Analysys Mason for Cambridge Wireless

Future mobile network trends

London, 6 October 2011

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Mobile traffic is growing and here is the reason why

Major factors driving increases in wireless network traffic from cellular users [Source: Analysys Mason, 2011]

Improved cellular devices

- Advanced smartphones, with improved displays, user interfaces, processing, memory and batteries
- Tablets, MBB devices (embedded and USB) and smartphones proliferate
- Falling prices of smartphones

Improved network architecture and delivery mechanisms

- Technology developments (including HSPA, HSPA+ and LTE), coupled with cell site backhaul enhancements
- Smaller cells offering faster throughput, greater capacity, better quality of service and reduced cost per megabyte for MNOs

Affordable pricing and bundling

- Voice bundles encourage usage
- Decreasing prices improve affordability (particularly of traffic-intensive services)
- Operators wish to reverse this trend, but in a competitive marketplace this is difficult

New services

- A new wave of mobile services will drive wireless network traffic growth
- The three important contributors will be:
  - video
  - social networks
  - non-human connections (M2M)

Spectrum

- Spectrum is a key driver for network traffic
- Globally important spectrum bands are becoming available
- Other initiatives like refarming and digital dividend will have a significant impact on network capacity and traffic

Increasing mobile connections

- There is great potential for mobile penetration to increase in emerging markets
- Mobile penetration is nearly saturated in developed markets, but users are adopting secondary devices, such as USB modems, tablets and phones, solely for business use

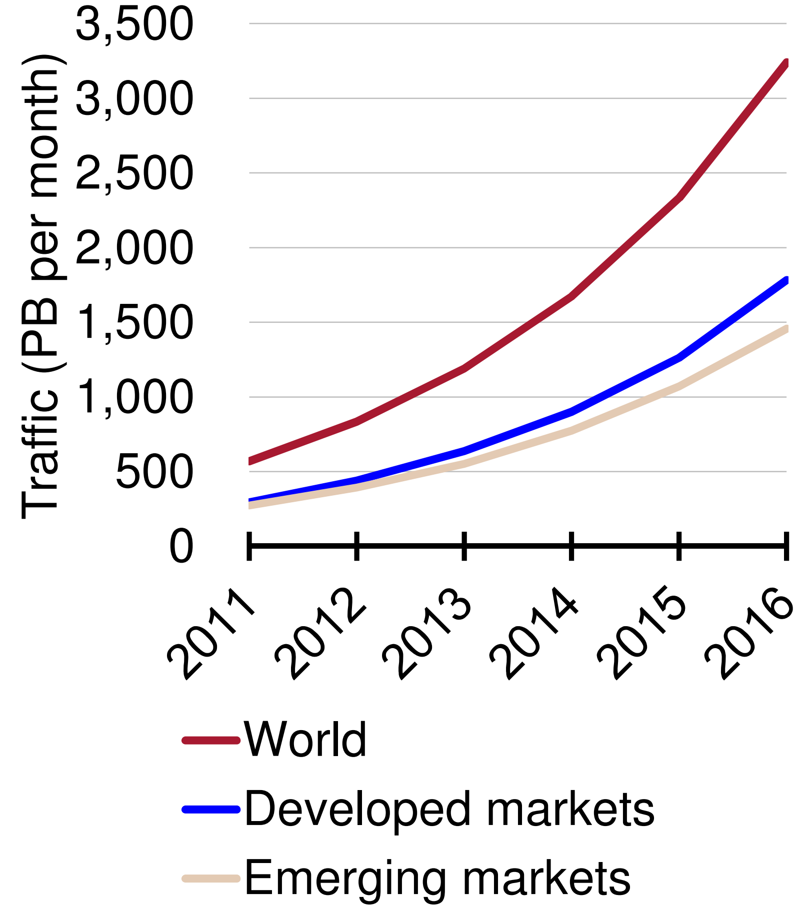
The combination of dramatic traffic growth and slow revenue growth is putting pressure on operators' cash-flow

- There are two strategies to mitigate the negative impact of traffic growth:
  - *revenue side*: introduction of tier pricing
  - *cost side*: adopt techniques to reduce network capex and opex.
- In this presentation we focus on the cost side.

We expect mobile traffic to grow at a CAGR of 42% from 2011 to 2016, from 570PB per month to 3243PB per month

- In developed markets, mobile traffic (voice and data) is expected to be six times higher by 2016.
  - Data-only traffic is predicted to be seven times higher than it was in 2011.
- In emerging markets, traffic is expected to be seven times higher in 2016.
  - The volume of data traffic alone is forecast to be eight times higher than it was in 2011.

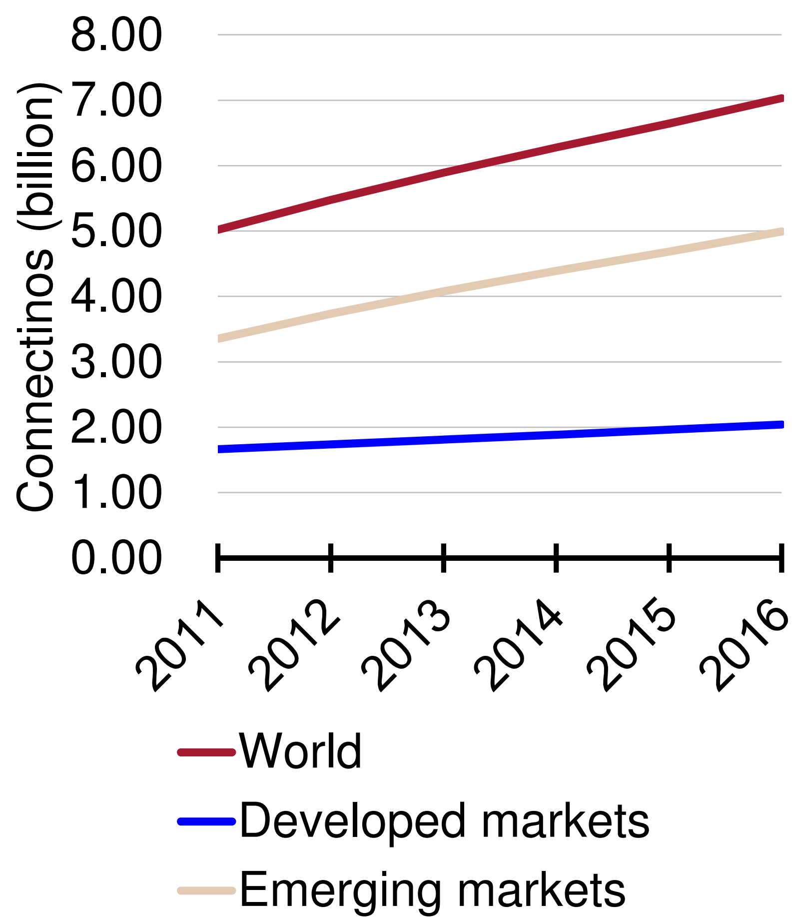
Traffic from mobile connections, worldwide, 2011–2016 [Source: Analysys Mason, 2011]



This is mainly a result of an increase in the number of mobile connections worldwide in emerging markets …

- In emerging markets, the number of connections is expected to grow substantially.
- Connections worldwide are predicted to grow at a CAGR of 7%, rising from 5 billion to 7 billion.
- Penetration has almost reached saturation in developed markets.

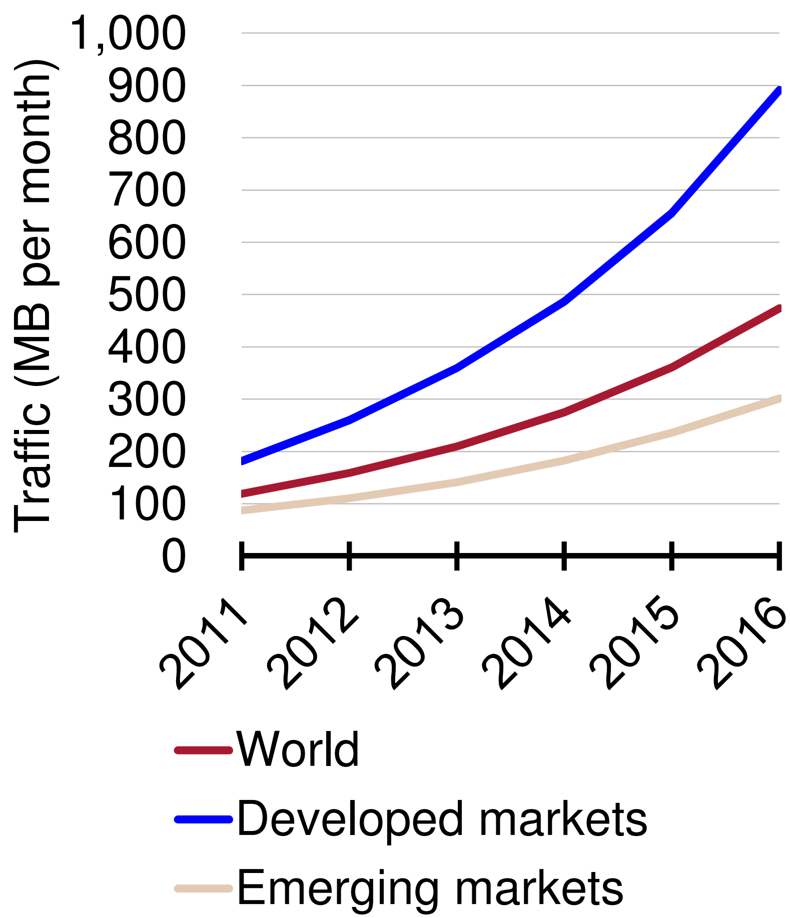
Mobile connections worldwide, 2011–2016 [Source: Analysys Mason, 2011]



… and of rising average wireless traffic per connection in developed markets

- In developed markets, traffic growth is driven by the proliferation of smart devices (MBB, smartphones, tablets etc) …
  - … and increasing use in homes and workplaces.
- Traffic per connection is expected to increase:
  - 182MB to 892MB per month, which is an average annual growth of 31%, in developed markets …
  - … and 87MB to 301MB per month, a CAGR of 28%, in emerging markets.

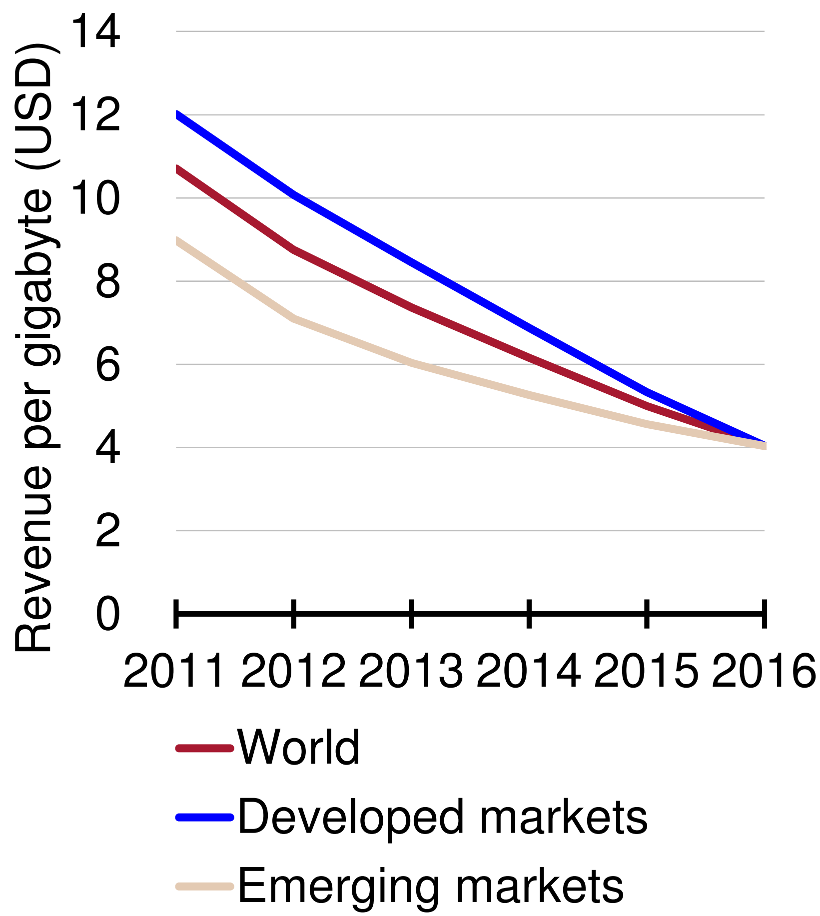
Average wireless network traffic per connection, worldwide, 2011–2016 [Source: Analysys Mason, 2011]



However, revenue per megabyte is expected to decline strongly

- Assuming operators continue using the flat-rate pricing model, we predict revenue of less than USD4 per GB by 2016 in both developed and emerging markets.
- The degree to which tiered pricing is adopted in the future will affect this forecast.
  - Differences are already emerging between Europe and North America.
  - The move towards tiered pricing is stronger in North America, and average prices are higher.

Revenue per gigabyte of mobile broadband traffic, worldwide, 2011–2016 [Source: Analysys Mason, 2011]

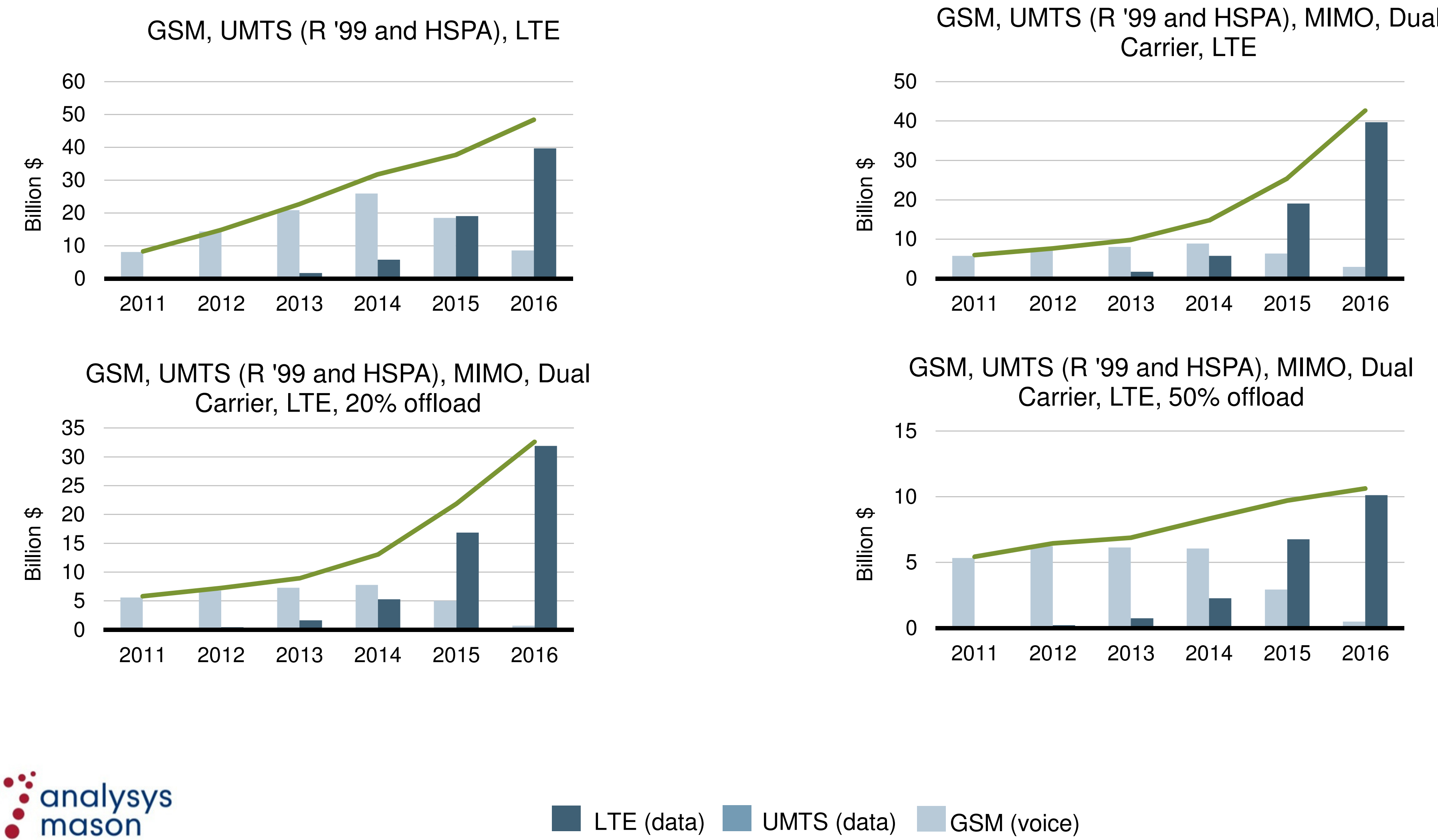


To generate sustainable cash flow, operators will have to reduce network costs by using several techniques …

- We have estimated the number of base stations (and cost) required to service the traffic growth.

- We modeled four different scenarios, based on four different assumptions:
  - **Scenario A**: assume operators will continue to deploy GSM and standard UMTS base stations with HSPA. Operators will also deploy LTE.
  - **Scenario B**: A plus assume operators will enhance the capacity of existing HSPA base stations to HSPA+.
  - **Scenario C**: B plus assume operators will achieve 20% reduction in network carriage costs
  - **Scenario D**: C plus offload 50% reduction in network carriage costs.

… technology choice optimisation and convergence will significantly reduce capex



Upgrading to HSPA+, buying spectrum, deploying LTE (from 2013) and offloading traffic are key requirements

- This analysis shows that operators must reduce network costs in order to meet the demand for traffic:
  - Neither Scenario A nor B are sustainable, because the operator spend on base stations is not feasible.
  - Scenarios C or D are the minimum sustainable approaches and imply that operators:
    - will upgrade their existing HSPA base stations to HSPA+ as required
    - will buy spectrum as it becomes available
    - will deploy LTE (from 2013)
    - Share networks - network sharing – 20-30% cost savings with passive sharing!
    - Self optimising networks
    - Small cell solutions - active network offloading – capacity enhancement with approximately 80% per site saving (compared with a second site)
    - Deploy 800 and 900 MHz frequencies
    - Maximise use of network capacity management and optimisation techniques
    - will offload as much traffic as possible onto an indoor (fixed broadband) network.

Offload will be a fundamental part of the technology mix

- This will become a driver for increased fixed–mobile convergence.
  - Combined operators should merge fixed and mobile operations in order to maximise the opportunity and reduce network carriage costs.
  - Mobile-only operators will be at a disadvantage, and will seek to acquire or establish partnerships with fixed assets, merge with fixed-only providers or reduce costs substantially in other ways (for example, by network sharing).

Wi-Fi as an offload technology [1]

- Wi-Fi is a cost-effective delivery mechanism in the context of the domestic user.
- End-to-end policy control or quality of service assurance; security and authentication.
- There is a legal obligation for operators to provide a point for legal interception of voice calls.
  - If the client is Skype (over Wi-Fi) for example?
- So the operators will force Skype over the macro network where they do have a legal intercept facility – this defeats the object of offload.
- This is also the case for SIPTO. In fact, this is why SIPTO is not being implemented in the UK, despite being a significant cost-reduction mechanism.
- As it stands, it is not a technology that can provide carrier-class services.

Wi-Fi as an offload technology [2]

- Despite the fact that a number of mobile operators are already using Wi-Fi, in order to facilitate widespread, global adoption by mobile operators authentication, encryption and policy control need to be standardised.
- Best estimates suggest between 225 000 and 250 000 hotspots globally.

PCCW – Hong Kong
>**9000** PCCW Wi-Fi hotspots
~2000 of these are in government premises
Free access
Other locations include food outlets, shopping centres or malls, universities and public transport
Access to subscribers of home broadband

Swisscom – Europe
>**1350** hotspots in Switzerland
Around another 150 in Europe
Brand name: Eurospot
Mostly located in hotels
Require a Swisscom subscription or pay as you go
Have some promotion days where access is free, at train-stations for example
Also allows access at “over 65 000 places worldwide”

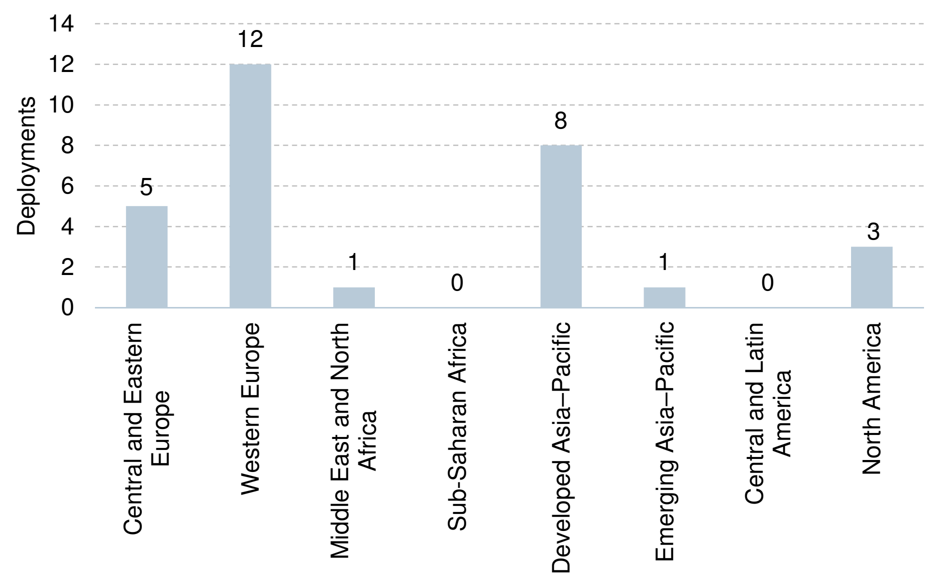
- The Wireless Broadband Alliance (WBA), a group of operators, was created to support the adoption of Wi-Fi as an integral component of ubiquitous and seamless wireless broadband services.
- The WBA expects to have user trials of standard mobile devices being authenticated and encrypted over Wi-Fi using standard protocols by the end of the year. Further it expects to see commercial adoption of these standards by mobile operators by the end of 2012.

Femtocell as an offload technology [1]

- It has been argued that femtocells are secure.
- IPSec tunnelling used for security. It prevents services like SIPTO, and denies legal intercept.
- Currently the solution is for the operator to own the backhaul or to have a trusted partner.
- Femtocells do not have the installed base that Wi-Fi has, not at the access and certainly not at the end user.
- But femtocells can run applications and they have a sense of 'presence'.
- Femtocells reduce churn.
- Customers may be reluctant to be tied in to this for extended periods.
- If femtocells become more commonplace in the home, it is likely that legislation will be introduced to allow MNP in femtocells.

At MWC this year:
Telstra rejected the business model behind domestic Femtocells, claiming the technology is already redundant with the widespread adoption of Wi-Fi for in-home data traffic.

Operational femtocell deployments worldwide, 2Q 2011



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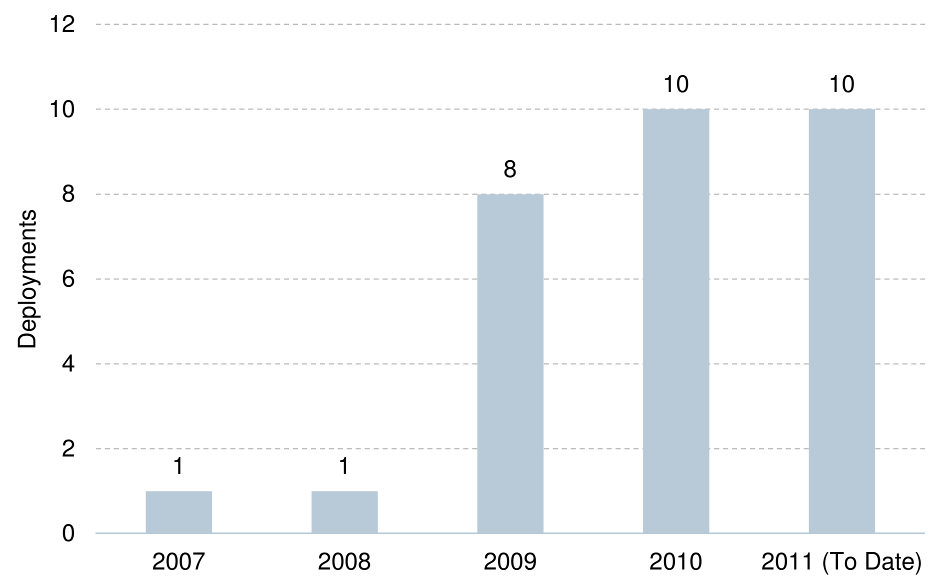
Femtocell as an offload technology [2]

- Femtocells do not have the economies of scale to achieve the benchmark unit price set by Wi-Fi.
- Femtocells operate in licensed spectrum. In contrast, Wi-Fi uses an unlicensed [ISM] band. This band will become more and more congested as time goes on.
- To prevent interfering with the macro network, femtocells are deployed on a separate carrier. In the future, LTE femtocells which use SON will make this unnecessary.
- There is talk of femtocells using the unlicensed band too. But this will require additional standards to allow frequency selection of a clear channel within the band – as Wi-Fi does.

Annual femtocell deployments, worldwide, 2007–2011



Backhaul is still a challenge

- Operators are designing tomorrow's backhaul based upon yesterday's architecture.
  - Current backhaul is not sufficiently fine grained to support offload nodes in the order of hundreds of thousands compared with current tens of thousands.
  - The points of aggregation are also not likely to placed in the optimum location.
- The problem of base station synchronisation is still not resolved.
- There are competing standards, but neither is ideal – the forerunners are SynchE and IEEE 1588v2.
  - SynchE uses the physical layer for synchronisation, but all nodes must be able to pass the synchronisation clock. SynchE offers synchronisation of frequency that is not adequate for LTE, which requires frequency and phase lock.
  - IEEE 1588v2 offers frequency and phase lock, but uses timing packets to pass timing information. Operators are understandably nervous about this – there have been timing discrepancies due to packet delay. Also all routers must be able to prioritise the timing packets. Not all routers are modern enough to do this. This implies that the operator must both own the backhaul network and accept expensive upgrade costs or work with a trusted partner.
- Most operators use SynchE for data (UMTS or GSM) and TDM for voice and timing.
- If this continues with LTE, then LTE will need to be co-located with GSM to enable synchronisation and will also delay the refarming of GSM frequencies.

Other comments

- Several other technologies are evolving to fill this space; examples include light radio ALU and NSN liquid radio. It is not clear if they are substitutive as yet, most are assuming they are complementary. But they have a number of advantages which may destabilise the Wi-Fi market in particular, and possibly femtocell too.
- Metronet will be problematic – time and cost of site acquisition.
- As far as – **which will be the dominant technology** – the next two years will tell: either femtocells will achieve a substantially increased market share and economies of scale to bring the cost down; or Wi-Fi will solve its problems of authentication, security and policy.

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