



UKC Science Bridge project on B4G

Energy aspects of backhaul

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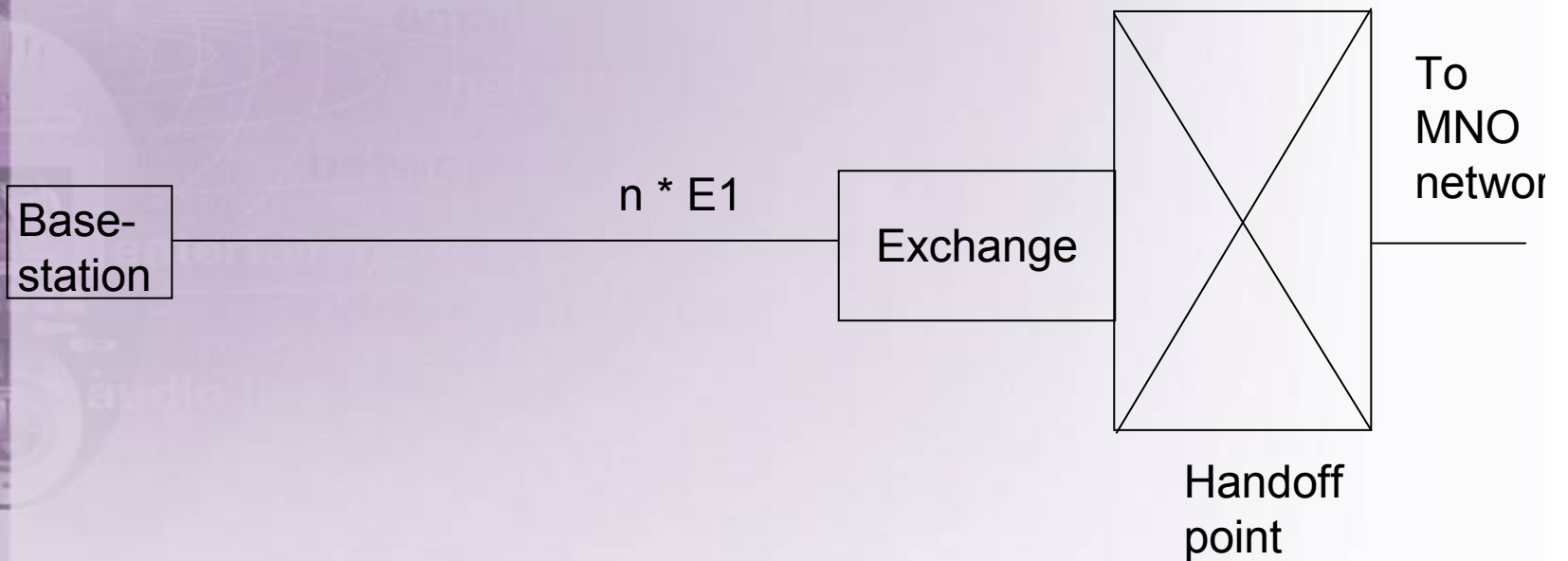
Why is the backhaul energy important to research ?

- **Smaller cells are more power efficient than larger ones**
 - MVCE finding
- **More backhaul connections are needed**
- **Many options**
- **Power consumed is generally constant**
- **Sleep modes etc not generally used on backhaul (but ADSL does have low power mode)**



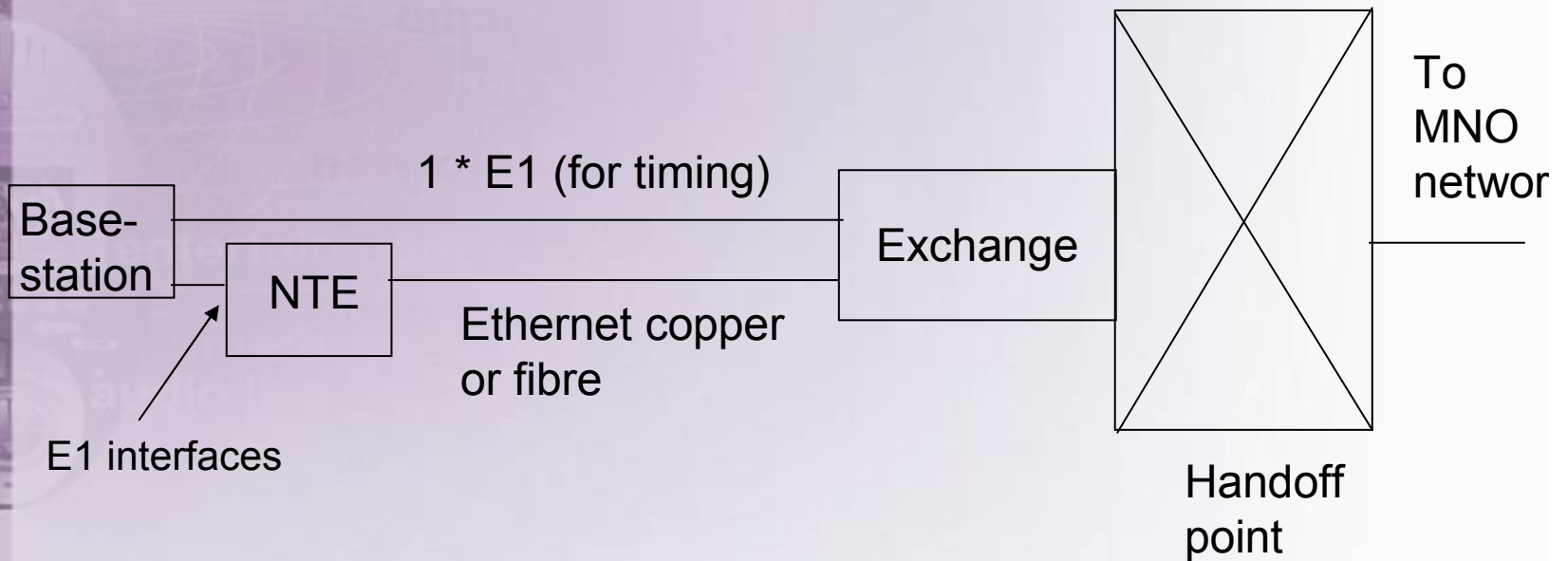
Backhaul options

Macro base-stations commonly use $n \cdot E1$ (2Mbit/s PDH)



Backhaul options

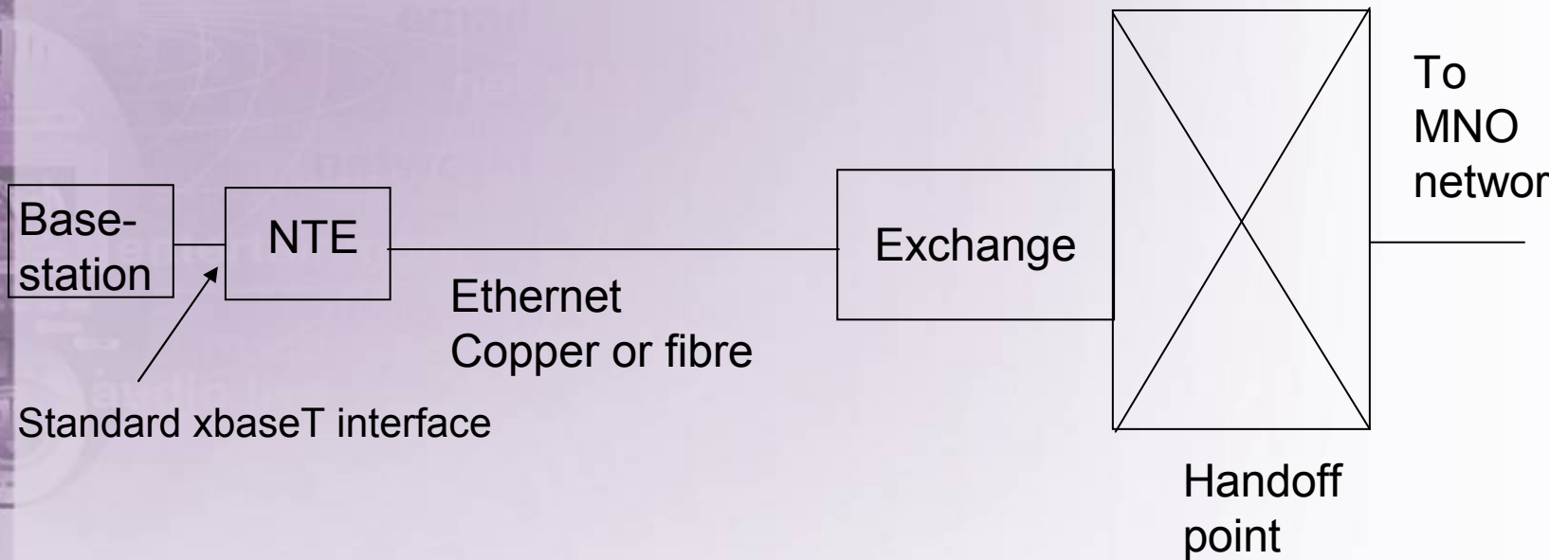
Macro base-stations are increasingly using 1Gbit/s ethernet



One E1 circuit remains for timing
To be replaced in due course by SyncE

Backhaul options

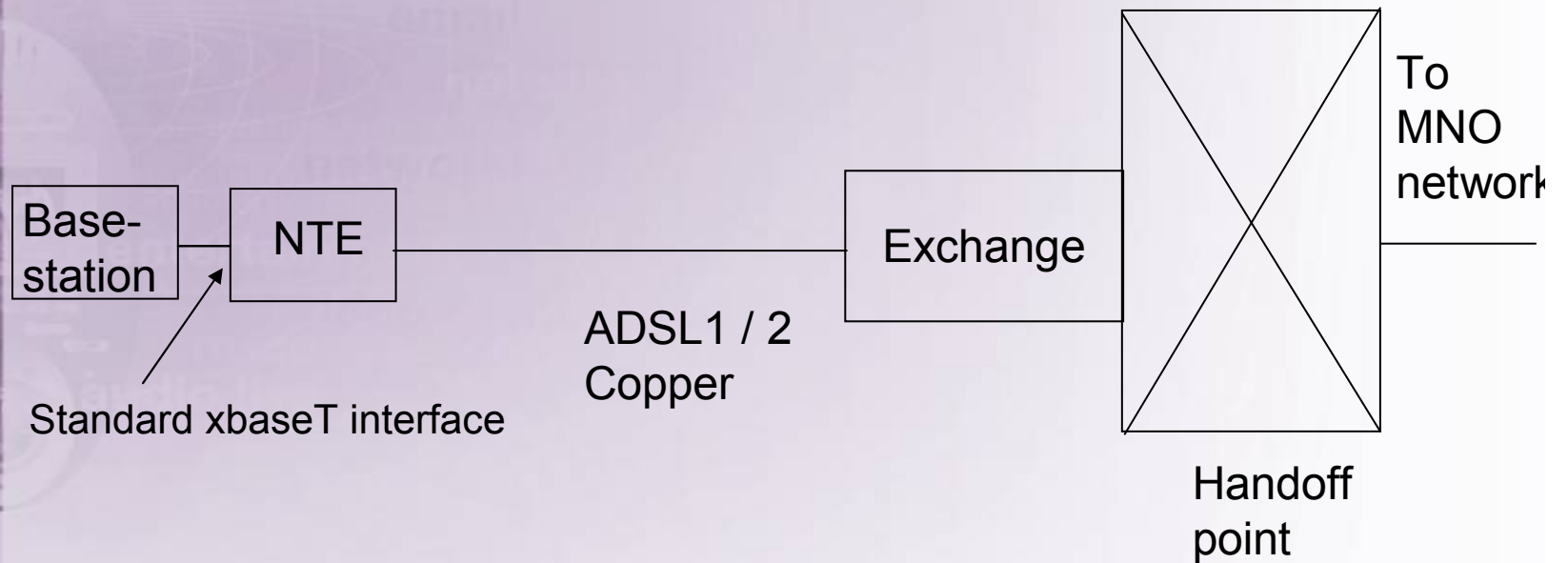
Smaller base-stations could use Ethernet



Small base-stations typically have relaxed sync requirements and derive frequency lock from a macro

Backhaul options

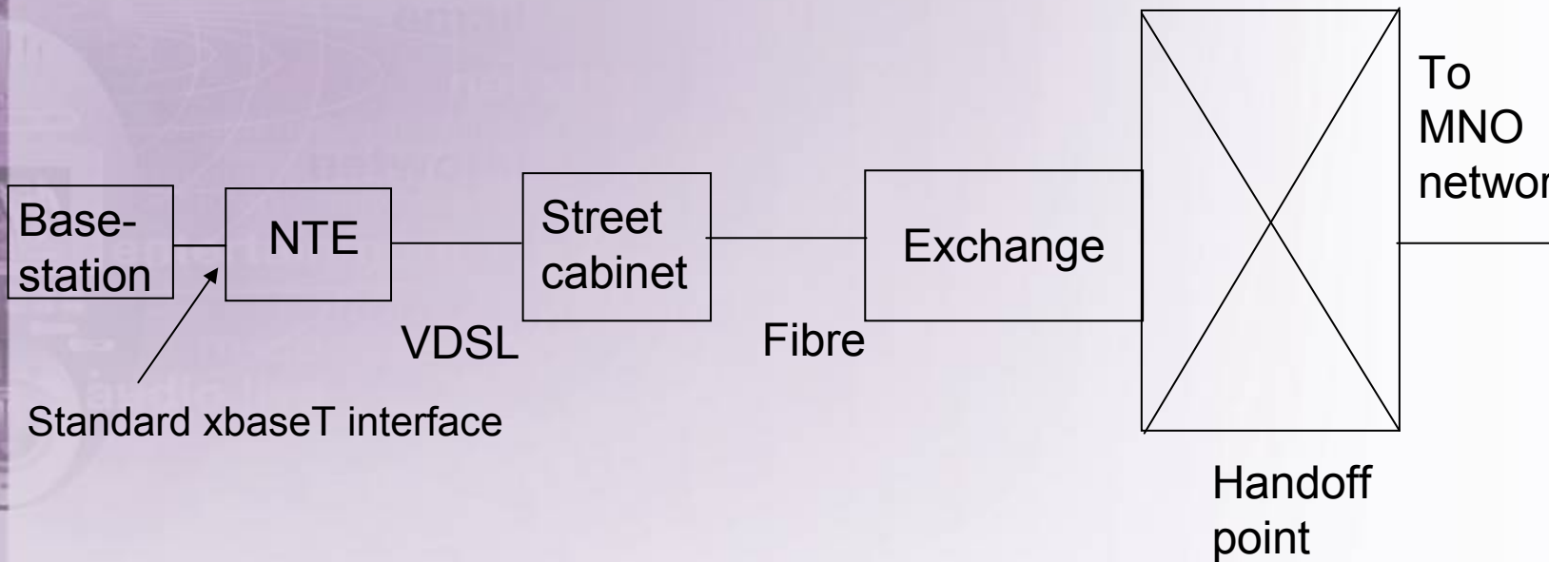
Smaller base-stations could use ADSL



ADSL bit-rates are typically 8Mbit/s down, 450kbit/s up, but rates are distance dependent

Backhaul options

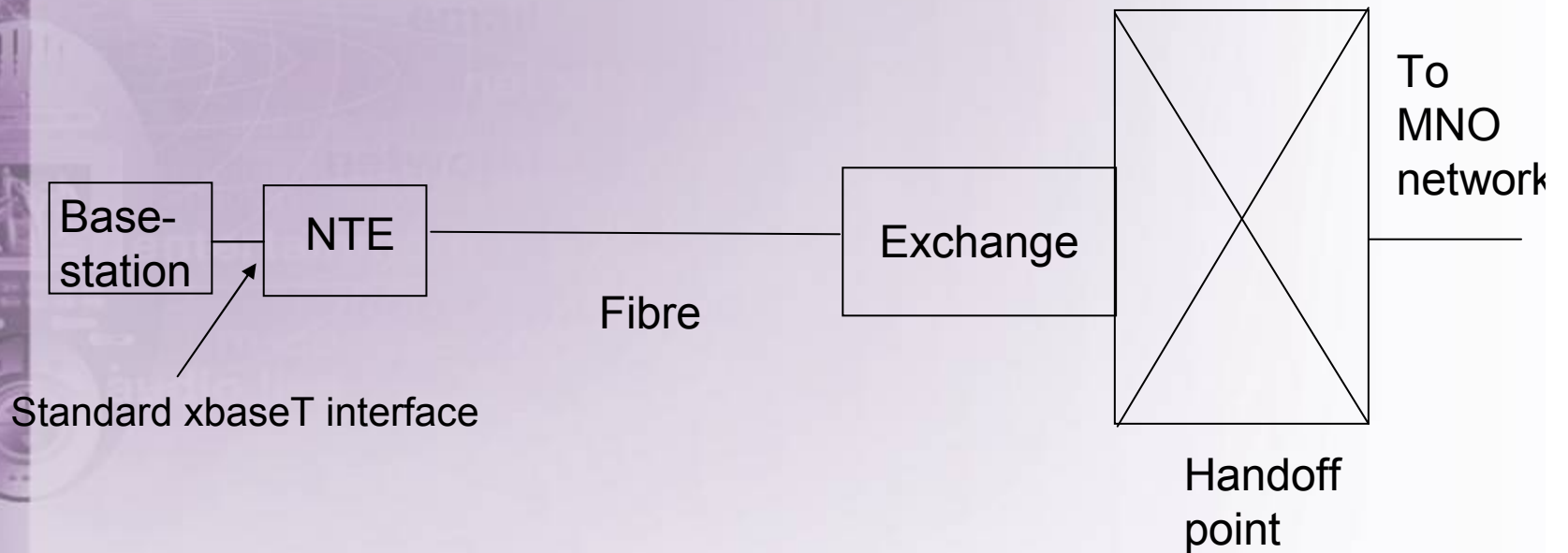
Smaller base-stations could use VDSL, but needs to be fed via a street cabinet



VDSL bit-rates depend on the profile but max is about 200Mbit/s down and up, rates are distance dependent

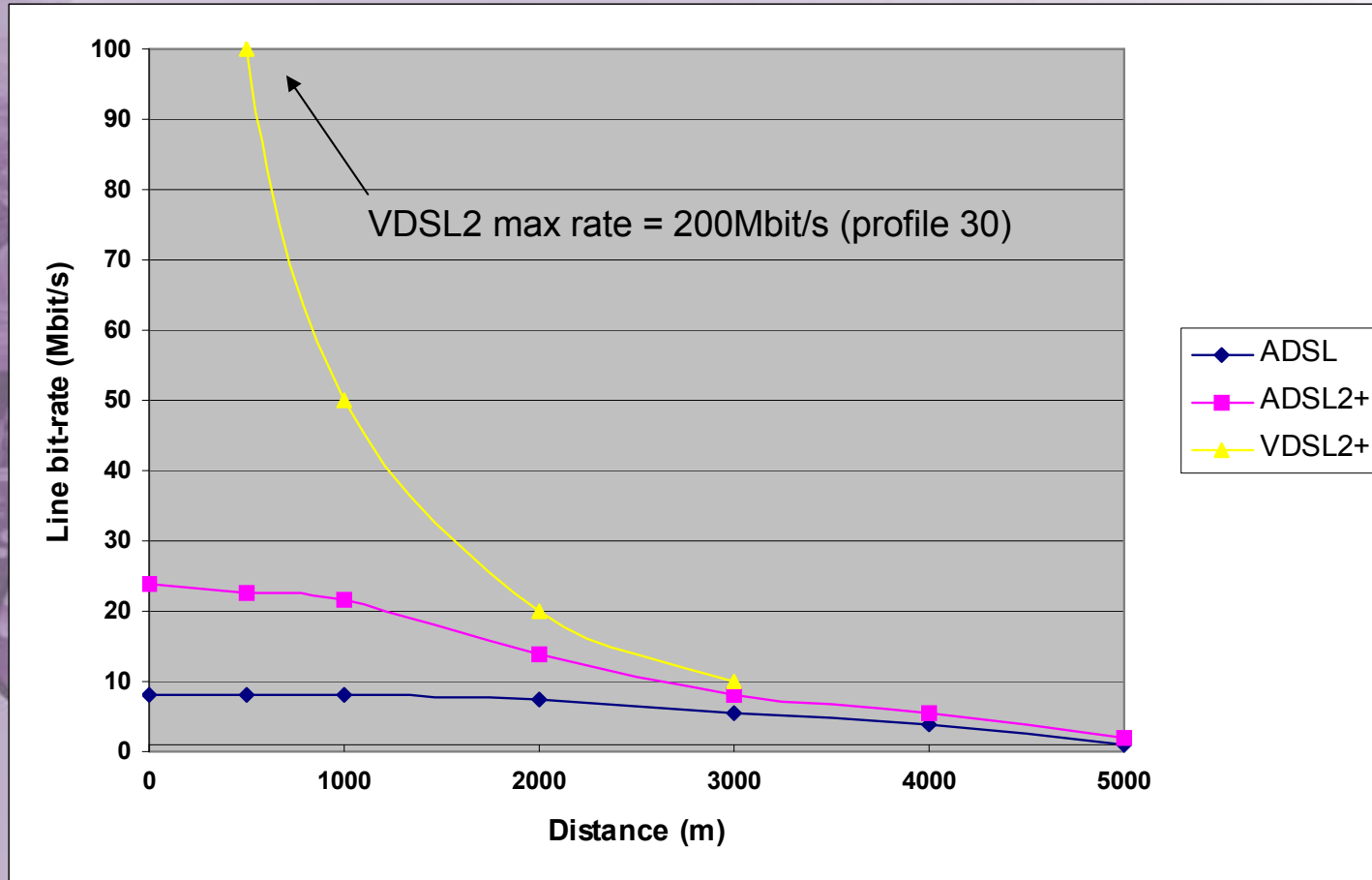
Backhaul options

Smaller base-stations could even use fibre all the way



The NTE is expensive on power in this case, as it contains high speed electronics (demodulates at fibre line rate)

DSL bit-rates against distance (downlink)



ADSL uplink approx 450kbit/s (capped)

VDSL is approximately symmetrical

Little difference between them for > 3km line length

www.mobilevce.com

FTTC helps this

Energy consumption of backhaul options

Option	Base-station end W (J/bit)	Network energy to handover (W)/(J/bit)	Band- width (Mbit/s)	Comments
E1 PDH	25 – 50 ($1.25 - 2.5 * 10^{-5}$)	Included	2	Estimate of power
Fibre Ethernet	26 ($<2.6*10^{-9}$)	21 / ($<2.1*10^{-9}$)	>100	Higher than EC code of conduct
Copper Ethernet	13 ($1.3*10^{-8}$)	15 ($1.5*10^{-8}$)	10	
ADSL	5 ($6.2*10^{-7}$)	1.3 ($1.6*10^{-7}$)	8 (typ)	Low power modes possible
VDSL	7.5 ($5*10^{-7}$)	2.5 ($1.7*10^{-7}$)	15 (typ)	
FTTP	9.7 ($9.0*10^{-8}$)	0.5 ($5*10^{-9}$)	>100	Network end shared between 32 users. 2Gbit/s gross rate.

Information from BT measurements and Code of Conduct on Energy Consumption of Broadband Equipment, Version 3, November 2008, European Commission.

Backhaul research challenges

- Low power modes
- Latency (eg related to low power modes)
- More meaningful comparisons
- Multiplication problem
- Electronics in fibre / ethernet switches etc
- Low cost timing solutions
- Optimum solutions for 3G / LTE small cells



Thank you !



MOBILE

VCE

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