

Table 1: COPPER Local Loop Unbundling (LLU) vs COPPER Virtual Unbundled Local Access (VULA)

	Copper LLU (at Main Distribution Frame (MDF))	Copper VULA (incumbent using copper SLU with VULA delivered at MDF or equivalent location)
Equipment which the alternative operator (altnet) can deploy	<p>Altnet can deploy ANY non-interfering equipment (on both the network side and the Customer Premises Equipment side - CPE) including new generations of advanced equipment on the copper wire.</p> <p>This enables:</p> <ul style="list-style-type: none"> the provision of any technically feasible speed, including: <ul style="list-style-type: none"> symmetric high speed services (fast upload) for businesses and for consumers that demand it Differentiated functionalities e.g. multi-VLAN, Ethernet Network-to-Network interface (NNI), multicast. LLU pair-bonding for very high (incl. symmetric) speeds 	<p>Altnet has to rely on incumbent technology choice, including possible speed, profile (downstream/upstream) and CPE restrictions.</p> <p>Note that the incumbent:</p> <ul style="list-style-type: none"> tends to optimise for consumer market, i.e. by offering asymmetric speeds (slow upload), a few VLANs for voice, IPTV, maybe a 'fast lane'; is unlikely to use SLU pair-bonding (which allows for higher speeds) unless it is truly under pressure from a parallel infrastructure.
Incentives for the incumbent and the altnet to upgrade	<p>Strong incentive for altnet to 'do better' than the incumbent; strong incentive for the incumbent to match any altnet deployment of advanced equipment/speed/services on the copper wire.</p> <p>Note that e.g. altnets took the lead with deploying new technologies such as ADSL2+, ShDSL, e-ShDSL, bonded e-ShDSL over LLU.</p>	<p>Weak incentive for incumbent to upgrade to next technology evolution, unless truly under pressure from parallel infrastructure.</p> <p>Note that incumbents have to a large extent upgraded to FttC rather than FttH where DOCSIS3 over Cable exists, suggesting that pressure is limited.</p>
Backhaul and level of contention	<p>Altnet can lease the copper wires, equip them with the best equipment, and build or lease fibre backhaul with zero contention, enabling provision of maximum speed to all its customers.</p>	<p>Strong incentive for incumbent to build contended network in the feeder segment (from street cabinet to MDF) to enable charging a premium for speed or even prevent altnets taking</p>

		VULA from providing maximum speeds to all their customers.
Pricing flexibility at retail level	Altnet can set any price (within wholesale charge + its own cost constraints, unless selling at a loss) and thus has freedom to experiment with pricing to drive take-up. Note that, as a matter of principle, providing additional speed will not generate additional material costs.	Strong incentive for the incumbent to charge high premium for higher speed at both retail and wholesale level, thereby neutralizing speed and price competition from altnets taking VULA.
Provision of wholesale services to third parties	Altnet can provide wholesale services to third parties (e.g. wholesale broadband access, leased lines terminating segment, any other).	Strong incentive for incumbent to structure the wholesale services it provides to the altnet (technical specifications) and wholesale charges in a manner which prevents altnets from providing wholesale services to third parties.

CONCLUSIONS

- Copper VULA is intrinsically not equivalent to copper LLU, and cannot be intrinsically equivalent to copper LLU.
- Copper VULA, if it is the only available wholesale input (i.e. no physical access available) has intrinsically inferior characteristics in terms of enabling competition, with important likely consequences for wholesale charges and retail prices and also for investment incentives.
- If the objective is to make copper VULA as close as possible to copper LLU, regulation needs to ensure that:
 - All VULA lines always operate at maximum speed enabled by the equipment; different profiles only if technology requires different balance between downstream/upstream. Note that this does not address the incentive for the incumbent to upgrade to next technology evolution;
 - VULA enables multi-VLAN (frame length at least 1580 Byte)/Ethernet NNI/multicast);
 - Altnet taking VULA can select, own and install any CPE (unless demonstrated technical impossibility – burden of proof on SMP operator);
 - Alleged contention is not accepted as a justification for tiering the wholesale prices by speed. Wholesale VULA charges that vary by speed or by downstream/upstream profile are prohibited. The only permissible difference in wholesale VULA charges would be for a different (more expensive) CPE, if the CPE has to be provided by the incumbent (see previous point).

Table 2: COPPER Sub-Loop Unbundling (SLU) vs COPPER Virtual Unbundled Local Access (VULA)

	Copper SLU (at street cabinet or equivalent)	Copper VULA (incumbent using copper SLU with VULA delivered at MDF or equivalent location)
Equipment which the alternative operator (altnet) can deploy	<p>Altnet can deploy ANY non-interfering equipment (on both the network side and the Customer Premises Equipment side - CPE) including new generations of advanced equipment on the copper sub-loop.</p> <p>Co-existence of operators on the copper sub-loop has been called into question by incumbent operators, in the context of the deployment of vectored VDSL2. Four NRAs have to-date adjusted regulatory remedies to reflect this claim.</p> <p>On 28 Nov 2012, at the ECTA conference, senior representatives of Alcatel Lucent and Huawei indicated that coexistence is possible within their respective equipment ecosystem (i.e. operators would have to use the same equipment vendor and coordinate interference management) (see Spruyt presentation). Note that AGCOM, the Italian NRA, is steering the development of multi-operator vectoring in Italy.</p> <p>Copper SLU enables:</p> <ul style="list-style-type: none"> • the provision of any technically feasible speed, including symmetric high speed services (fast upload) for businesses and for consumers that demand it; • differentiated functionalities e.g. multi-VLAN, Ethernet Network-to-Network interface (NNI), multicast; • SLU pair-bonding for very high (incl. symmetric) speeds. 	<p>Altnet has to rely on incumbent technology choice, including possible speed, profile (downstream/upstream) and CPE restrictions.</p> <p>Note that the incumbent:</p> <ul style="list-style-type: none"> • tends to optimise for consumer market, i.e. offering asymmetric speeds (slow upload), a few VLANs for voice, IPTV, maybe a 'fast lane'; • is unlikely to use SLU pair-bonding unless it is truly under pressure from a parallel infrastructure.

	Even if the same equipment vendor is used by the incumbent and altnets at the sub-loop, the altnet would still have greater differentiation possibilities than when taking VULA from the incumbent, e.g. to optimise for symmetry of speeds, to introduce greater flexibility in the number of VLANs, to enable different use of VLANs, to take the lead with SLU pair-bonding, etc.	
Incentives for the incumbent and the altnet to upgrade	<p>Strong incentive for the altnet to 'do better' than the incumbent; strong incentive for the incumbent to match any altnet deployment of advanced equipment/speed/services on the copper sub-loop.</p> <p>Note that altnets took the lead with deploying alternative technologies over SLU (altnets such as ERENIS in Paris and E-Leven in Brussels deployed VDSL on inside wiring in multi-tenant buildings – ERENIS was subsequently acquired by a larger altnet (now SFR) and E-Leven's assets were taken over by Destiny, which is a leading provider of pair-bonded e-ShDSL).</p>	<p>Weak incentive for incumbent to upgrade to next technology evolution, unless truly under pressure from parallel infrastructure.</p> <p>Note that incumbents have to a large extent upgraded to FttC rather than FttH where DOCSIS3 over Cable exists, suggesting that pressure is limited.</p> <p>Note that if copper SLU is at risk of being phased-out and/or not subject to cost-orientation, this strongly distorts competition in favour of incumbents and discourages altnet investments in taking-up copper SLU. Such a state of affairs is also likely to stimulate incumbents in investing in FttC rather than FttH.</p>
Backhaul and level of contention	Altnet can lease the copper sub-loops, equip them with the best equipment, and build or lease fibre backhaul with zero contention, enabling provision of maximum speed to all its customers.	Strong incentive for incumbent to build contended network in the feeder segment (from street cabinet to MDF) to enable charging a premium for speed or even prevent altnets taking VULA from providing maximum speeds to all their customers.
Pricing flexibility at retail level	Altnet can set any price (within wholesale charge + its own cost constraints, unless selling at a loss) and thus has freedom to experiment with pricing to drive take-up. Note that, as a matter of principle, providing additional speed will not generate additional material costs.	Strong incentive for the incumbent to charge high premium for higher speed at both retail and wholesale level, thereby neutralizing speed and price competition from altnets taking VULA.

Provision of wholesale services to third parties	Altnet can provide wholesale services to third parties (e.g. wholesale broadband access, leased lines terminating segment, any other).	Strong incentive for incumbent to structure the wholesale services it provides to the altnet (technical specifications) and wholesale charges in a manner which prevents altnets from providing wholesale services to third parties.
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CONCLUSIONS

- Copper VULA is intrinsically not equivalent to copper SLU, and cannot be made intrinsically equivalent to copper SLU, in particular because it is provided over a hybrid copper-fibre architecture and is delivered at the MDF or equivalent location - i.e. includes feeder segment. On the contrary when using SLU, the altnet can build its own feeder segment or lease fibre in the feeder segment and equip it with the best equipment to ensure zero contention.
- Copper VULA, if it is the only available wholesale input (i.e. if physical access is not available) has intrinsically inferior characteristics in terms of enabling competition, with important likely consequences for wholesale charges and retail prices, and for investment incentives.
- For comments on the characteristics of copper VULA, please refer to the table on Copper LLU vs Copper VULA.

Table 3: FIBRE Unbundling vs FIBRE Virtual Unbundled Local Access (VULA)

	Unbundled access to the fibre loop (at Optical Distribution Frame (ODF))	VULA (incumbent using fibre GPON with VULA delivered at MDF, ODF or equivalent location)
Equipment which the alternative operator (altnet) can deploy	<p>Altnet can deploy ANY equipment (on both the network side and the Customer Premises Equipment side - CPE) including new generations of advanced equipment on the fibre line. There are no interference concerns on fibre lines.</p> <p>This enables:</p> <ul style="list-style-type: none"> the provision of any technically feasible speed, including symmetric multi-Gigabit services for businesses and for consumers that demand it; differentiated functionalities e.g. multi-VLAN, Ethernet Network-to-Network interface (NNI), multicast; wavelength Division Multiplexing (WDM), enabling Terabit speeds; use of multiple fibres for even higher speeds, physical separation of traffic types (e.g. for security reasons). 	<p>Altnet has to rely on incumbent technology choice, including possible speed, profile (downstream/upstream) and CPE restrictions.</p> <p>Note that the incumbent:</p> <ul style="list-style-type: none"> often prefers GPON, in which the feeder segment is a shared medium among 64/128 customers; preference for GPON may be a strategic choice in light of regulatory considerations – i.e. preventing unbundling (until WDM is commercially available); tends to optimise for consumer market, i.e. by offering asymmetric speeds (slow upload), a few VLANs for voice, IPTV, maybe a ‘fast lane’; is unlikely to aggressively upgrade to the fastest equipment (incl. to WDM) or use multiple fibres, unless it is truly under pressure from a parallel infrastructure.
Incentives for the incumbent and the altnet to upgrade	<p>Strong incentive for the altnet to ‘do better’ than the incumbent; strong incentive for the incumbent to match any altnet deployment of advanced equipment, speed or services on the fibre line.</p> <p>Note that e.g. altnets took the lead with deploying new technologies on fibre (multi-gigabit services offered to business customers by altnets on</p>	<p>Weak incentive for incumbent to upgrade to next technology evolution (incl. WDM), unless truly under pressure from parallel infrastructure.</p> <p>Note that incumbents have to a large extent upgraded to FttC rather than FttH where DOCSIS3 on Cable exists, and where they</p>

	own/rented fibre for many years; genuine 1 Gbit/s and 2 Gbit/s consumer offers emerging where unbundled access to the fibre loop is operational).	have deployed FttH they have often preferred GPON, suggesting that pressure is limited.
Backhaul and level of contention	Altnet can lease the unbundled fibre loops, equip them with the best equipment, and build or lease fibre backhaul with zero contention, enabling provision of maximum speed to all its customers.	Strong incentive for incumbent to build contended network in the feeder segment (from first GPON splitter to ODF) to enable charging a premium for speed or even prevent altnets taking VULA from providing maximum speeds to all their customers.
Pricing flexibility at retail level	Altnet can set any price (within wholesale charge + its own cost constraints, unless selling at a loss) and thus has freedom to experiment with pricing to drive take-up. Note that, as a matter of principle, providing additional speed will not generate additional material costs.	Strong incentive for the incumbent to charge high premium for higher speed at both retail and wholesale level, thereby neutralizing speed and price competition from altnets taking VULA.
Provision of wholesale services to third parties	Altnet can provide wholesale services to third parties (e.g. wholesale broadband access, leased lines terminating segment, any other).	Strong incentive for incumbent to structure the wholesale services it provides to the altnet (technical specifications) and wholesale charges in a manner which prevents altnets from providing wholesale services to third parties.

CONCLUSIONS

- Fibre VULA is intrinsically not equivalent to unbundled access to the fibre loop, and cannot be intrinsically equivalent to unbundled access to the fibre loop.
- Fibre VULA, if it is the only available wholesale input (no physical access) has intrinsically inferior characteristics in terms of enabling competition, with important likely consequences for wholesale charges and retail prices, and investment.
- If the objective is to make fibre VULA as close as possible to unbundled access to the fibre loop, regulation needs to ensure that:
 - All VULA lines always operate at maximum speed enabled by the equipment; different profiles defined only if technology requires different balance between downstream/upstream. Note that this does not address the incentive for the incumbent to upgrade to next technology evolution;
 - VULA enables multi-VLAN(frame length at least 1580 Byte)/Ethernet NNI/multicast;
 - Altnet taking VULA can select, own and install any CPE (unless demonstrated technical impossibility – burden of proof on SMP operator).
 - Alleged contention is not accepted as a justification for tiering the wholesale prices by speed. Wholesale VULA charges that vary by speed or by downstream/upstream profile are prohibited. The only permissible difference in wholesale VULA charges would be for a different (more expensive) CPE, if the CPE has to be provided by the incumbent (see previous point).

Table 4: UNBUNDLING OF FIBRE TERMINATING SEGMENT vs FIBRE Virtual Unbundled Local Access (VULA)

	Unbundled access to the fibre terminating segment (at the first aggregation point)	VULA (incumbent using fibre GPON with VULA delivered at MDF, ODF or equivalent location)
Equipment which the alternative operator (altnet) can deploy	<p>Altnet can deploy ANY equipment (on both the network side and the Customer Premises Equipment side - CPE) including new generations of advanced equipment on the fibre terminating segment (no interference concerns on fibre lines).</p> <p>This enables:</p> <ul style="list-style-type: none"> the provision of any technically feasible speed, including symmetric multi-Gigabit services for businesses and for consumers that demand it differentiated functionalities e.g. multi-VLAN, Ethernet Network-to-Network interface (NNI), multicast. Wavelength Division Multiplexing (WDM), enabling Terabit speeds use of multiple fibres for even higher speeds, physical separation of traffic types (e.g. for security reasons) 	<p>Altnet has to rely on incumbent technology choice, including possible speed, profile (downstream/upstream) and CPE restrictions.</p> <p>Note that the incumbent:</p> <ul style="list-style-type: none"> often prefers GPON, in which the feeder segment is a shared medium among 64/128 customers; preference for GPON may be a strategic choice in light of regulatory considerations– i.e. preventing unbundling until WDM is commercially available; tends to optimise for consumer market, i.e. by offering asymmetric speeds (slow upload), a few VLANs for voice, IPTV, maybe a ‘fast lane’; is unlikely to aggressively upgrade to the fastest equipment (incl. to WDM) or use multiple fibres, unless it is truly under pressure from a parallel infrastructure.
Incentives for the incumbent and the altnet to upgrade	<p>Strong incentive for the altnet to ‘do better’ than the incumbent; strong incentive for the incumbent to match any altnet deployment of advanced equipment/speed/services on the fibre terminating segment.</p> <p>Note that e.g. altnets took the lead with deploying new technologies on fibre (multi-gigabit services offered to business customers by altnets on own/rented fibre; genuine 1 Gbit/s and 2 Gbit/s consumer offers</p>	<p>Weak incentive for incumbent to upgrade to next technology evolution (incl. WDM), unless truly under pressure from parallel infrastructure.</p> <p>Note that incumbents have to a large extent upgraded to FttC rather than FttH where DOCSIS3 on Cable exists, and where they</p>

	emerging where unbundled access to the fibre loop and/or fibre terminating segment is operational).	have deployed FttH they have often preferred GPON, suggesting that pressure is limited.
Backhaul and level of contention	Altnet can lease the fibre terminating segments, equip them with the best equipment, and build or lease fibre backhaul with zero contention, enabling provision of maximum speed to all its customers.	Strong incentive for incumbent to build contended network in the feeder segment (from first GPON splitter to ODF) to enable charging a premium for speed or even prevent altnets taking VULA from providing maximum speeds to all their customers.
Pricing flexibility at retail level	Altnet can set any price (within wholesale charge + its own cost constraints, unless selling at a loss) and thus has freedom to experiment with pricing to drive take-up. Note that as a matter of principle providing additional speed will not generate additional material costs.	Strong incentive for the incumbent to charge high premium for higher speed at both retail and wholesale level, thereby neutralizing speed and price competition from altnets taking VULA.
Provision of wholesale services to third parties	Altnet can provide wholesale services to third parties (e.g. wholesale broadband access, leased lines terminating segment, any other).	Strong incentive for incumbent to structure the wholesale services it provides to the altnet (technical specifications) and wholesale charges in a manner which prevents altnets from providing wholesale services to third parties.

CONCLUSIONS

- Fibre VULA is intrinsically not equivalent to access to the fibre terminating segment, and cannot be intrinsically equivalent to access to the fibre terminating segment.
- Fibre VULA, if it is the only available wholesale input (no physical access) has intrinsically inferior characteristics in terms of enabling competition, with important likely consequences for wholesale charges and retail prices, and investment.
- For comments on the characteristics of fibre VULA, please refer to the table on Fibre Unbundling vs Fibre VULA.

GLOSSARY

Ethernet NNI Network-to-Network interface	Ethernet Network-to-Network interface specified by Metro Ethernet Forum (MEF)
Feeder segment	The segment connecting the street cabinet to the MDF or the GPON fibre splitter to the ODF.
FttC	Fibre to the cabinet
FttH	Fibre to the home
Fibre terminating segment	Fibre running from the customer premises to the first aggregation point, which can be at the foot of the building, or specific aggregation points of +/- 300-1000 lines.
GPON	Gigabit Passive Optical Network
IPTV	Internet Protocol Television
MDF	Main Distribution Frame (the rack on which copper lines are aggregated in the incumbent's building)
Multicast	http://en.wikipedia.org/wiki/Multicast
Multi-VLAN	Multiple Virtual LANs (enabling Quality of Service guarantees to support IPTV, telephony, and any other applications which need separate VLANs)
ODF	Optical Distribution Frame (the rack on which fibre lines are aggregated)
Pair bonding	Use of two or more copper pairs simultaneously to enhance speed
SLU	Sub-loop unbundling
VULA	Virtual Unbundled Local Access
VDSL	Type of digital subscriber line technology (delivered over copper)

ADSL2+, ShDSL, e-ShDSL, bonded e-ShDSL	Other types of digital subscriber line technologies (delivered over copper)
WDM	Wavelength Division Multiplexing (allowing multiple 'colours' of light to flow through the fibre, e.g. Dense WDM systems can support 160 wavelengths each carrying 10 Gbit/s or even 100 Gbit/s, leading to Terabit performance).