The Mobile Perspective - Next Generation Mobile Networks

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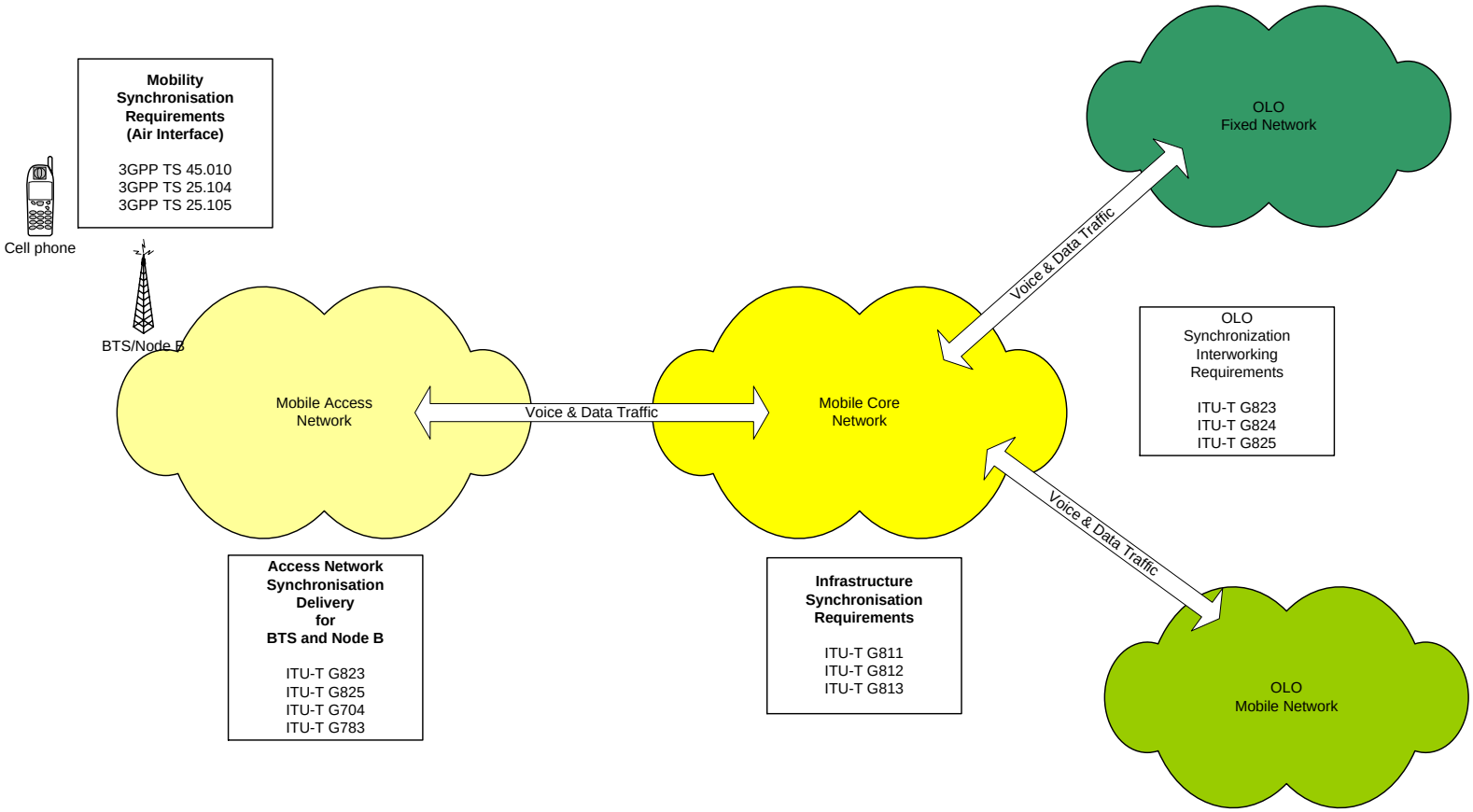
T-Mobile

Overview of Mobile Network Architecture



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GSM & WCDMA Requirements for Timing Accuracy

GSM Requirements

- 3GPP TS45.010 – "The BTS uses a single frequency source of absolute accuracy better than 0.05 ppm for both RF frequency generation and clocking timebases"
- 3GPP TS45.010 – "The pico BTS type absolute accuracy requirement is relaxed to 0.1 ppm"

WCDMA Requirements

- 3GPP TS25.104 – "The Node B uses a single frequency source of absolute accuracy better than 0.05ppm for both RF frequency generation and clocking timebases"

Base Station Type	Accuracy
Wide Area (GSM & UMTS) until R5	+/- 0.05 ppm
Medium Range	+/- 0.1 ppm
Local Range	+/- 0.1 ppm

R7 Requirements

Background for Timing Accuracy Requirements

GSM/UMTS Requirements

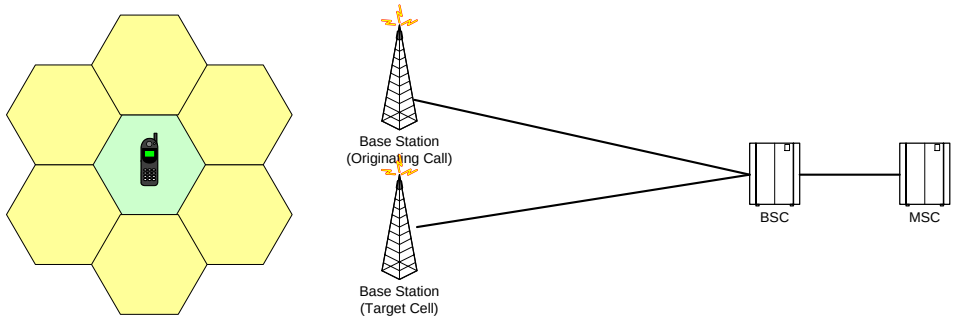
- The mobile must be successfully be able to successfully decode signals with a frequency offset to enable handover and cell access whilst travelling at speed in Wide Area Networks.
- The largest offset is caused by Doppler Shift. The frequency error of the base station adds to the Doppler shift.
- The accuracy of the radiated signal is specified to ensure that the frequency error is kept to within manageable limits
- The most stringent requirement is for Wide Area Networks and is specified at 0.05ppm.
- Pico cells can be relaxed to 0.1 ppm.
- A larger relaxation may cause problems with the mobile

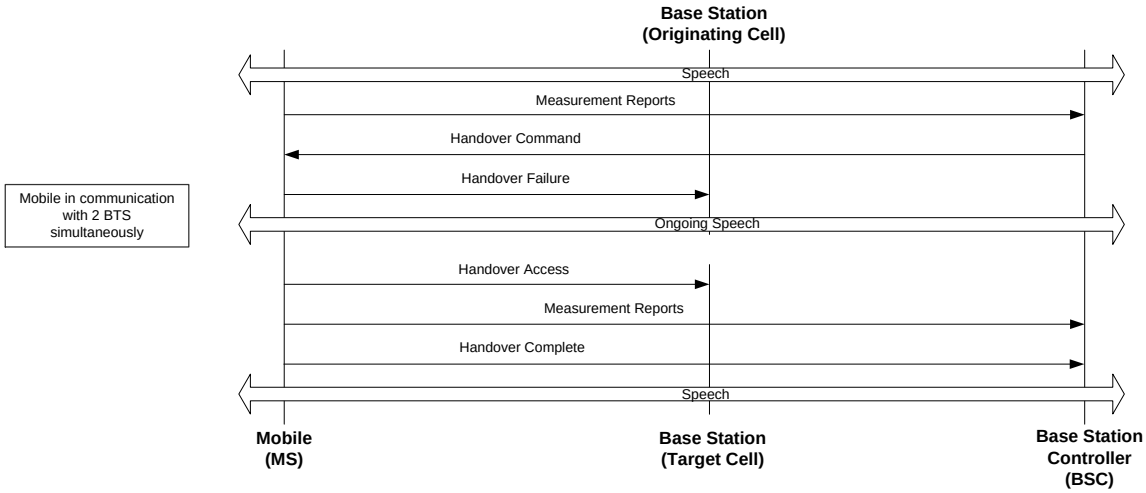
Type	GSM 900 MHz	GSM 1800 MHz	WCDMA 2100 MHz
0.05 ppm contribution	45 Hz	90 Hz	105 Hz
Velocity & Doppler	250 km/h & 210 Hz	250 km/h & 420 Hz	250 km/h & 486 Hz
Total Mobile Offset	225 Hz	510 Hz	591 Hz

Requirements for Successful Mobile Handover between cells

Requirements for Successful Handover

- Contiguous coverage between cells.
- Adequate Capacity.
- Adequate Synchronisation.





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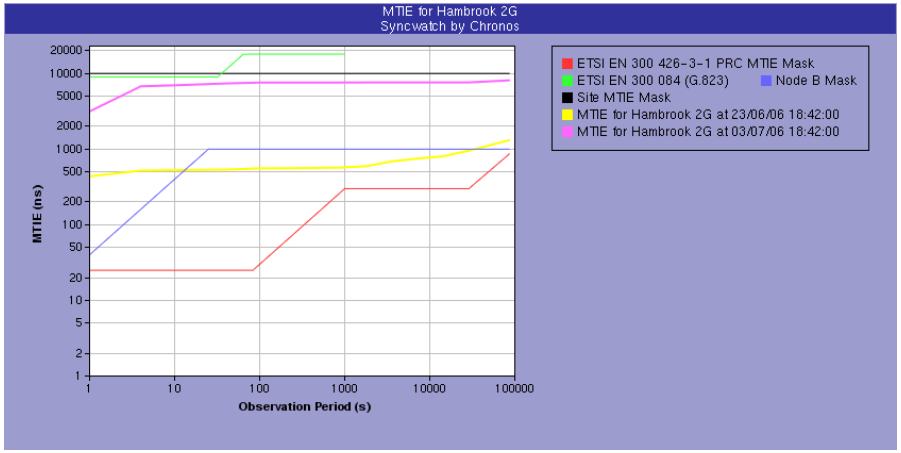
Synchronisation & Traffic Performance Review 1

Sync Quality for Cell in Synchronisation Review 1

- MTIE of Synchronisation on Transmission link is < 0.05 ppm
- Jitter increases slightly between observations

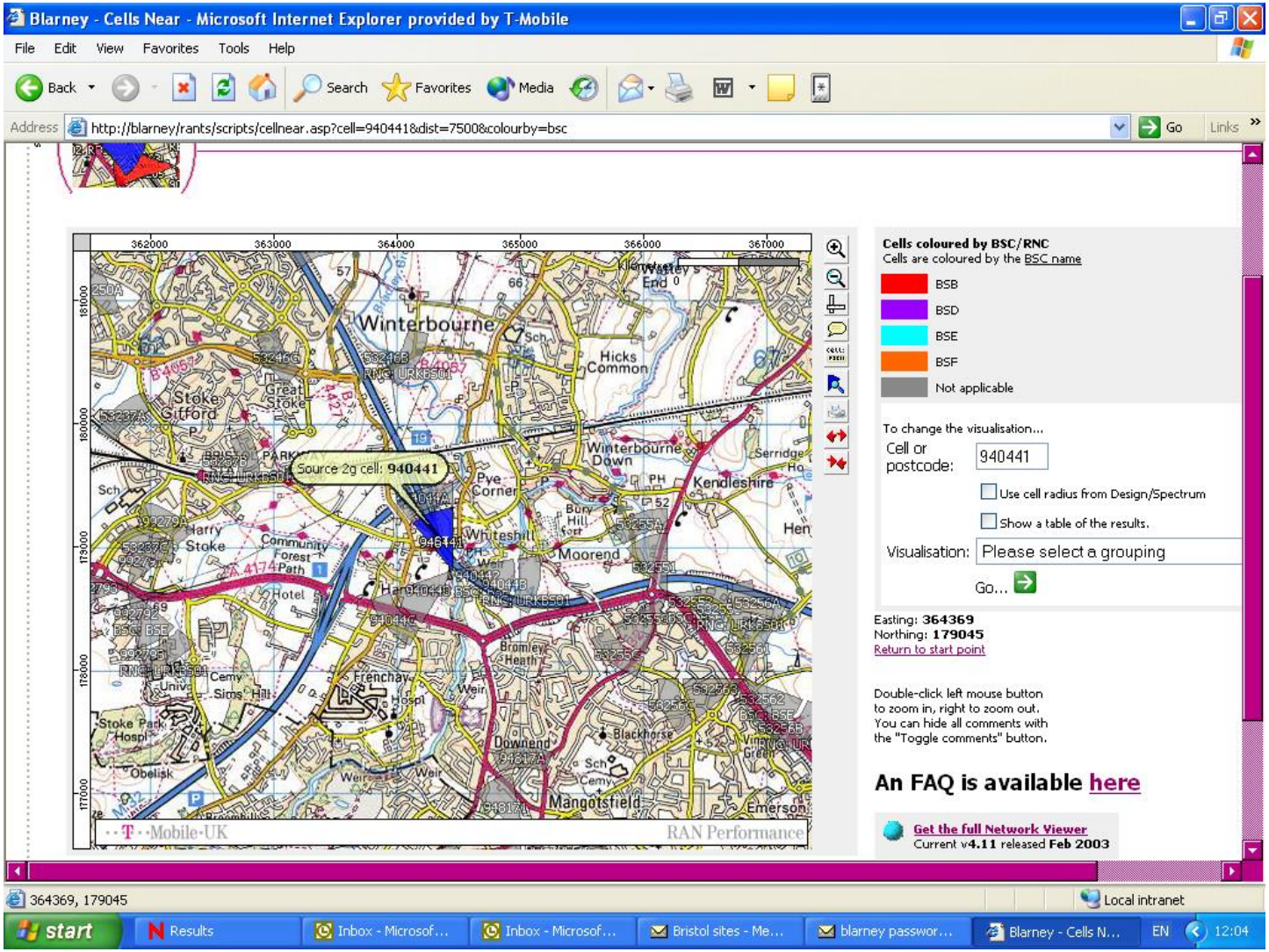


Call Performance for Cell in Synchronisation Review 1

- Sector 1 has high incidence of dropped calls and lower call set up success

Cell/Sector	Call Setup	Call Termination	Dropped Call Rate
Sector 1	95.27%	99.09%	3.91%
Sector 2	98.48%	99.57%	1.09%
Sector 3	97.29%	98.40%	1.19%

Topology for Cell in Synchronisation Review 1



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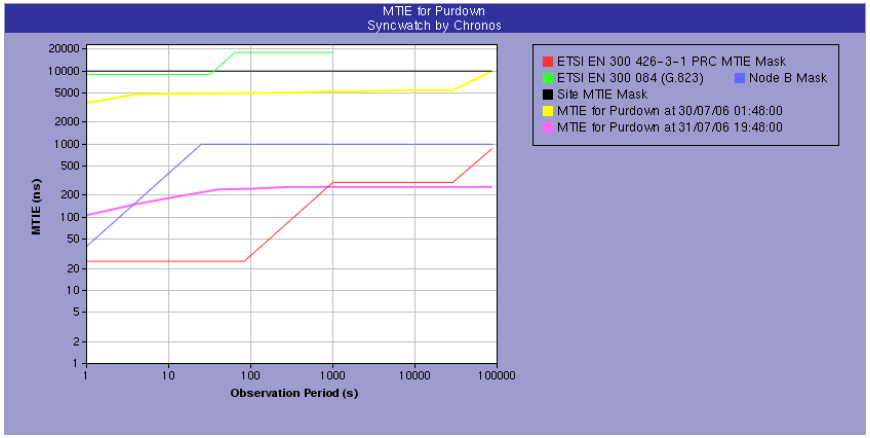
Synchronisation & Traffic Performance Review 2

Sync Quality for Cell in Synchronisation Review 2

- MTIE of Synchronisation on Transmission link is < 0.05 ppm
- Jitter increases slightly between observations



Call Performance for Cell in Synchronisation Review 2

- Sector 2 has high incidence of dropped calls and lower call set up success

Cell/Sector	Call Setup	Call Termination	Dropped Call Rate
Sector 1	98.13%	99.20%	1.07%
Sector 2	97.19%	98.85%	1.68%
Sector 3	97.61%	99.01%	1.34%

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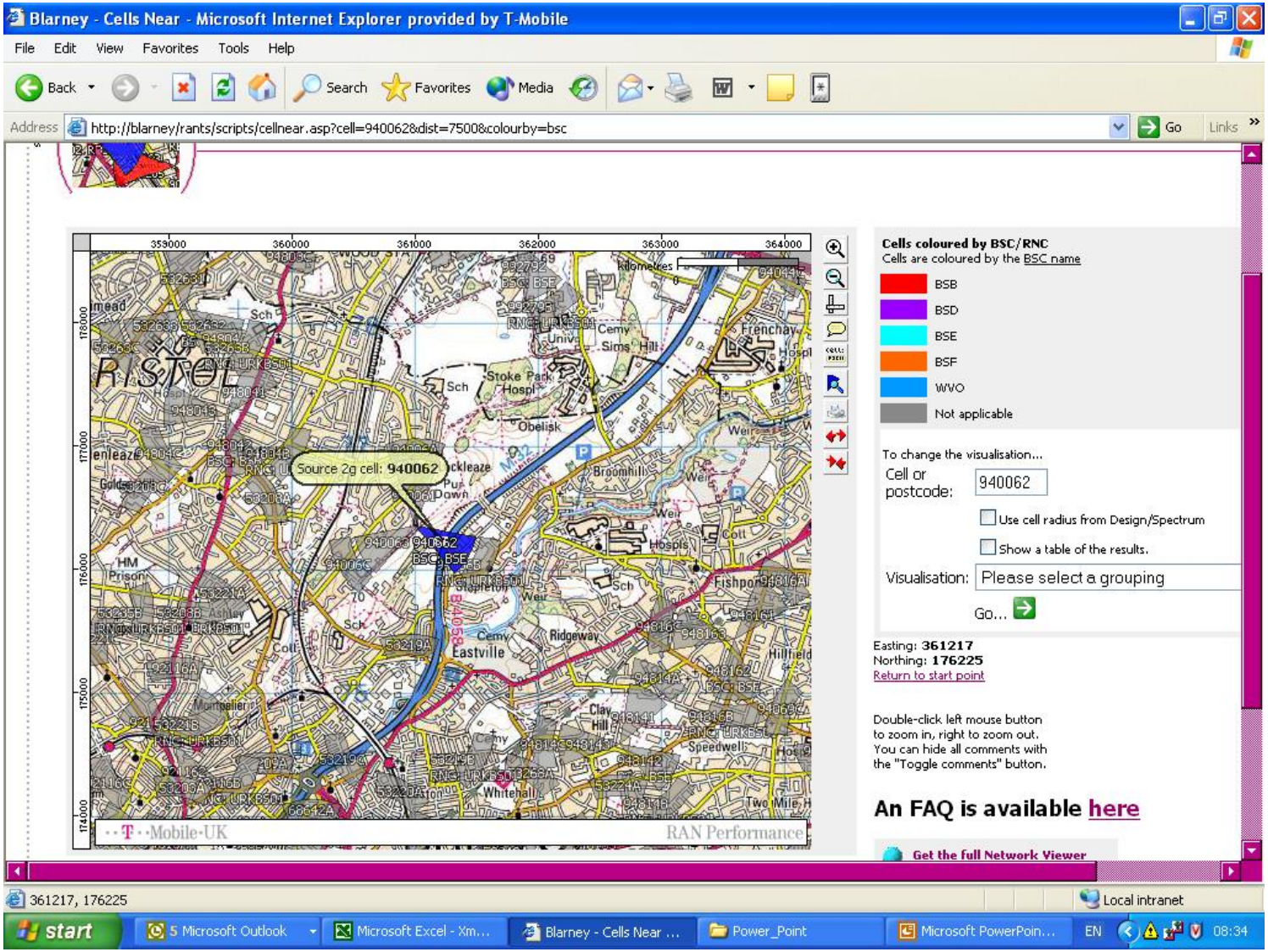
Topology for Cell in Synchronisation Review 2



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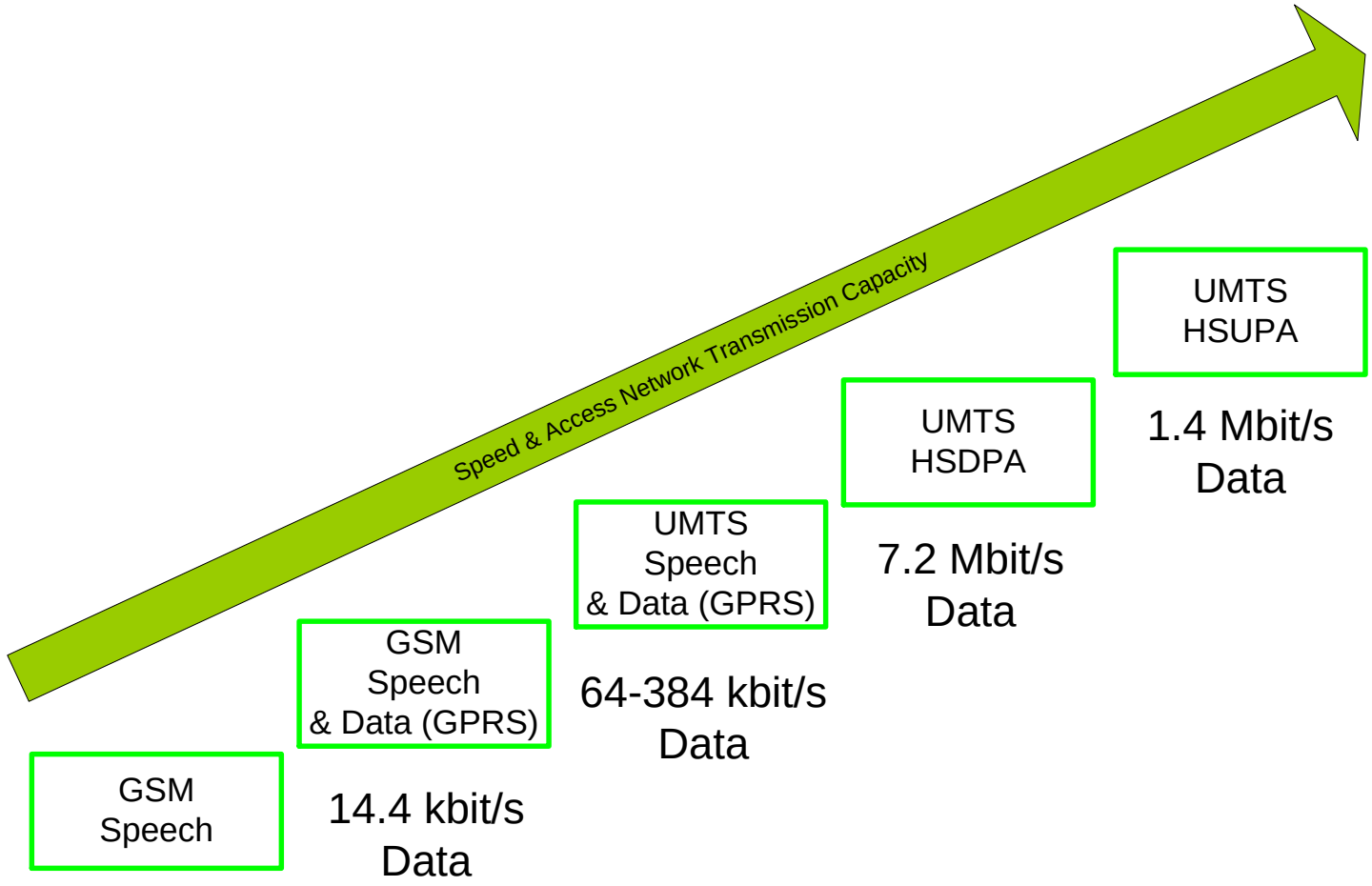
Conclusions from Synchronisation Review

Conclusions

- Synchronisation signals of required accuracy were present at the BTS.
- Dropped call rates on some sectors were higher than expected when compared to the performance of other sectors.
- Although higher than expected the dropped call rate was less than 4 in 100
- Upon examination these sectors were handling mobiles that were probably travelling at high speeds.
- Other factors may have been present in contributing to high dropped call rate such as insufficient capacity in the target cell

Evolution of Mobile Network Voice and Data Services



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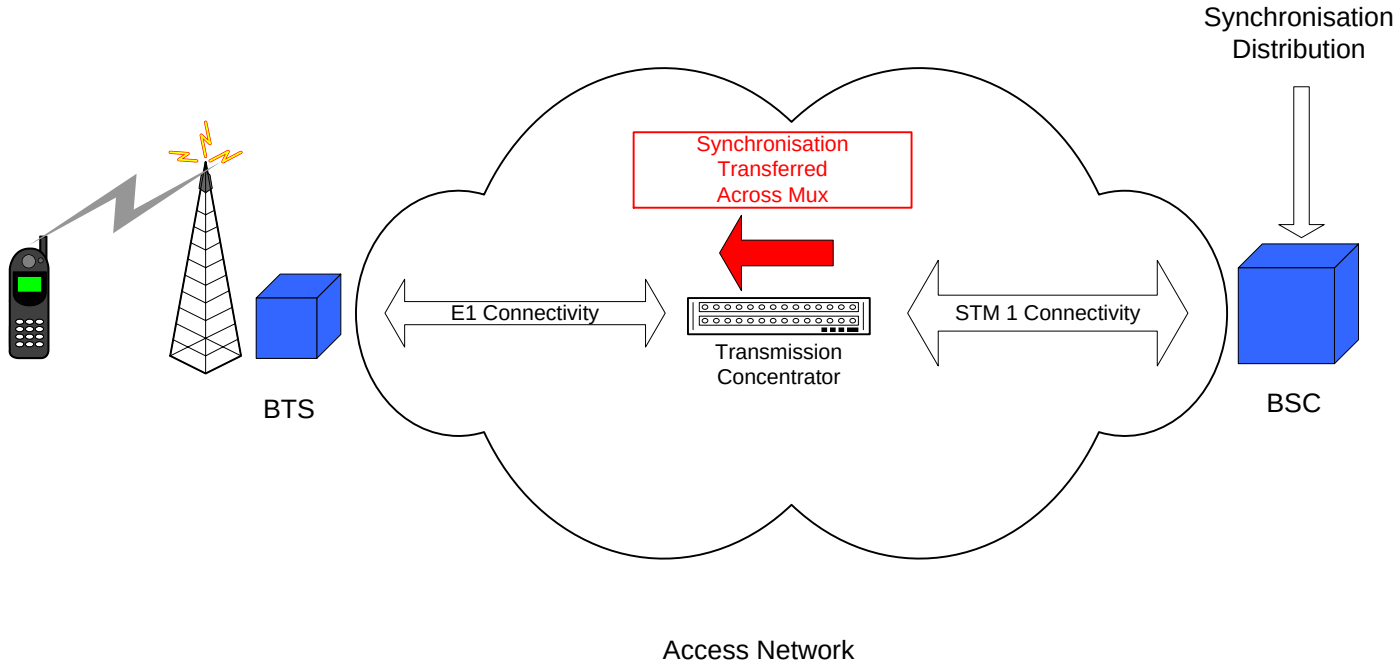
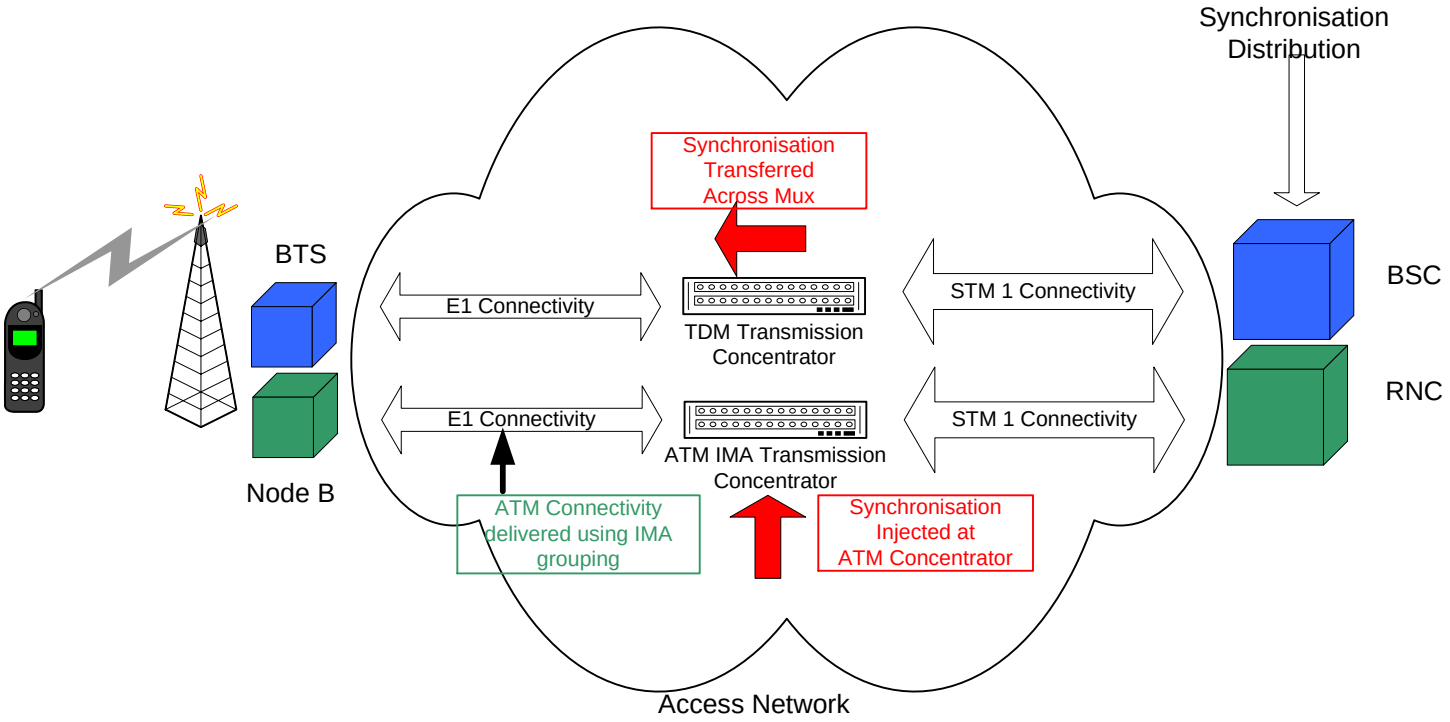
Access Network Synchronisation Distribution
GSM Architecture



GSM Architecture

- Synchronisation is delivered to the base station over the transmission network.
- Synchronisation is transferred across any PDH/SDH Cross Connects or Multiplexors
- Final link is over E1 connection which always forms the final connection to the BTS
- Synchronisation can be transferred over E1, VC12 or STM1

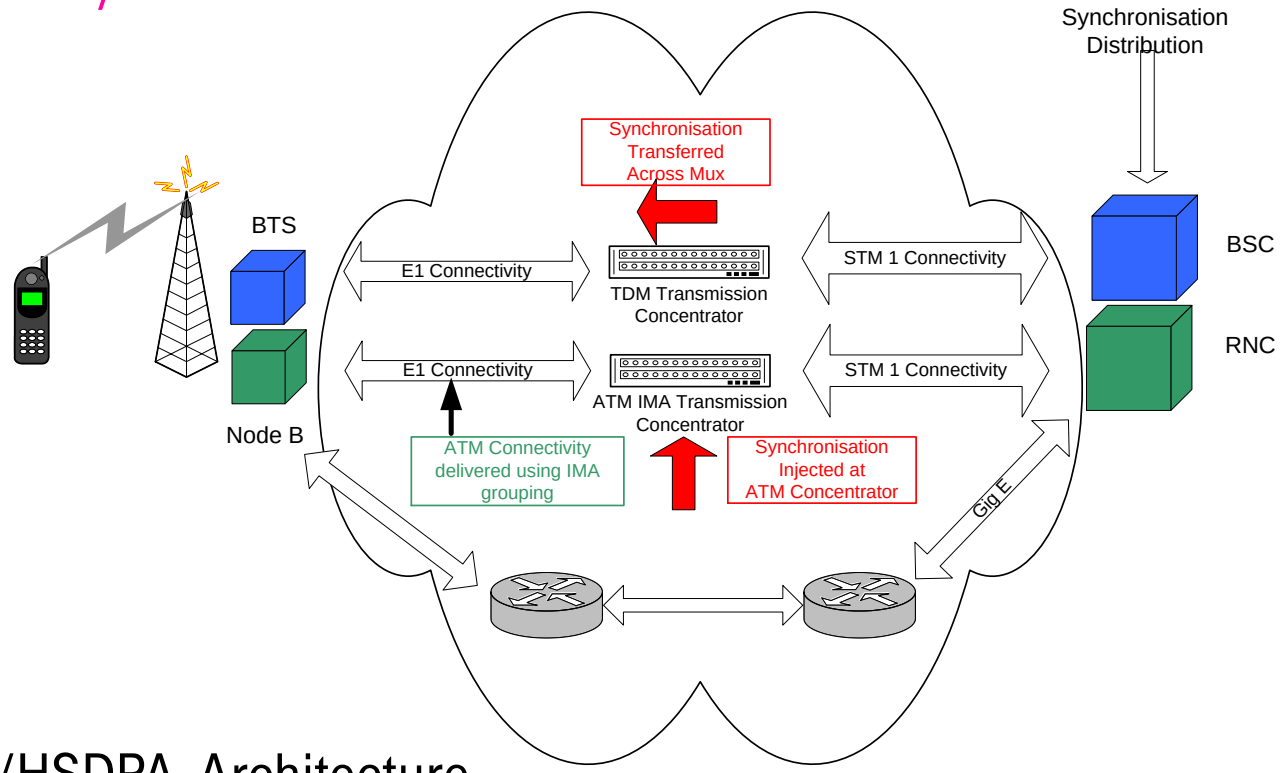
Access Network Synchronisation Distribution
GSM/UMTS Architecture



UMTS Architecture

- Synchronisation is delivered to the base station over the transmission network.
- Synchronisation is delivered to Node B's via E1 carrying IMA grouped traffic.
- Synchronisation is delivered to IMA concentrator in a retiming process.

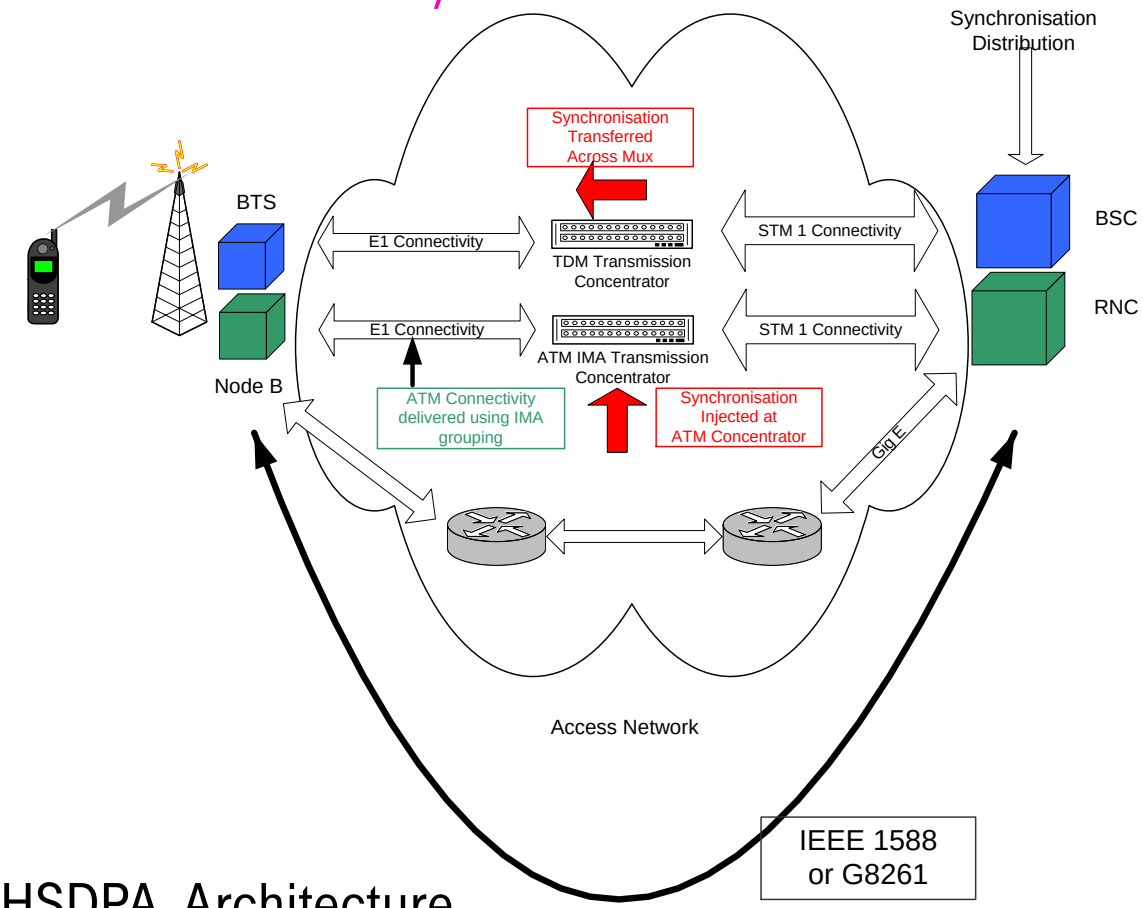
Access Network Synchronisation Distribution GSM/UMTS with HSDPA



UMTS/HSDPA Architecture

- Synchronisation is delivered to the base station over the transmission network.
- Synchronisation is delivered to Node B's via E1 carrying IMA grouped traffic.
- Synchronisation is delivered to IMA concentrator in a retiming process.
- Timing over Ethernet not required for initial IP connectivity rollout.

Access Network Synchronisation Distribution over Packet infrastructure GSM/UMTS with HSDPA



UMTS/HSDPA Architecture

- Migration to timing over packet infrastructure will require implementation of IEEE 1588 or G8261 in the access network.

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Access Network Synchronisation Distribution over Packet Connections.

Key Issues for V1of IEEE 1588

- Enhancements for increased resolution and accuracy.
- Extensions to allow correction for asymmetry.
- A fault tolerance capability.
- Support for QOS (Contended Services)

Review of G8261

- Features appropriate for distribution of synchronisation using G8261 are under review.

Access Network Synchronisation Distribution Over a Packet Connection – Supplier Situation

Supplier Activity

- Interest is growing in 1588 but there are still no clear understanding over accuracy in loaded networks. Solutions in this area rely on proprietary algorithms.
- G8261 is also being reviewed as a solution to physical synchronisation distribution over Packet Networks.
- Timing recovery over TDM & ATM Pseudowires using IP/MPLS Networks is being reviewed
- Suppliers are generally looking at all options as no one standard is emerging as the dominant solution at present.

Access Network Synchronisation Distribution for NGN Mobile Networks

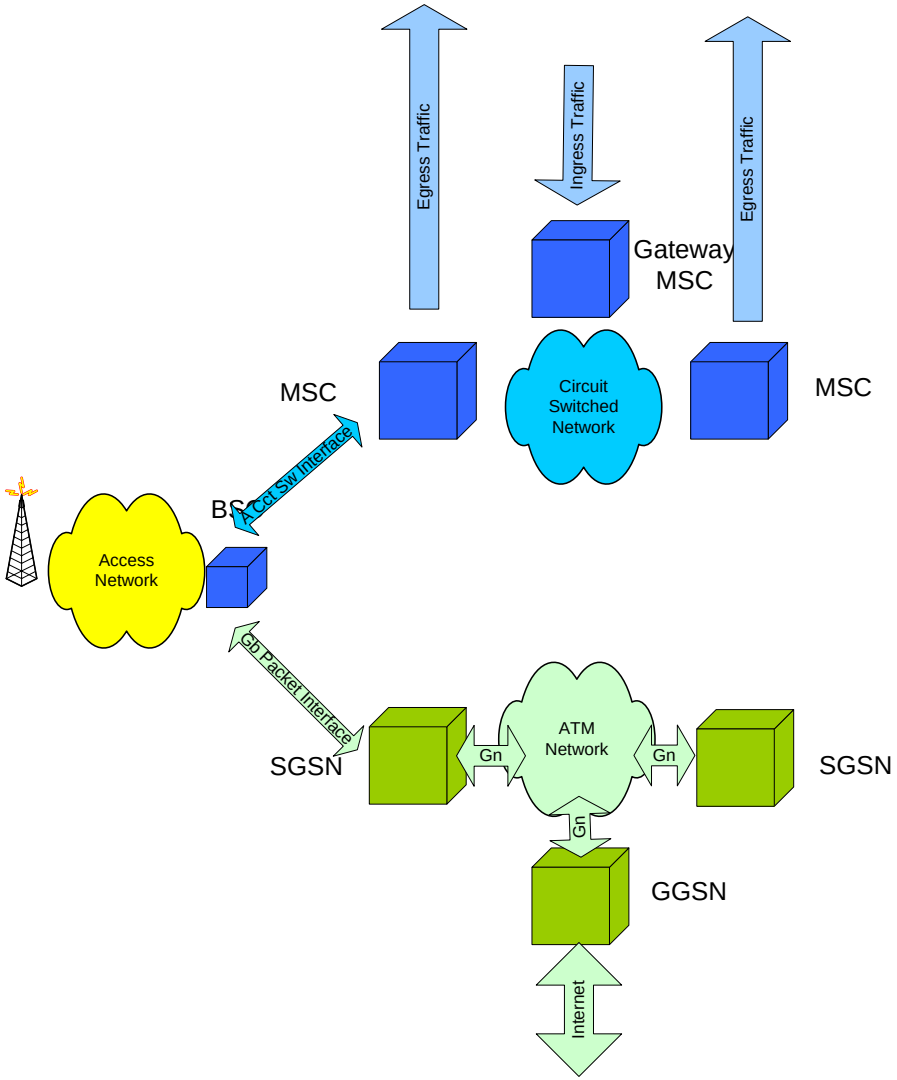
Strategy for Synchronisation Distribution in Access Network for NGN Mobile Networks

- Existing IMA infrastructure supports timing distribution at E1
- Access networks are currently being built using this strategy
- All UMTS/HSDPA cells will receive synchronisation over existing infrastructure
- IEEE 1588 or G8261 will only be required for packet only access networks.
- In the longer term a strategy using IEEE 1588 or G8261 will be required for packet only connectivity

Mobile Core Network Architecture – Voice\GPRS

Core Network Voice\GPRS

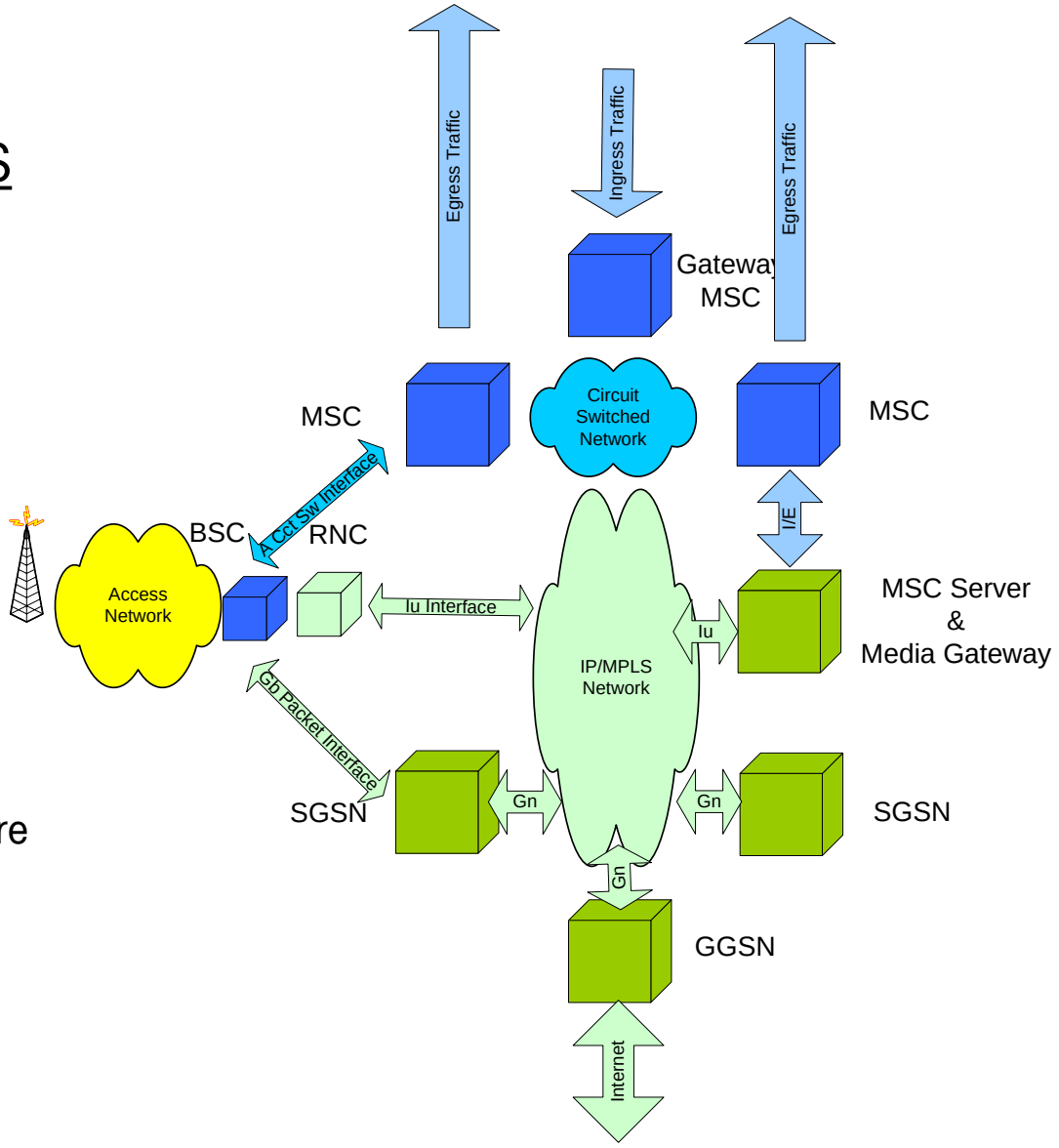
- The introduction of GPRS into mobile networks generated a requirement to handle packet data in the core network.
- Typical architectures keep speech on Circuit Switched connectivity and introduce ATM to support data.
- Mobility and Gateway management of data traffic is done by SGSN and GGSN nodes.



Mobile Core Network Architecture – Voice\GPRS\UMTS

Core Network Voice\GPRS\UMTS

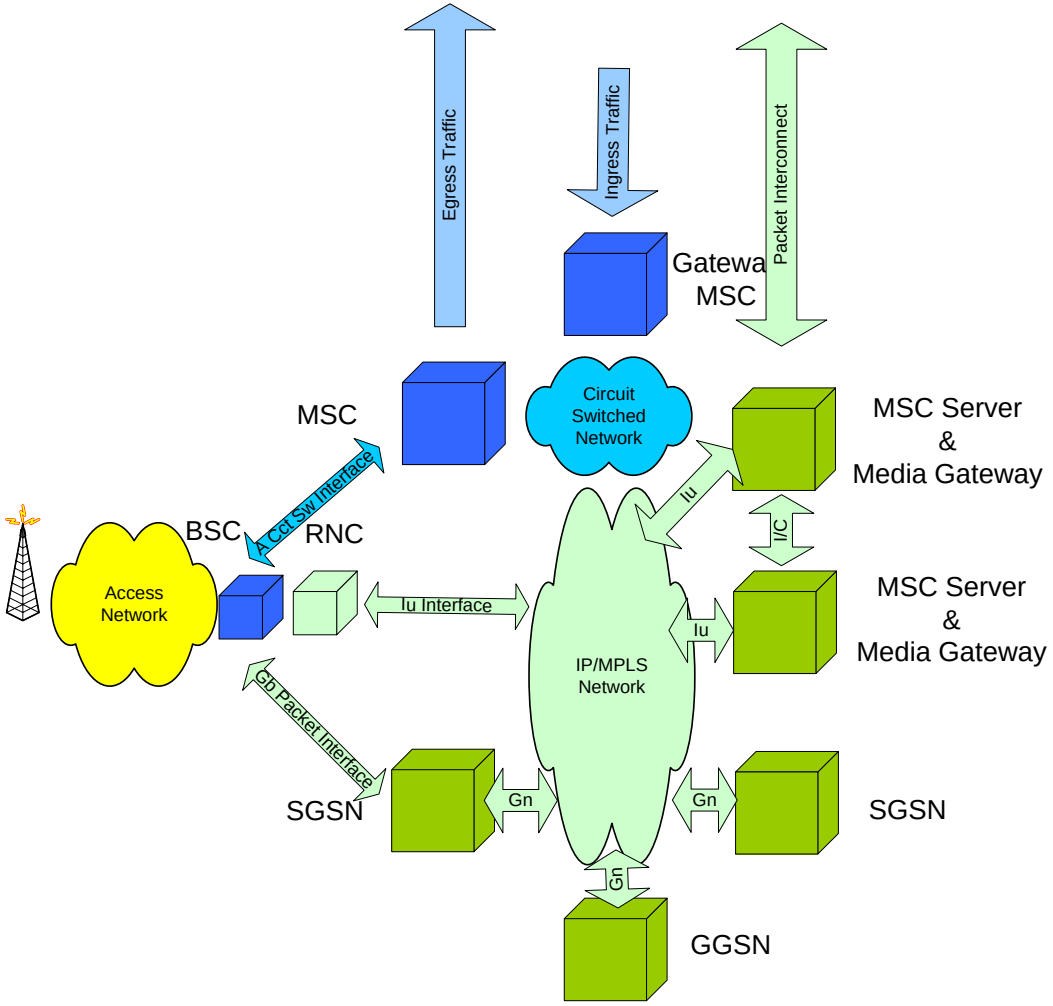
- Introduction of UMTS brings Packet Speech to the core network.
- The size of the packet network increases & IP/MPLS is introduced.
- MSC Servers and Media Gateways are introduced to support UMTS Speech in the core network.



Mobile Core Network Architecture – Voice/GPRS/UMTS/Interconnect

Core Network Voice\GPRS

- As UMTS capacity is developed the MSC Server architecture is developed along with IP/MPLS architecture.
- With the introduction of Packet Interconnect traffic is migrated away from the circuit switched interconnect and Internet Access is migrated to a Packet Interconnect for Speech and Data.



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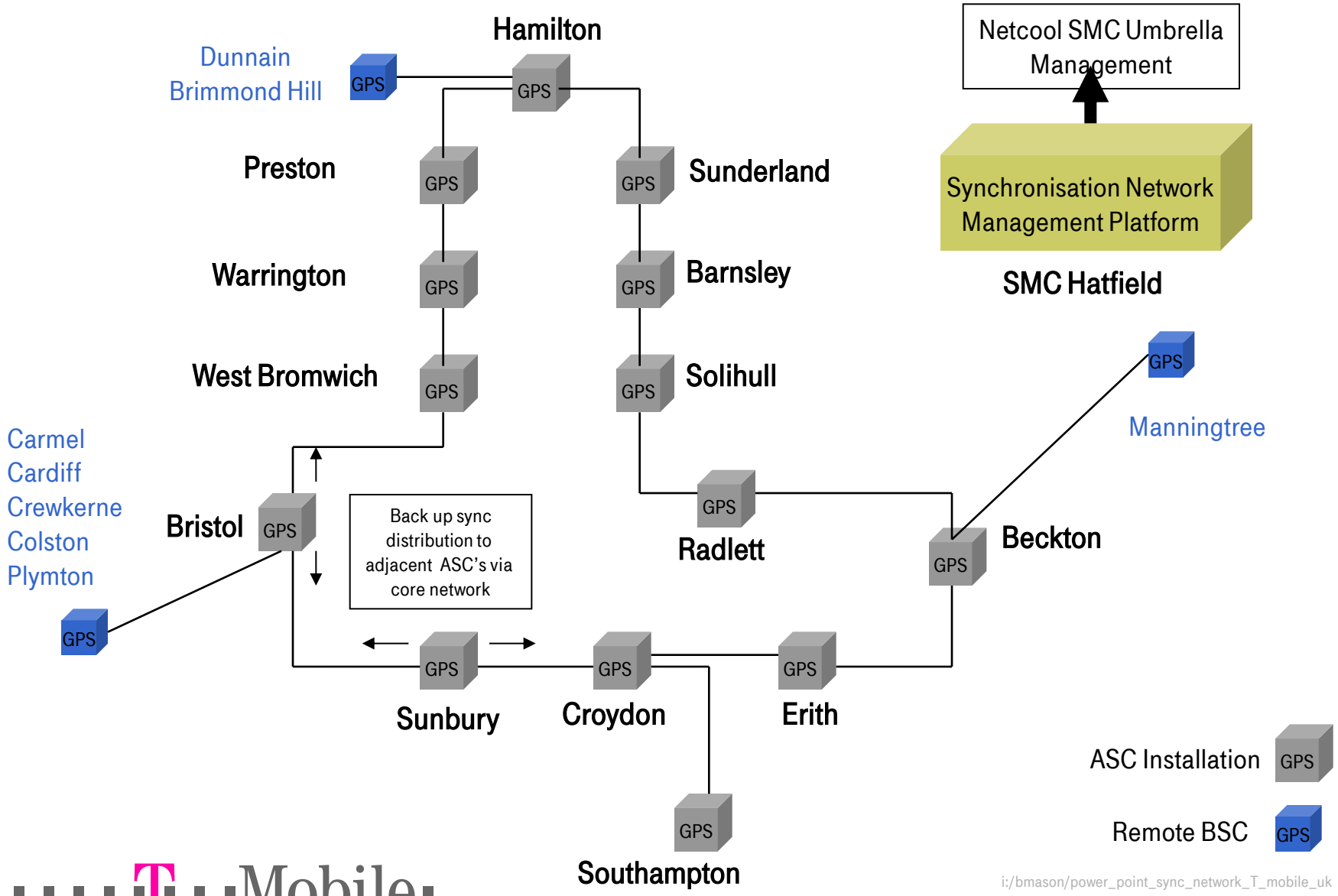
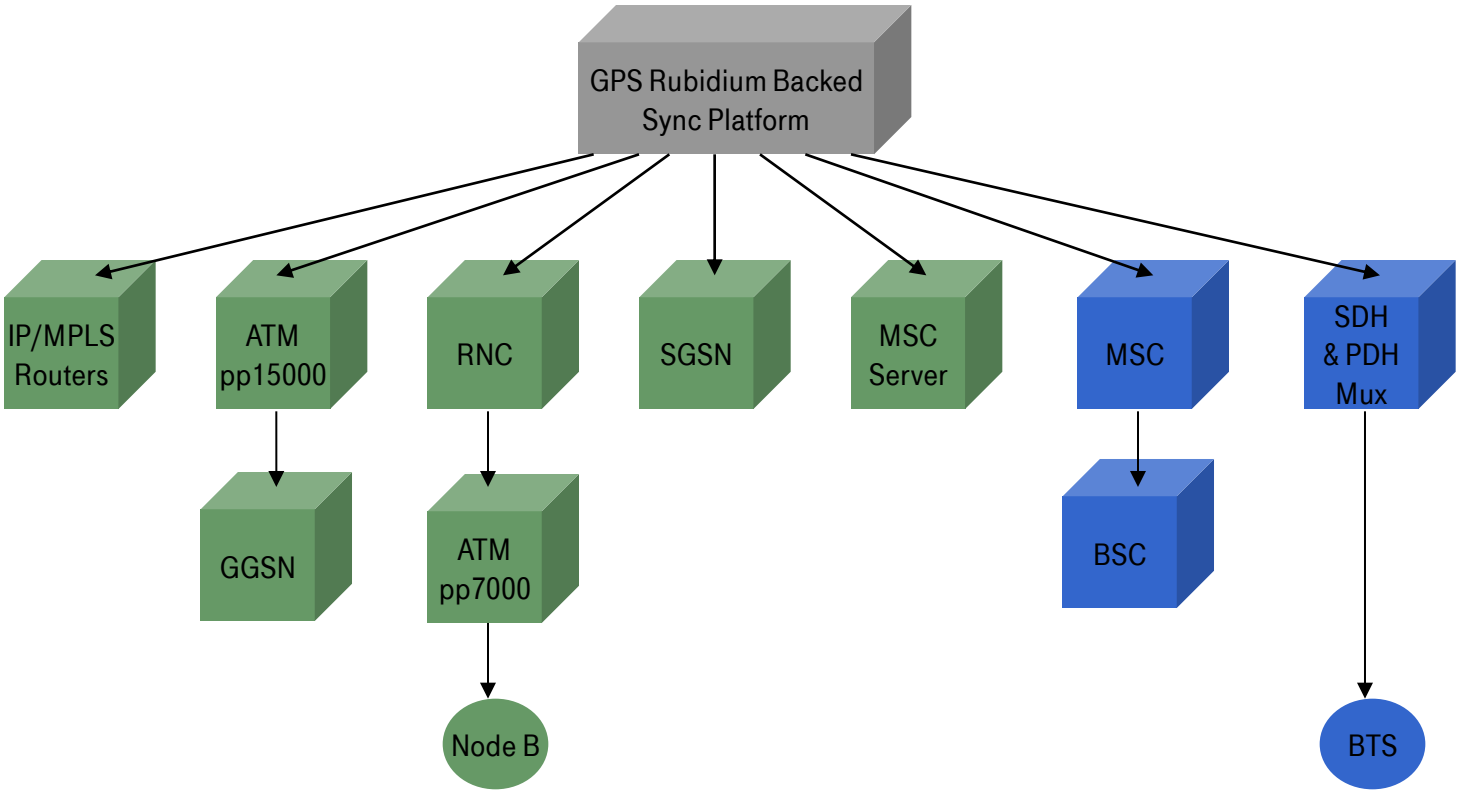
Synchronisation Network - T Mobile UK – Network Overview



Synchronisation Network - T Mobile UK – Sync Distribution



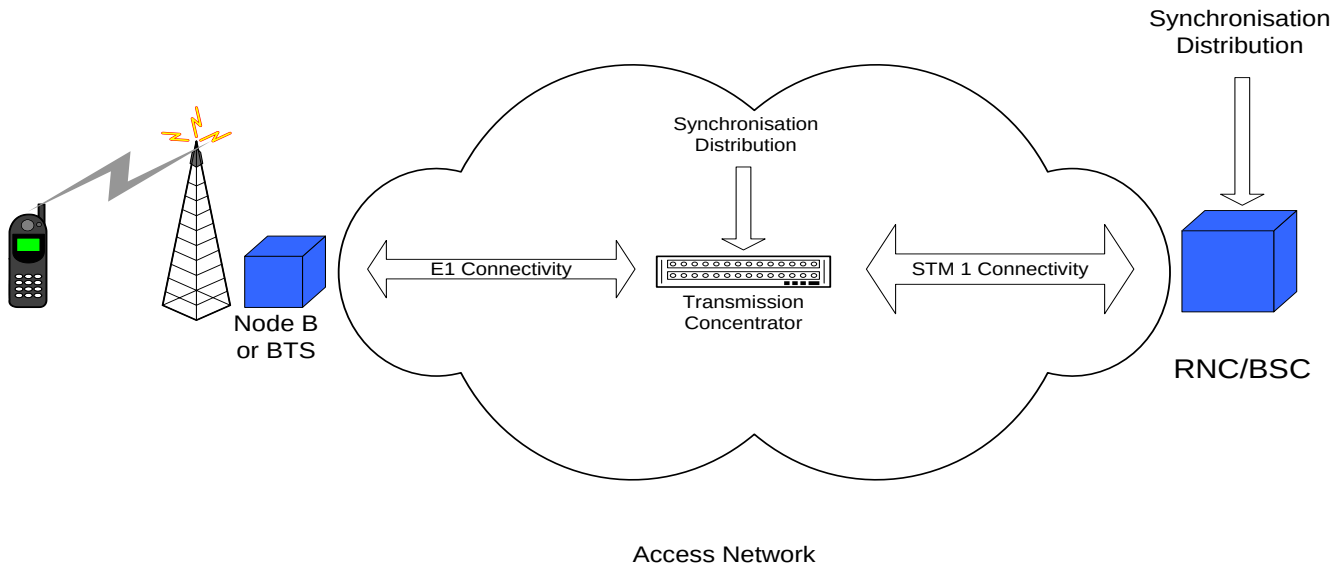
Core Network Synchronisation Distribution for NGN Mobile Networks

Strategy for Synchronisation Distribution in Core Network for NGN Mobile Networks

- Existing synchronisation feeds are provided at each Switching node from GPS disciplined Oscillators.
- As new nodes are introduced new synchronisation feeds are introduced.
- There is no requirement in the core network to distribute synchronisation over transmission links.
- Synchronisation fall back scenarios are developed to guard against failure scenarios.

Back Up Slides

Access Network Synchronisation Distribution



Existing Architecture

- Synchronisation is delivered to the base station over the transmission network.
- This is achieved over an E1 connection which always forms the final connection to the BTS/Node B