Challenges in Future Wireless Broadband Access Networks

C1 – Öffentlich / Public

Version 1.0

Dr. Andreas Jungmaier
Network Strategy & Assessment / TNS
Vodafone D2

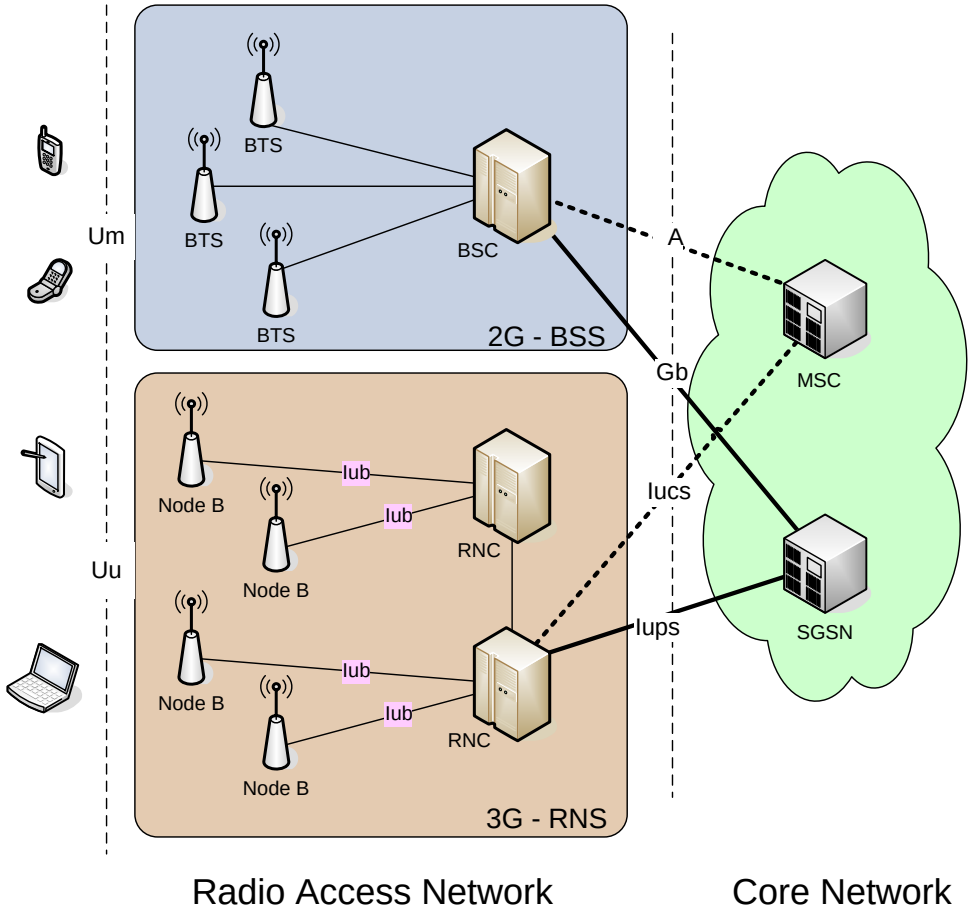
“The Future of Broadband Wireless”
26. Treffen der ITG Fachgruppe 5.2.4
Düsseldorf, 28.02.2008

vodafone

Agenda

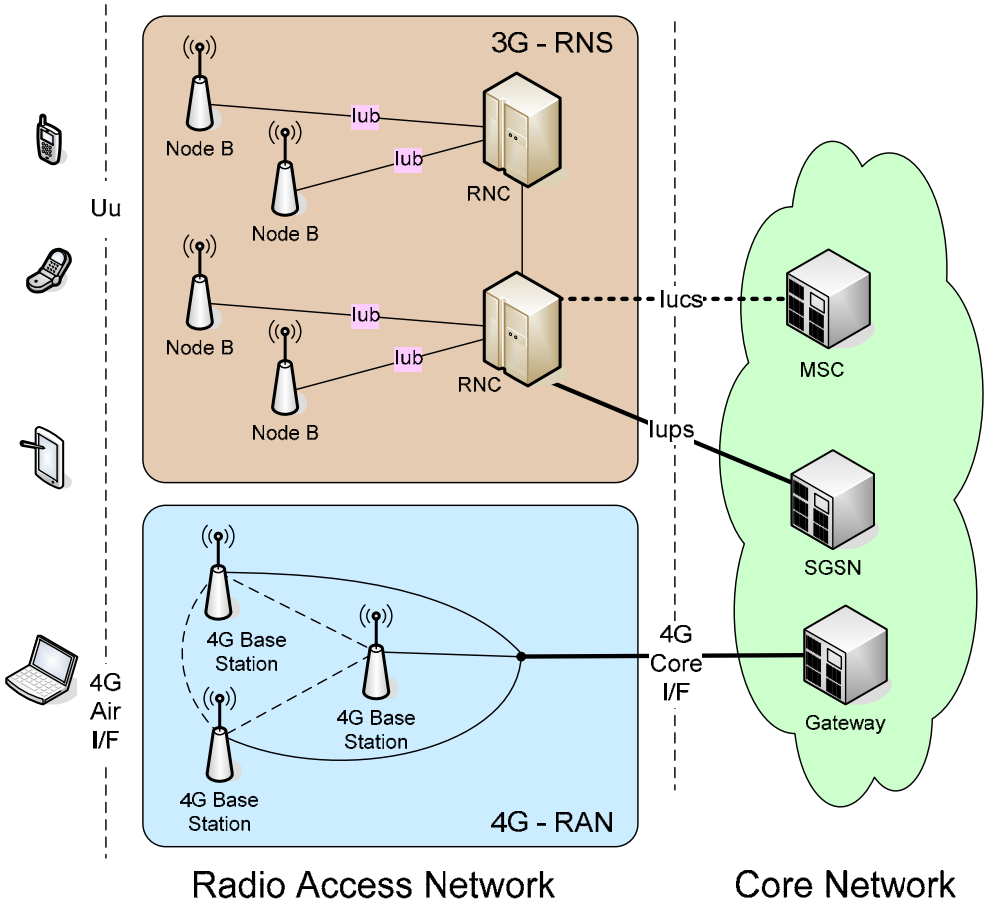
- **Access architectures – technology brief**
- **Drivers and requirements in future access networks**
- **Infrastructure options for the future access**
  - Leased Lines
  - DSL
  - Microwave Links
  - Fibre to the Node
- **Switching technologies in the future access**
  - ATM
  - MPLS and Pseudowire Emulation Edge-to-Edge (PWE3)
  - Carrier Ethernet
- **Outlook and conclusion**

Access architectures – technology brief (i)



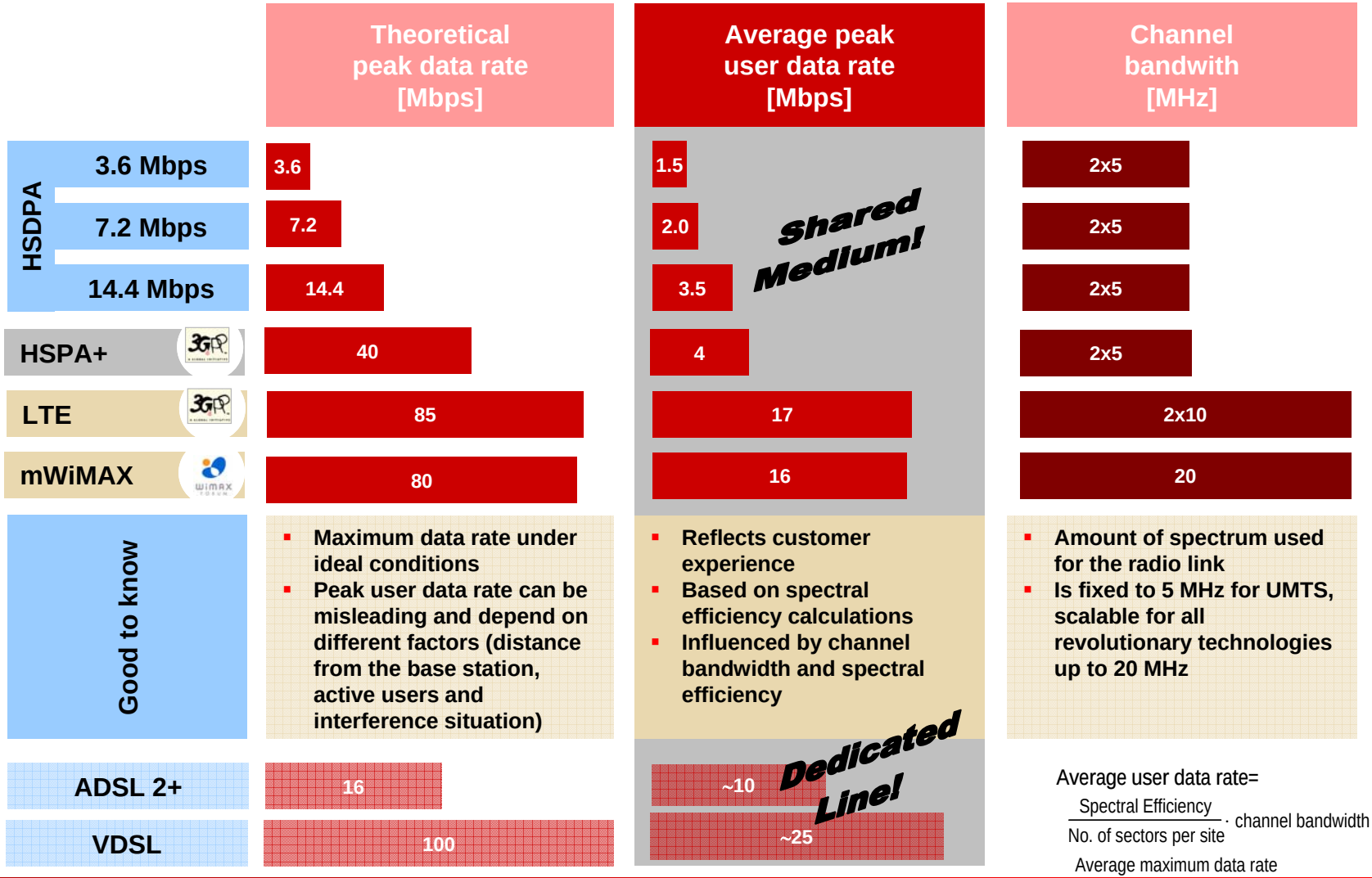
- **2G BSS is TDM based**
  - Circuit switched voice
  - GPRS / EDGE
- **Low connection capacities**
  - typically PDH: 1 x E1
  - mostly microwave links or leased lines
- **3G RNS is typically ATM based**
  - R'99 circuit switched voice
  - R'99 packet switched Data
  - Rel.5/6 HSDPA/HSUPA packet switched data
- **Medium connection capacities**
  - typically PDH: 1-8 x E1
  - mostly microwave links or leased lines

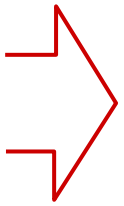
Access architectures – technology brief (ii)



- **3G RNS is ATM and IP based**
  - as per Rel-5, native Iub over IP may be used
  - ATM is not ruled out, however
  - Rel.5/6 HSDPA/HSUPA packet switched data suggest higher connection bandwidths
- **Medium connection capacities**
  - typically PDH: 1-8 x E1
  - mostly microwave links or leased lines
- **4G RAN is IP based with a flat architecture**
  - base stations and core network gateways
  - this is true for mobile WiMAX and 3GPP Long Term Evolution (LTE)
- **High connection capacities !**
  - Ethernet based

New technologies push peak access bandwidth requirements





Next generation radio networks will require Ethernet/IP connectivity with capacities between 50 and 200 Mbps…

Infrastructure Options for Future Access (i)

	Leased Lines	xDSL
PRO	• Last resort solution where nothing else works • Low CAPEX • Direct termination at controller site possible (BSC, RNC, etc.)	• Low CAPEX • Lower OPEX than Leased Lines • An option for leased line replacement • High bandwidths in the future
CON	• High OPEX • Low bandwidth (1xE1) • Higher bandwidths (E3, STM-1) are extremely expensive • Ethernet not supported out of the box • terminal equipment may be needed for IP/Ethernet support • Low guaranteed availability	• Bandwidth depends on length of local loop • Maximum reach about 5 km from central office • Carrying PDH/ATM and Ethernet at the same time is not trivial • Cost-efficient backhaul needed from central office to controller site • Low guaranteed availability

Infrastructure Options for Future Access (ii) - DSL

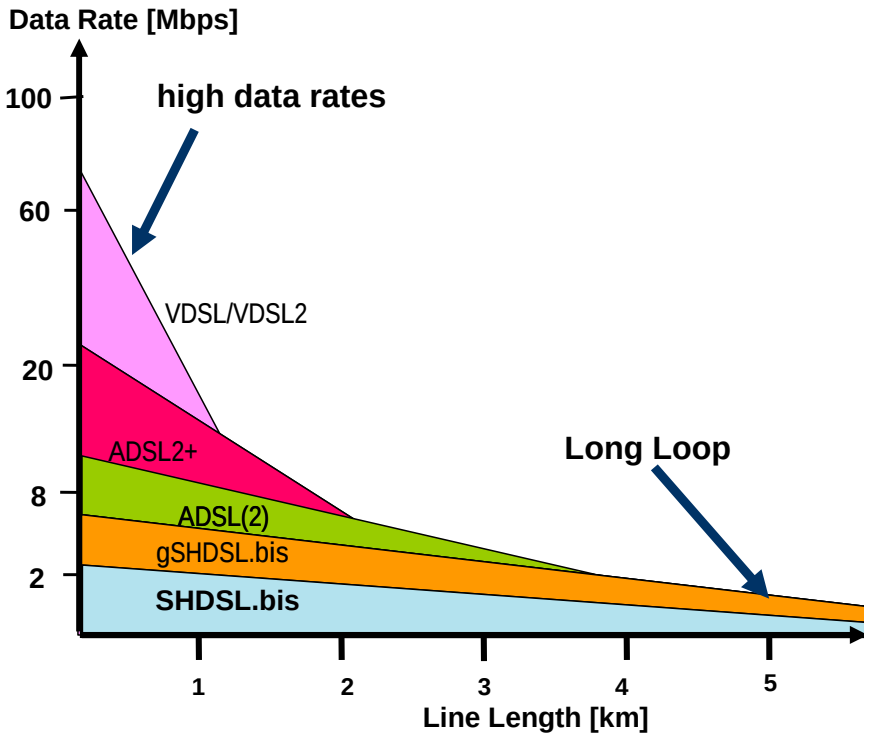
xDSL

PRO

- Low CAPEX
- Lower OPEX than Leased Lines
- An option for leased line replacement
- High bandwidths in the future

CON

- Bandwidth depends on length of local loop
- Maximum reach about 5 km from central office
- Carrying PDH/ATM and Ethernet at the same time is not trivial
- Cost-efficient backhaul needed from central office to controller site
- Low guaranteed availability



- SHDSL offers symmetrical services at long distances from the central office
- gSHDSL.bis enhances the symmetrical bandwidth per copper pair and allows the bonding of up to 4 pairs

Infrastructure Options for Future Access (iii)

Microwave Links

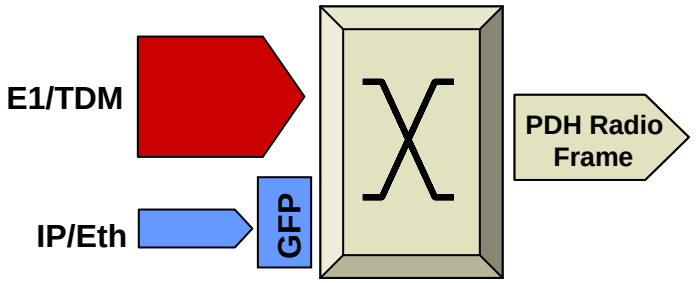
PRO

- Low OPEX
- High bandwidths can be realised
- Next generation microwave links provide hybrid transport of PDH and Ethernet
- High availability (>99.99%)
- P2P and PmP systems available
- Dynamic modulation can adapt to link conditions

	Example : Packet radio system capacity with 28 MHz channel spacing					
Modulation QAM	*4*	*16*	*32*	*64*	*128*	*256*
Typical Peak Capacity [Mbps]	*40*	*80*	*100*	*125*	*150*	*175*

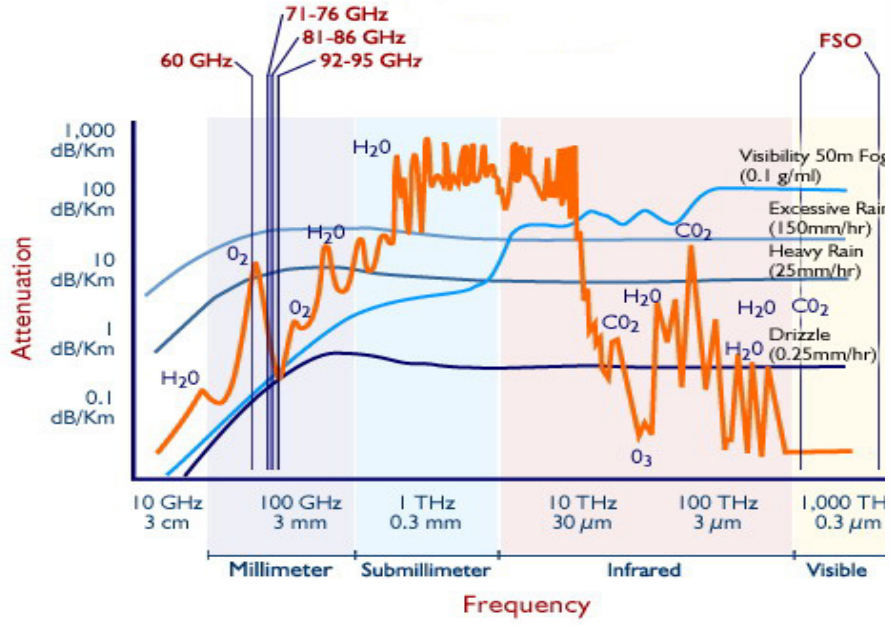
CON

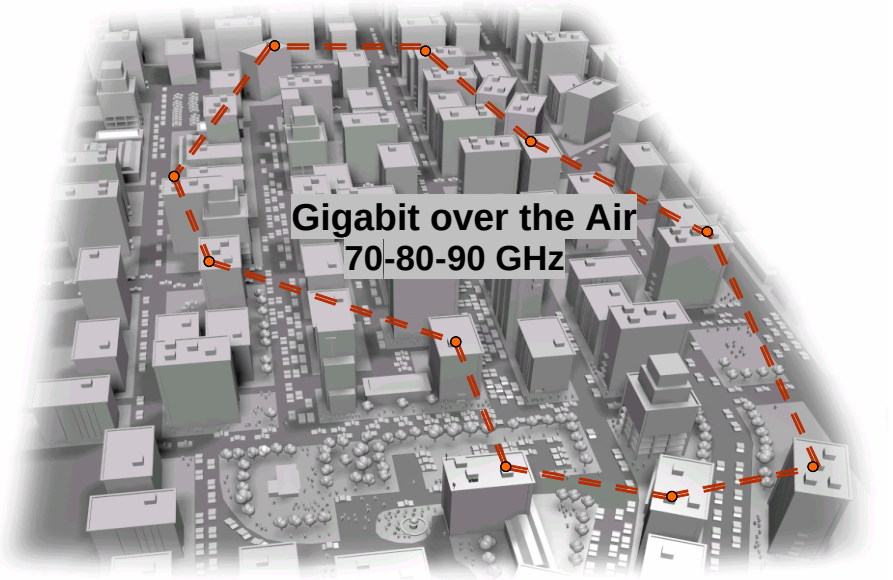
- High CAPEX
- Line of sight needed
- Frequencies are regulated by BNetzA



Gigabit microwave links will be available in the near future

- **Point-to-point links using millimeter waves (aka the E-band) between 60 GHz and 80GHz → ETSI approval is ongoing**
- **Large blocks of frequency spectrum can be used**
- **Narrow line of sight beams → high spectrum reusability**
- **may be a supplement to fiber optics, especially in metro areas**
- **low range (1 to 4 km) because of high attenuation**





Source: Gigabeam

Infrastructure Options for Future Access (iv)

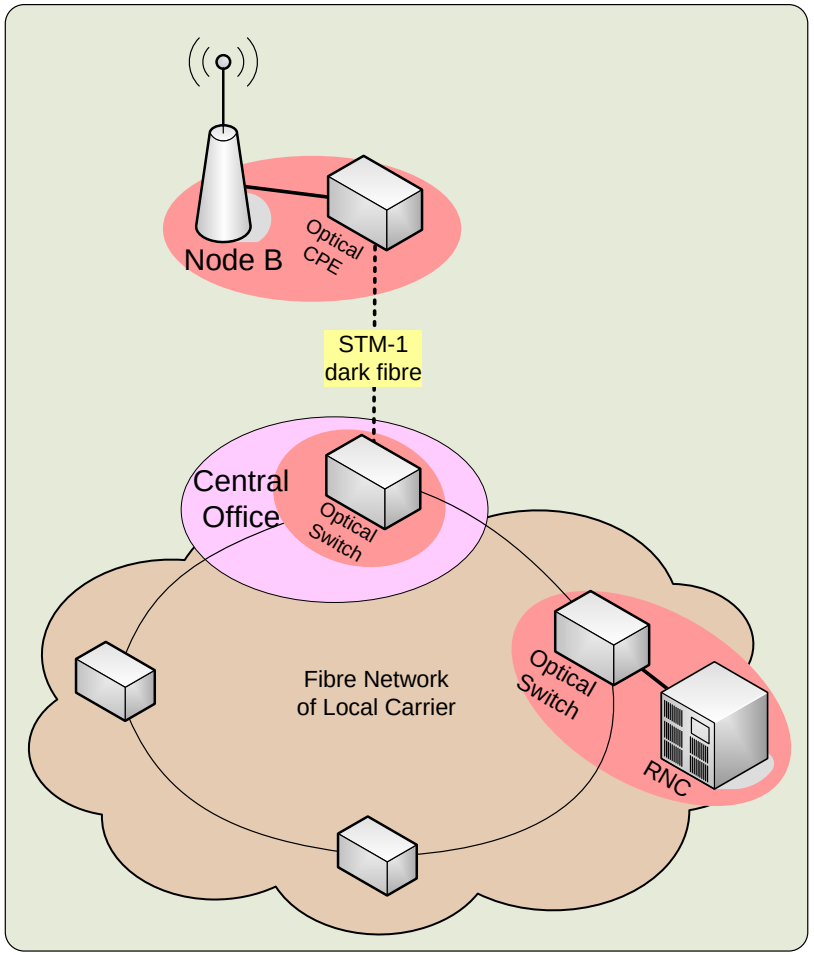
Fibre to the Concentrator/Node

PRO

- Medium CAPEX
- Low OPEX for fibre lease
- High bandwidth can be realised
- Bandwidths can be enhanced easily

CON

- High costs for civil works – depending on length of new fibres
- Cost-efficient backhaul needed from central office to controller site
- Realisation and planning comparably complicated
- Availability can be critical

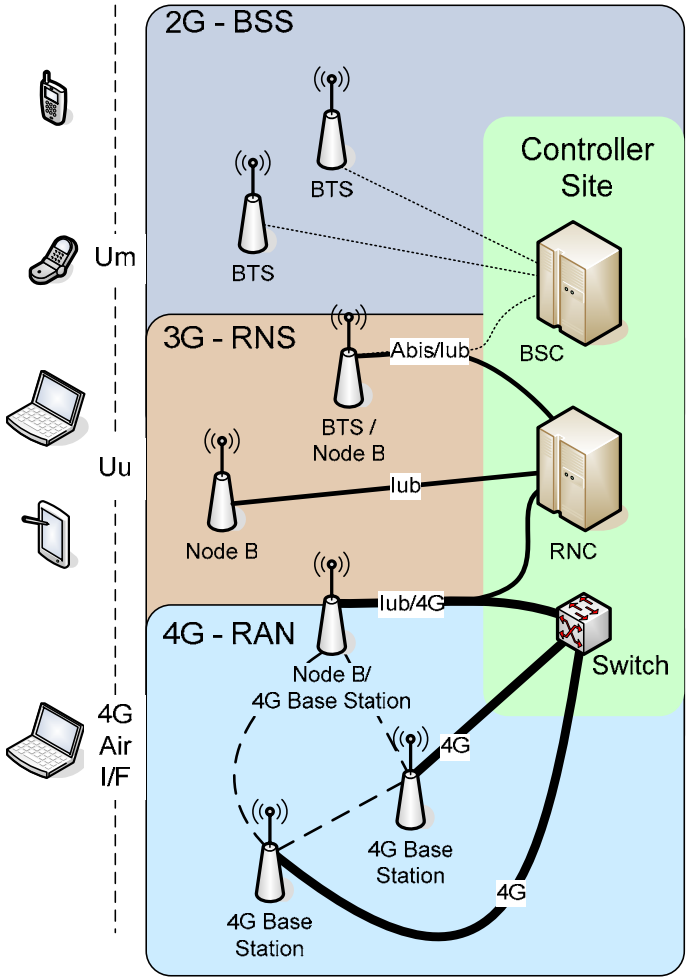


Early and cost-efficient switching is key for the success of the future mobile broadband wireless access network

Switching technologies in the future access (i): ATM

- **ATM is standardised for 3G Iub**
  - User data typically transported over AAL2 (CBR, rt-VBR, UBR)
  - Signalling data transported over AAL5
- **2G traffic can be carried using ATM Circuit Emulation Service (CES)**
- **Ethernet or IP can be transported, e.g. as Classical IP over ATM (CLIP) or LAN Emulation (LANE)**
  - large overheads (AAL5, ATM headers)
- **ATM switching capacity and interfaces are expensive compared to MPLS or Ethernet**
- **early aggregation is difficult**

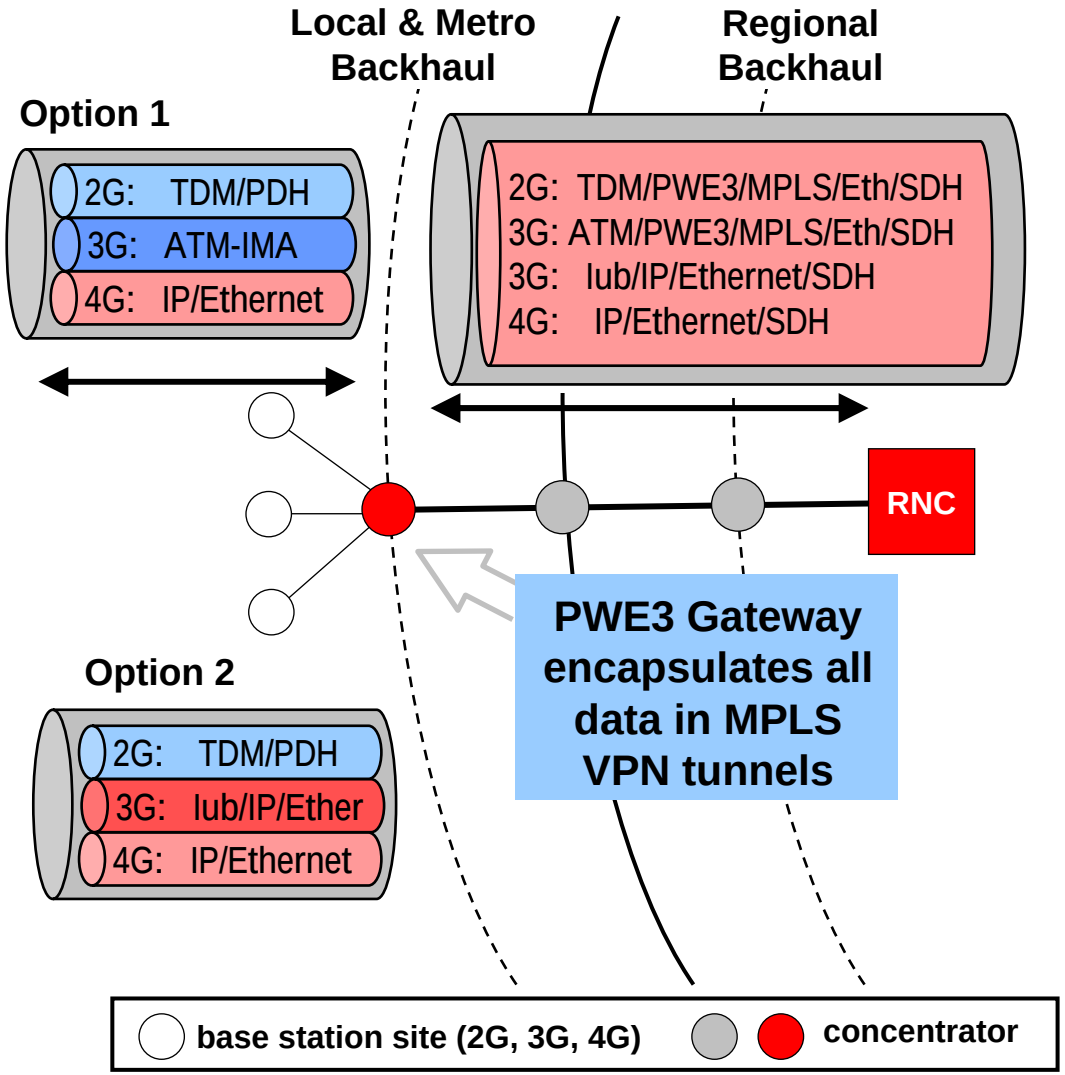
ATM may not be optimal for a data centric 4th generation RAN



Switching technologies in the future access (ii): MPLS and Pseudowire Emulation Edge-to-Edge (PWE3)

- **2G TDM and ATM cells are carried over MPLS VPNs that implement PWE3 tunnels**
  - MPLS is not a “must”, but typically used for PWE3
- **Solution allows an All-IP backhaul**
- **early aggregation gains can be achieved over all technologies**
- **PWE3 incurs additional overheads and delays**
  - MPLS and PWE3 headers
  - buffering delays for packetisation
  - Probably works best with high bandwidth links > 50 Mbps
- **New PWE3 gateways are needed at most concentrator sites (CAPEX!)**

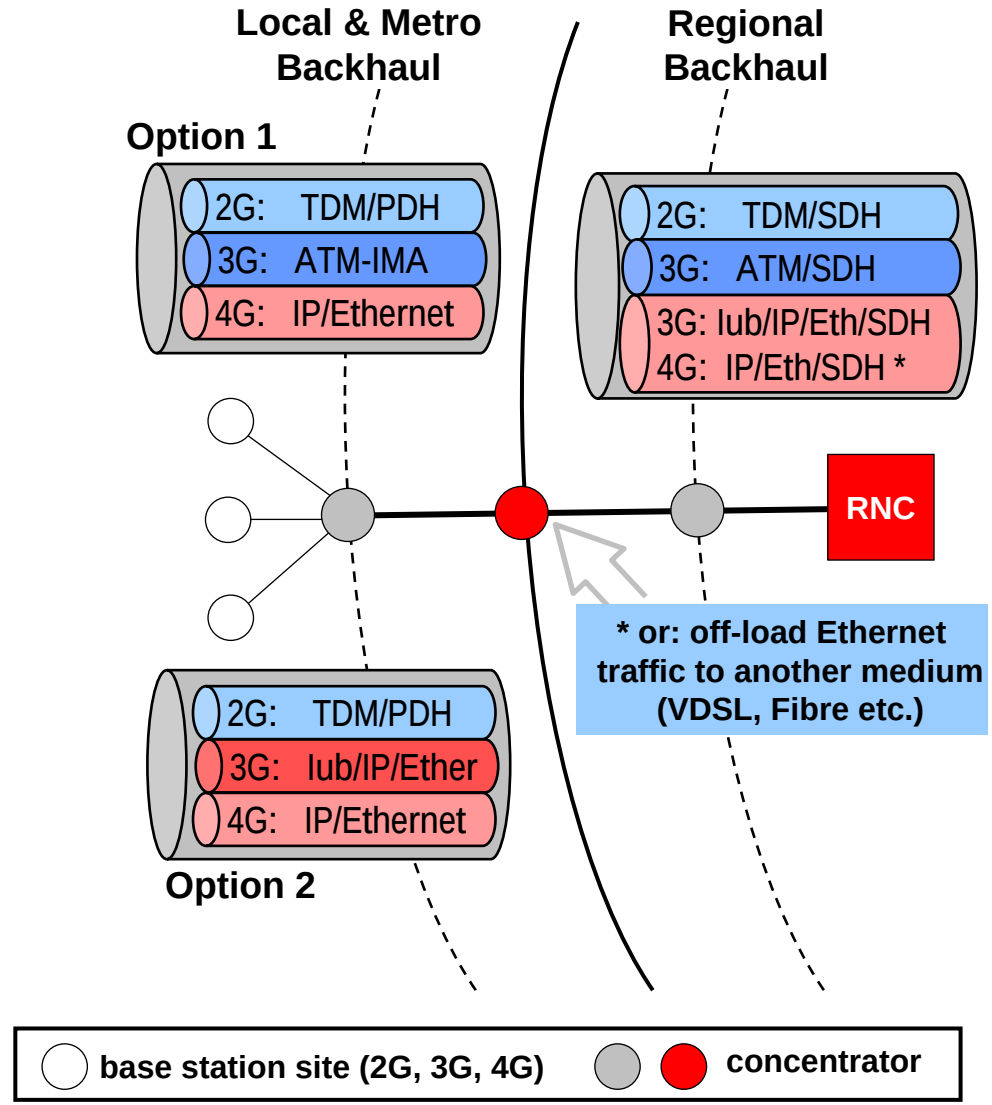
PWE3 is probably a good solution for a green-fielder with small existing install base



Switching technologies in the future access (iii)
Carrier Ethernet

- **Carrier Ethernet enhances traditional Ethernet transport by**
  - providing Ethernet Virtual Connection (EVC) services like P2P E-Line and PmP E-LAN (multipoint layer 2 VPNs)
  - this may be useful, e.g. for handover traffic between 4G base stations
  - Circuit Emulation Service (for E1)
  - better management options
- **Small Eth switches are integrated in NodeB or microwave equipment**
  - allows early aggregation gains
- **Parallel Carrier Ethernet infrastructure can be established step-by-step**
- **Ethernet works everywhere (PDH, DSL, Microwave Radio, Fibre)**
- **But: requires management of three separate switching infrastructures!**

Carrier Ethernet is probably a good solution for enhancement of a large existing install base



Key conclusions

1. There are plenty of options to choose from: future mobile access networks will become more diverse – just like the radio technologies they support.

2. Future traffic demands drive high bandwidth capabilities in Gbps region at concentrator sites. A trade-off between all available media is necessary, taking into account individual costs.

3. Technology trends and increasing packet switched data traffic suggest that future mobile access solution should be optimised for IP/Ethernet traffic, not forgetting the legacy install base

4. Early switching is key to the success of the future mobile broadband access networks since an early aggregation could be achieved thus relieving the regional backhaul links.