Mobile network evolution
A tutorial presentation

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everything everywhere™

hello

About Everything Everywhere

Everything Everywhere – one company running two of Britain's most famous brands, Orange and T-Mobile.

In September 2009 it was announced that France Telecom and Deutsche Telekom had agreed to merge T-Mobile UK and Orange UK into a 50:50 joint venture to create the UK's leading mobile operator. After dotting the i's and crossing the t's, the company was officially formed on April 1 2010.

We have more than 30 million customers and more than 700 stores across our two brands.

Agenda

- The evolution of 'mobile'
- 3GPP logical network architectures
- Network architecture design
- Mobile backhaul
- TDM to Ethernet
- The growth of 'sharing'
- Getting ahead of the game
- Summary

The evolution of 'mobile'

Mobile…

- From the novelty of a mobile telephone to the convenience of access to everything everywhere
- Connected mobile devices are now an integrated part of our work and leisure at an individual level
- Mobile data usage is increasing on a per subscriber basis however many new opportunities are driving overall network data to even higher levels
  - M2M, security, tele-medicine, telemetry, tracking, automotive etc…
- The mobile industry is responding with new radio access network technologies and increasingly complex control and policing techniques
  - GSM – GPRS – EDGE – eEDGE – UMTS – HSPA (multi-carrier, MIMO, HOM etc.) – LTE – LTE-A…
  - Policy and control functions, DPI, traffic shaping, time of day tariffs etc…
- New RAN architectures will continue to enhance the overall capacity available within a given geographical zone
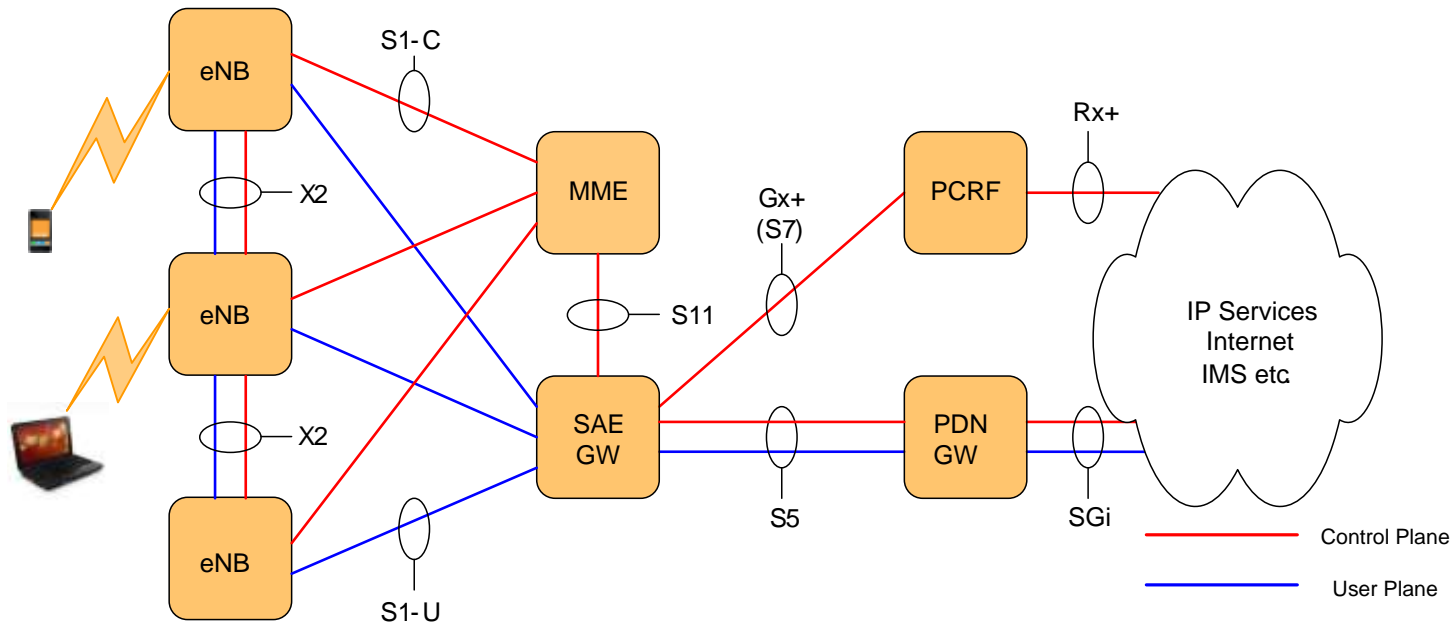
3GPP logical network architecture
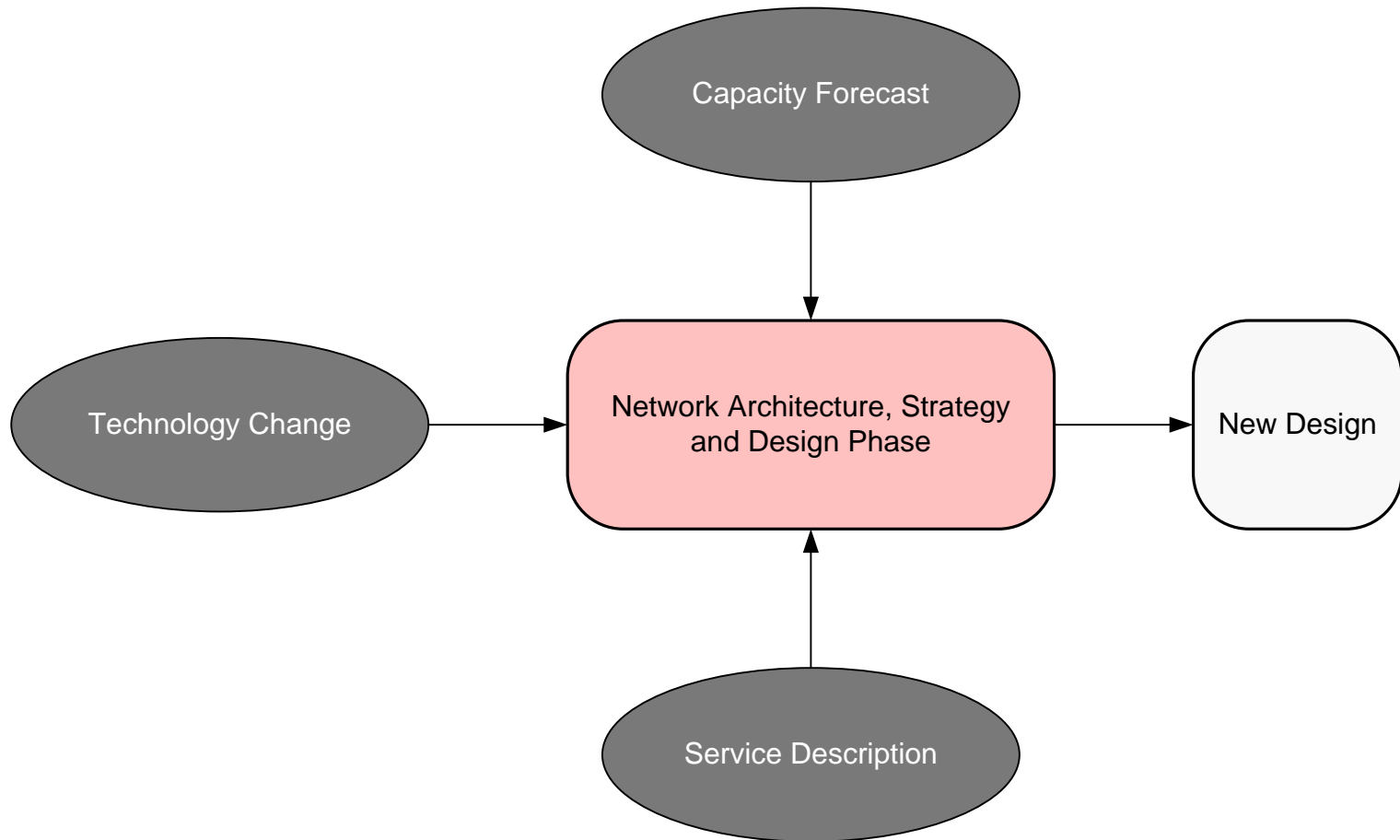
GSM logical architecture
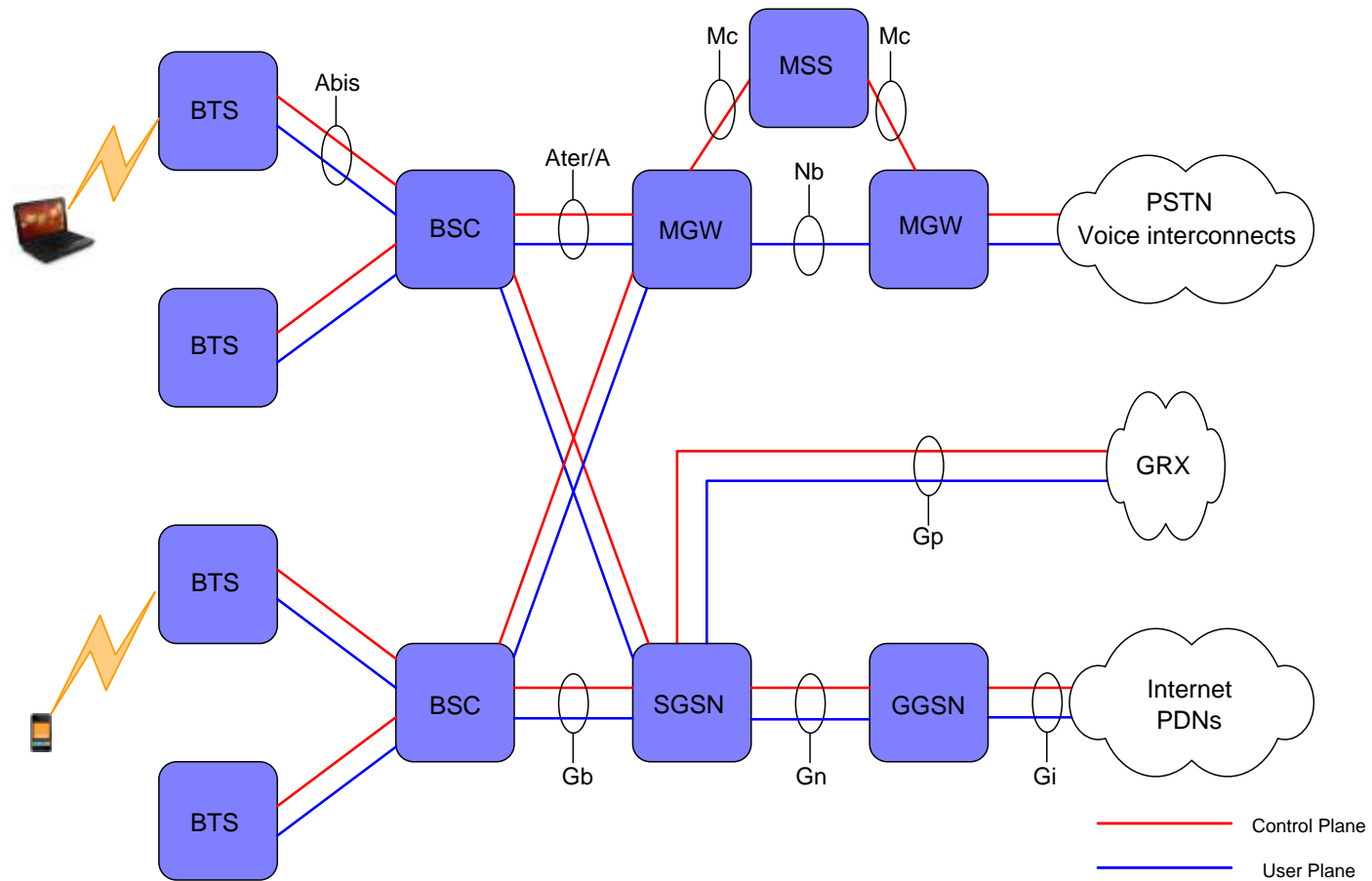
UMTS logical architecture
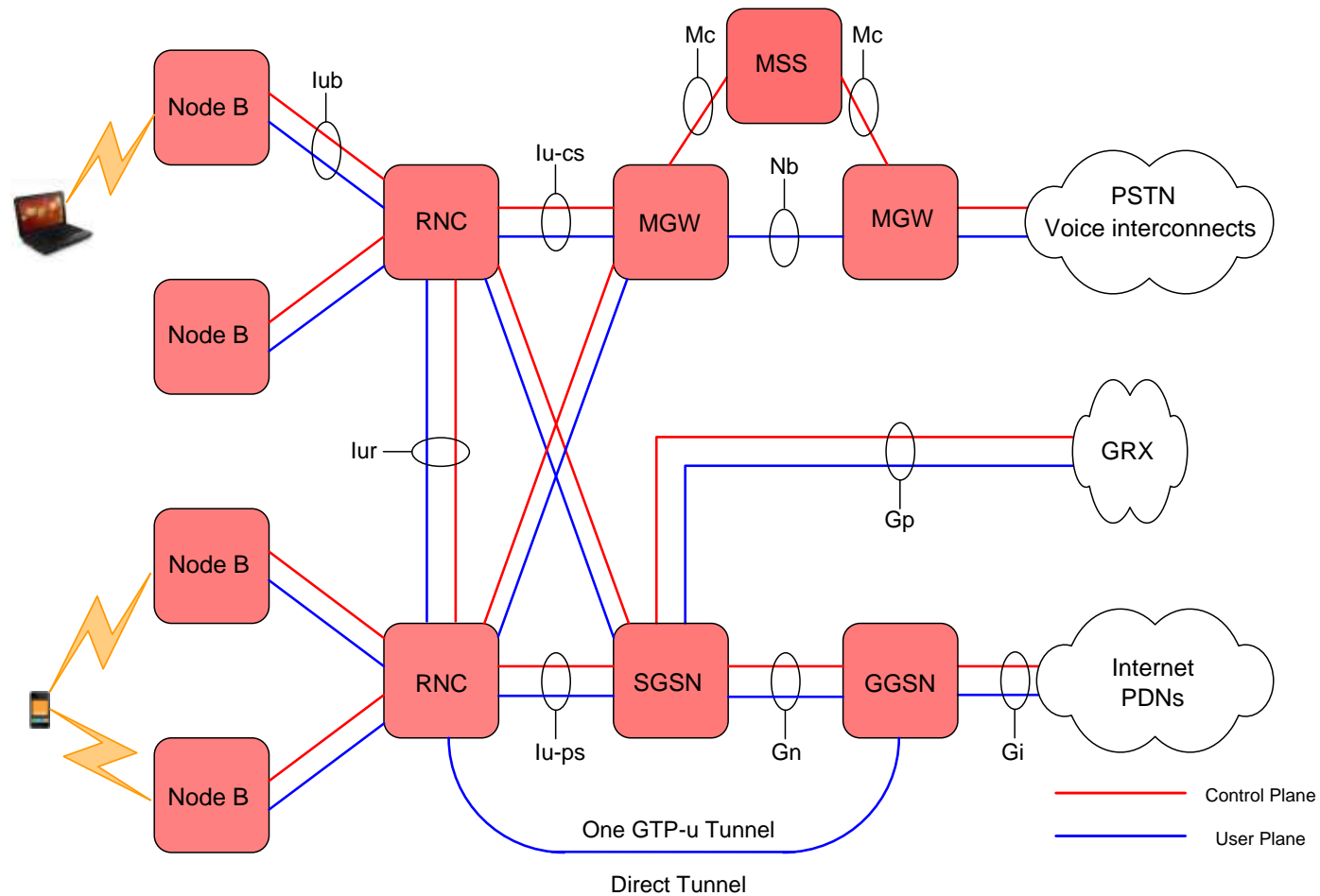
EPS logical architecture

Network architecture design

Architecture design

# Mobile backhaul

What do we backhaul?

In the beginning

- I'll start with GSM rather than analogue however it's a similar story…
- TDM circuits, E1, T1 etc.
- Dimensioned against Erlang B
- Established multiplexing hierarchies - PDH & SDH
- Enhanced OAM&P with SDH
- Very standards based, ITU-T
- 3G arrived with ATM (R99)
- Built on experience within fixed ATM deployments however cracks started to show…

Today and tomorrow

- Mobile broadband has changed the game significantly
- The number of E1s required makes scalability a costly challenge
- Not as simple as Erlang B anymore
- Migration towards Ethernet and IP transport Network Layer
- Many standards however still breaking new ground
- Mobile backhaul is no longer simple transmission
- How do we sync without HDB3…
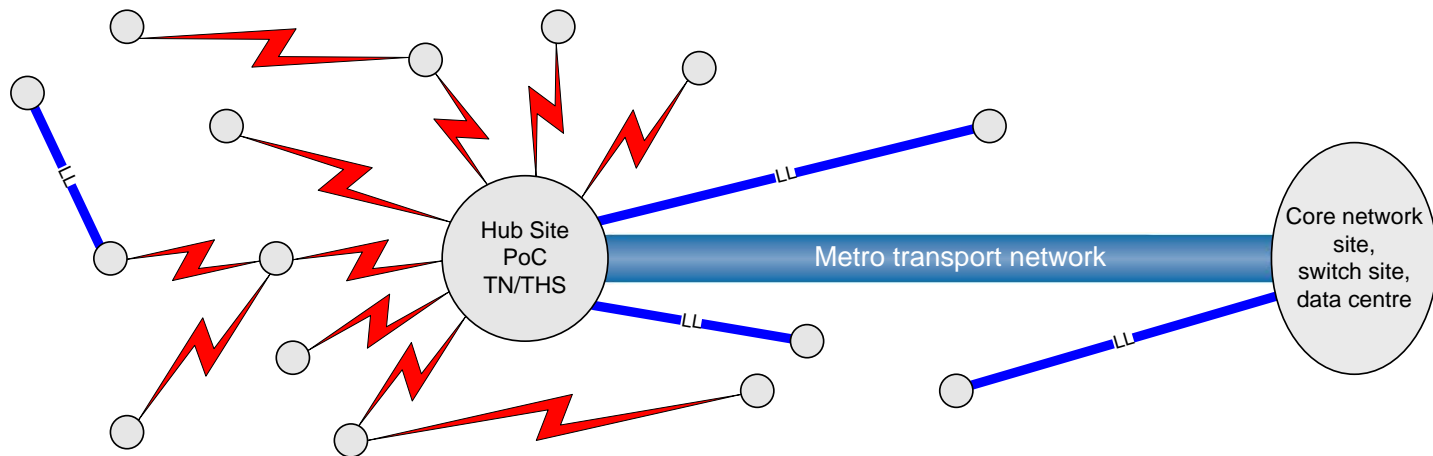
Typical backhaul #1

- A large amount of point to point microwave radio was rolled out as part of the early/mid 1990s GSM expansion activities
- These links grew in capacity and functionality as GSM traffic increased and UMTS was introduced
- HSPA pushed capacity requirements still further and started to drive the evolution towards Ethernet based backhaul

Hub Site
PoC
TN/THS

Metro transport network

Core network site, switch site, data centre
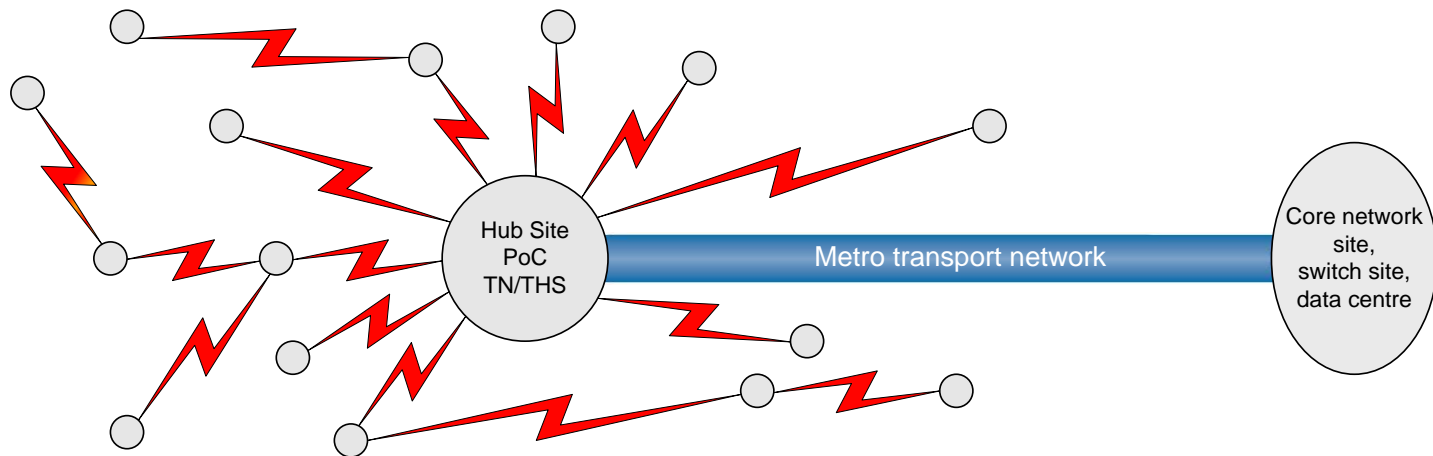
Note: Diagram illustrates a relatively small PoC, it's not uncommon for 50 to 100 sites to connect to such a node
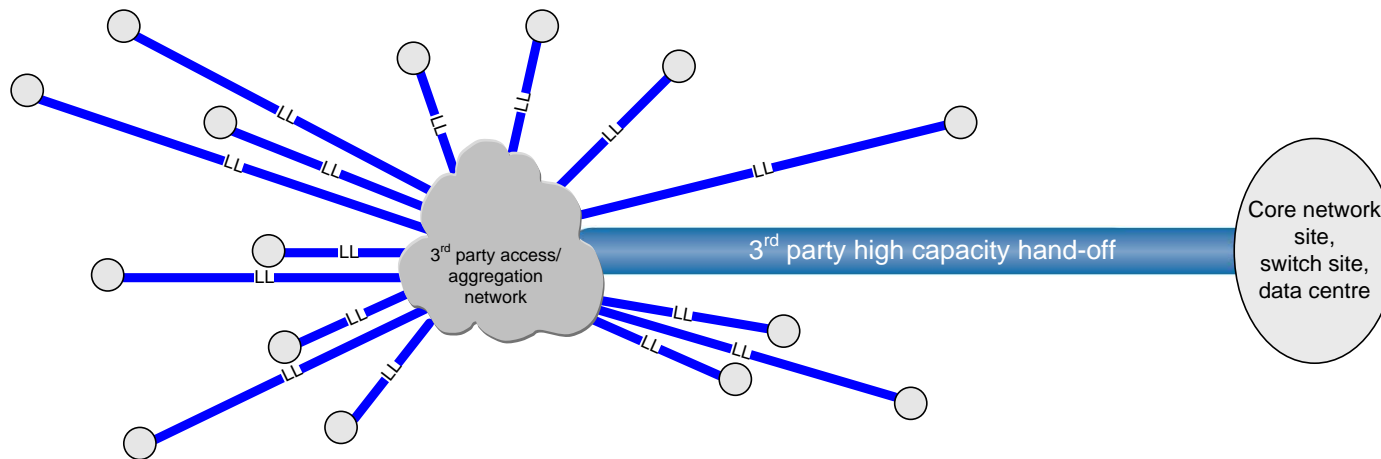
Typical backhaul #2

- Self-provide microwave remains the backhaul option of choice however for a number of reasons this isn't always possible
- Leased lines, initially TDM then possibly ATM were introduced as necessary
- HSPA pushed capacity requirements still further and started to drive the evolution towards Ethernet based backhaul, LL too…

Hub Site PoC TN/THS

Metro transport network

Core network site, switch site, data centre

Note: Diagram illustrates a relatively small PoC, it's not uncommon for 50 to 100 sites to connect to such a node

Typical backhaul #3

- Mobile operator doesn't self-build any backhaul
- All backhaul is part of a managed service
- Is this just transmission or transport too? <u>A big difference!</u>
- HSPA pushed capacity requirements still further and started to drive the evolution towards Ethernet based managed backhaul

3rd party access/ aggregation network

3rd party high capacity hand-off

Core network site, switch site, data centre

Note: Diagram illustrates a relatively small PoC, it's not uncommon for 50 to 100 sites to connect to such a node

TDM to Ethernet

What is Ethernet backhaul?

- More capacity?
- Cheaper?
- A future-proof solution?
- The next-generation backhaul?

- Gigabit Ethernet and 10Gigbit Ethernet do offer a large capacity however so do STM-16 or STM-64 circuits
- Ethernet is generally cheaper than TDM however be sure to calculate the total cost of ownership
- Our industry is certainly converging on IP and Ethernet, fixed and mobile, residential and business, access and core…
- I've lived through several next-generation telecommunications solutions in my 26 years in this industry, however, Ethernet does appear to be the unifying transmission (?) technology of choice

Protocols and interfaces

GSM
BTS

UMTS
NodeB

LTE
eNB

GSM BTS
- TDM E1s for the Abis interface
- TDM over Ethernet results in PWE3
- 2G Refresh offers an opportunity for IP Abis

UMTS NodeB
- ATM IMA within TDM E1s for Iub interface
- ATM over Ethernet results in PWE3
- R5 IP TNL evolution aligns with Ethernet backhaul

LTE (EPS) eNB
- IP TNL as standard, Ethernet interface
- New challenges associated with IPSec and connectivity model (S1 and X2 interfaces)

The growth of 'sharing'

Network deployment

- We're witnessing an increase in site sharing and network sharing initiatives that drive overall mobile backhaul requirements in terms of:
    - Capacity
    - Connectivity
        - Logical
        - Physical
    - OAM&P
- How much capacity?
    - Is FE enough at the cell site?
    - When is GE required?
    - Depends upon mix of fibre and microwave
- Ports to serve today's needs yet support evolution
- Mobile operators don't want traffic to disappear into a cloud with no visibility

GSM BTS

GSM BTS

UMTS NodeB

UMTS NodeB

LTE eNB

LTE eNB

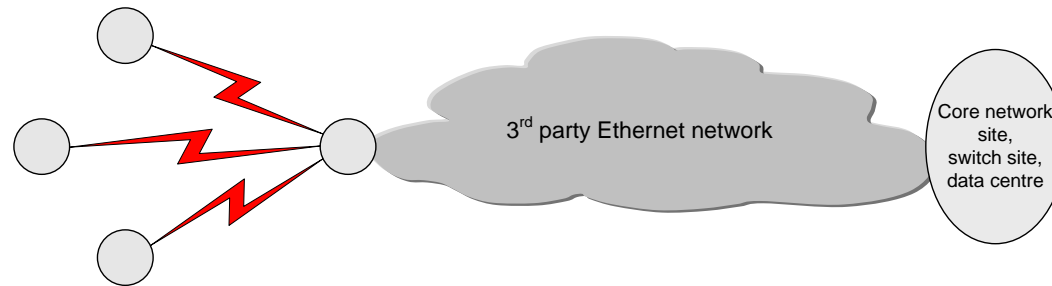Backhaul
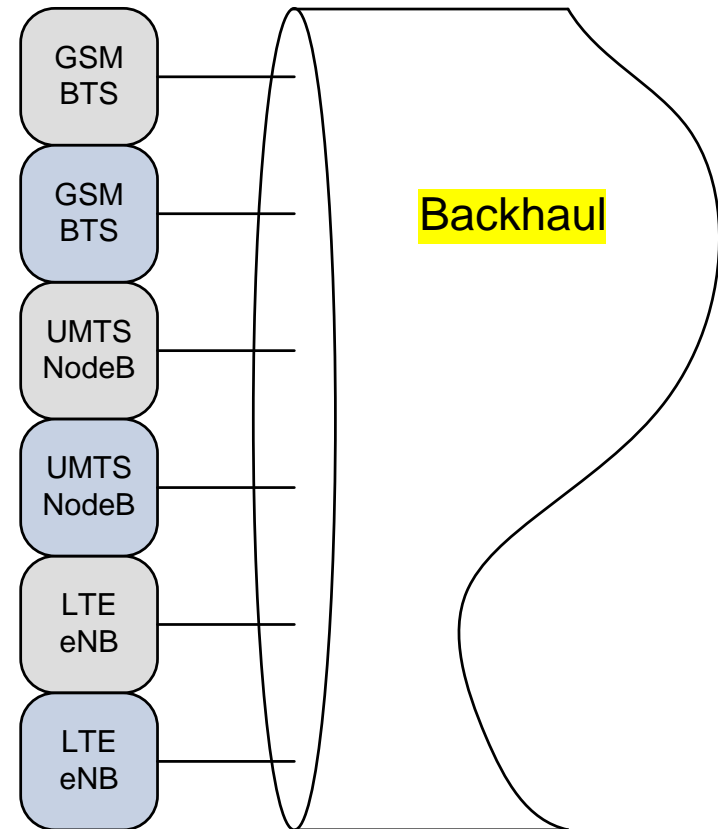
Getting ahead of the game

Deeper fibre, smaller PoC

- Pushing fibre deeper into the network will ensure higher capacity becomes available at the cell site
- Shortening or removing the chaining of microwave links will increase capacity to cell sites
- This solution may be owned or leased dark fibre however how practical and cost-effective is this approach?
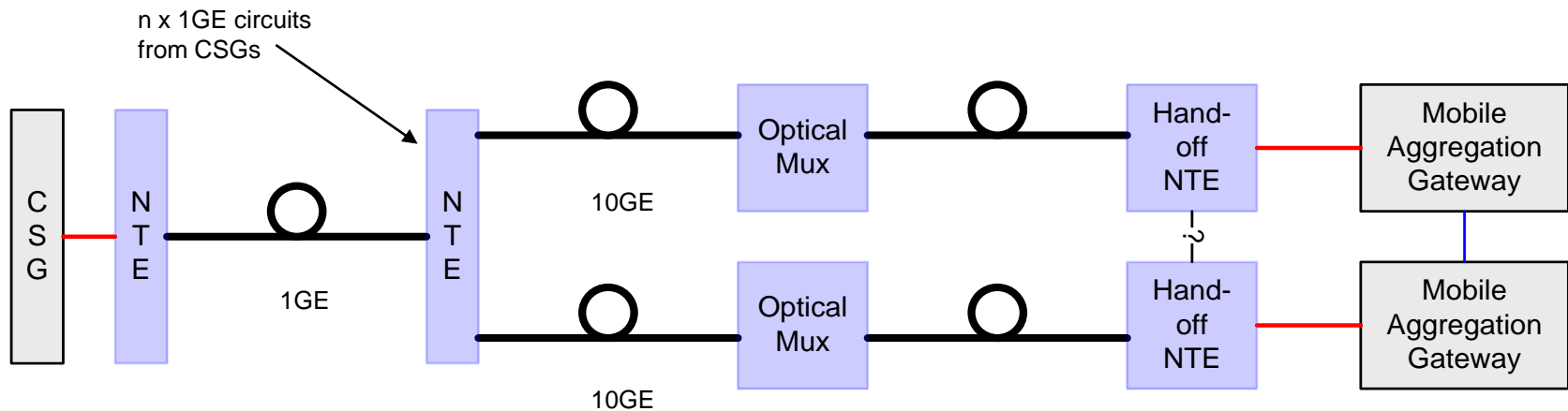- The Gigabit Ethernet is very likely to be a leased service offering

Gigabit Ethernet – fibre based backhaul

Core network site, switch site, data centre
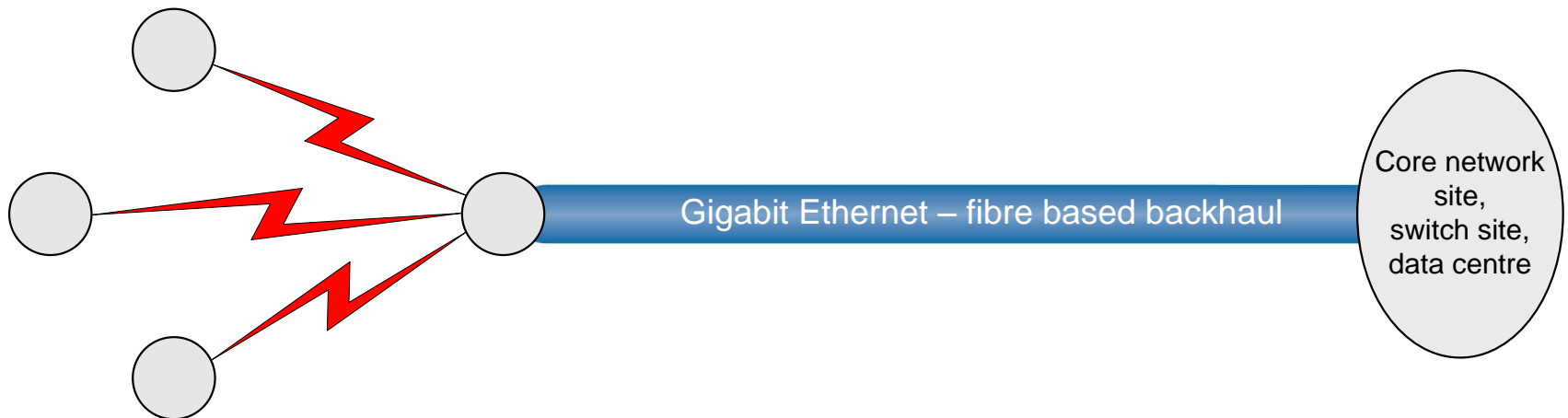
3rd party Ethernet

Very different from point to point fibre, is it transmission or transport?

3rd party Ethernet network

Core network site, switch site, data centre

Let's open the cloud

n x 1GE circuits from CSGs

CSG — NTE — 1GE — NTE — 10GE — Optical Mux — Hand-off NTE — Mobile Aggregation Gateway

10GE — Optical Mux — Hand-off NTE — Mobile Aggregation Gateway

Open questions, how do we protect this solution such that we can guarantee the high-order transport and hand-off at 10GE? What about sync for the cell site and how do we guarantee acceptable OAM&P?

Who owns and operates the CSGs and aggregation gateways? This will impact the operational model

Summary

Summary

- Mobile is an exciting and evolving eco-system, lot's more innovation to come!
- Ethernet, coupled with IP, will without doubt become the mobile backhaul technology of choice
- There are however many outstanding issues to address from a real-world perspective, these include:
  - Protection mechanisms
  - Synchronisation
  - Scalability
    - Capacity and interfaces, physical and logical
  - OAM&P
  - Operational model
- Cell site backhaul design is becoming increasingly complex due to multiple generations of technology, mobile and transmission/transport
- High-capacity hand-off is extremely challenging and must be urgently addressed, protection mechanisms and scalability are key, 100GE and underlying optics etc…
- Addressing the sync challenge of today is essential however we need to consider tomorrow's challenge given the lead times associated with mobile backhaul evolution

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orange™   T··Mobile·

Thanks

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