - Selected set of configuration parameters (e.g., SNRM, MAXNDR)
- Goal to define short TDD frames for delay sensitive applications
 - Radio fronthaul, CPRI transport, Ethernet backhaul
 - Assessing the requirements/need, liaising with 3GPP

Emerging G.mgfast - Multi-Gigabit fast

- G.mgfast is the project defining the MGfast technology
- New project to address functionality beyond G.fast
 - Profiles beyond 212 MHz (e.g., 424 MHz and 848 MHz)
 - Full-duplex operation (echo cancelled mode)
 - Co-exist with G.fast in overlapping frequency bands through mutual vectoring
- Targets
 - Aggregate data rates of 5 - 10 Gbit/s over single TP/coax.
 - Operation over twisted pair, quad and coaxial cable.
 - Consent mid 2019.
- Open points under discussion
 - Topologies: (multi?)point-to-(multi?)point
 - Advanced coding (e.g., LDPC)
 - Multi-stream support for QoS differentiation / 5G slicing
 - Convergence of access and in-home networking



Thank you