

Future Options for Efficient Backhaul

Project conclusions and key messages

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Ofcom R&D Symposium, 23rd November 2006

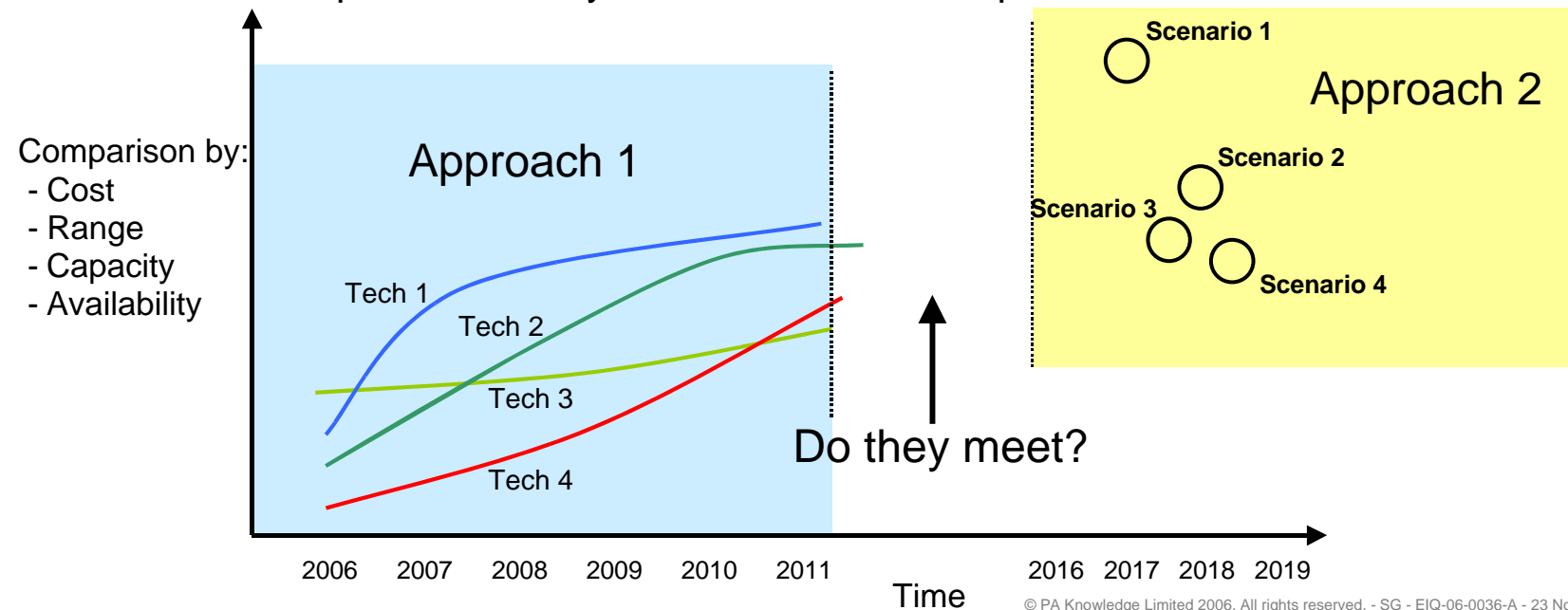
Conclusions and Key Messages

1. High-capacity Point-to-Point (PtP) Microwave for the final link to outdoor Base Stations (BTS).
 - This will be on the basis of reduced costs:
 - Reduce overall costs by avoiding leased lines
 - Quick and cheap to install compared to digging trenches
 - Low cost of scaling up capacity to BTSs as it is required
 - Wireless will be able to deliver the link capacities required
 - Combinations with mesh-type topologies will be needed for micro- and pico-BTSs in urban & suburban Non-Line-Of-Sight (NLOS) environments.
2. High-speed DSL will be used for indoor pico-BTS deployments where available.
3. Optical Fibre and xDSL will otherwise be used on a link-by-link basis to connect outdoor BTSs only where they provide a lower life-time cost than PtP Microwave.
4. The final link to the BTS will become shorter as Fibre-To-The-Cabinet (FTTC) pushes fibre further into the access network, increasing the number of fibre PoPs.

Matching Future Scenarios Against “Predictable” Evolution

We adopt a two-pronged approach to this project:

1. Investigate the current state of the art and predictable evolution of the technologies over the coming years
2. Brainstorm potential future scenarios for wireless communications usage and what implications these have for backhaul requirements
 - Compare the future scenarios against the predictable evolution to see if the logical evolution paths are likely to meet the future requirements



We identified a number of possible Future Scenarios...

Scenario	National Offered Traffic (Gbit/s)	Average Traffic per Person (kbit/s)	Normalised Traffic Increase	Main Driver of Traffic
GSM today	12	0.2	1	Voice
All-You-Can-Eat	4,200	70	350	Upload & download of work and personal data
Entertainment	35,000	583	2,917	Video-on-Demand
Interactive	6,000	100	500	Interactive Gaming
Governed	840	14	70	Education services

- Today's GSM networks in the UK are dominated by simple voice, with a total peak load of 12 Gbit/s generated across all networks.
 - Voice (~10kbit/s) @ 20mErlang/sub in Busy Hour (BH), with ~60M subs

... and how different Deployment Types support them

The following backhaul requirements are shown for different Deployment Types and Scenarios, where:

- “High” equates primarily to the Entertainment scenario
- “Medium” generally equates to the All-You-Can-Eat and Interactive scenarios
- “Low” equates to the Governed scenario

Area Type	No. of Operators	Deployment Type	Backhaul Req's per BTS per Scenario (Mbit/s)		
			High	Medium	Low
Rural	6	Cellular Macro-BTS	228	180	40
Suburban	6	Cellular Macro-BTS	228	80	20
Urban	6	Cellular Macro-BTS	228	80	20
	6	Cellular Micro-BTS	60	30	10
	6	Cellular Pico-BTS	30	20	10
	1	WiFi Pico-BTS	60	30	10

Current and Emerging Backhaul Technologies

There are several different techniques and technologies that can be employed for backhauling. Those considered are:

Backhaul Technology	Likely to have a major future role?
PtP Microwave	Yes – preferred
Optical Fibre	Yes
xDSL	Yes
Mesh Radio Techniques	Yes – In conjunction with PtP Microwave in NLOS environments
PtMP Microwave	Probably Not – Not appropriate for NLOS micro- and pico-BTSs
WiMAX	No – Another flavour of PtMP
Free Space Optics	No – Not reliable enough for practical deployments
Satellite	No – Limited capacity
Power-Line Communication	No – Limited in range and by location of nearest transformer

The Big Challenges ahead are

PtP Microwave Radio:

Combinations with mesh-type topologies will probably be needed for micro- and pico-BTSs in NLOS environments.

- Getting mesh topologies to work with high-capacity, high-frequency spectrum to hop back to fibre PoPs or aggregation points for future micro- and pico-BTS deployments.
- Developing backhaul mesh topologies to support performance targets and mobility requirements expected of public mobile networks.
- Developing auto-configuring “plug-and-play” mesh backhaul networks to make ad-hoc pico-BTS deployment easier and cheaper.
- Developing wall-mounted, phased-array flat panel antennas forming multiple beams (to help overcome planning permission issues with, and public opposition to the deployment of more micro- and pico-BTSs and associated antennas).

The Big Challenges – continued...

Optical Fibre:

- Limited by time & cost to dig trenches and perceived lack of competition in the access market.
- Need to encourage greater deployment and availability of optical fibre, increasing the number of optical PoPs and improving competition for the provision of optical fibre in the access and backhaul networks.

DSL:

- Limited by range vs. capacity. VDSL2 ranges mean the market penetration needed limits competition from new entrants and smaller players.
- Enabling the widespread deployment and availability of advanced DSL technologies such as VDSL2.

Both Optical Fibre & DSL:

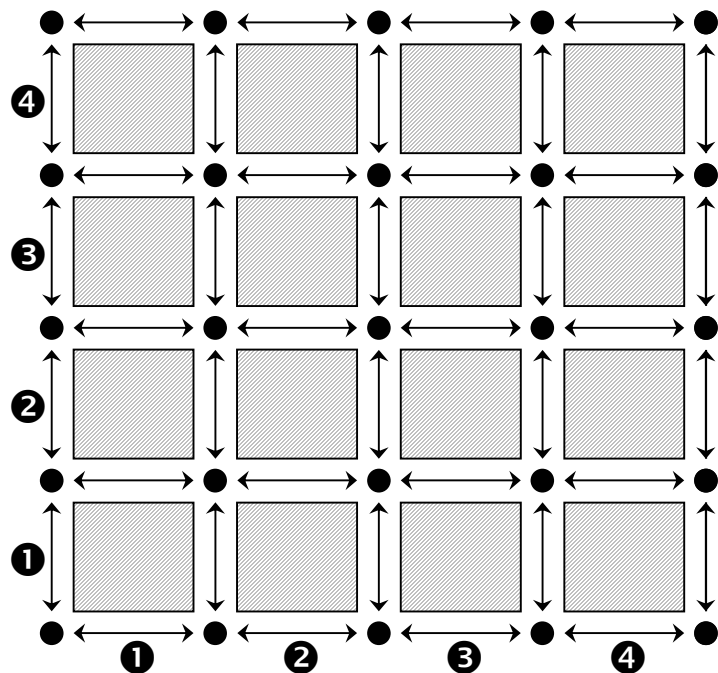
- Researching solutions for the re-use of existing in-building cabling to provide the final link to indoor, wall-mounted and roof-mounted BTSs.

A number of the major obstacles to future backhaul will be unchanged and logistical (digging trenches, antenna planning permission, getting copper pairs to streetlamps).

The Wireless MAN – Impact on Spectrum

Future Metropolitan WiFi networks may see cities build outdoor wireless transmission networks that use very high capacity, high frequency links to mesh back to optical fibre PoPs.

- Cities see it as a part of the infrastructure to boost their local economy
- It lets new players enter the market
- There is enough PtP spectrum to support very high capacity networks.



Link capacity (symmetric)	622 Mbit/s
Number of links from each BTS	4
Frequency re-use factor needed to meet interference requirements	11
Spectrum required for 1 operator	~1.4 GHz
Spectrum required for 8 operators, overlaid on each other	~11 GHz
Total PtP spectrum available by 2007	30 GHz

In Conclusion – Preferred Options for Backhaul

The preferred options for the different deployment options against the different scenarios (High / Medium / Low) are summarised in the table below.

- Other potentially suitable technologies are shown in brackets that would act as backup options where the preferred option is not available or suitable.

		High	Medium	Low
Rural	Macro-BTS	PtP Microwave (Optical Fibre)		PtP Microwave (Optical Fibre)
Suburban	Macro-BTS			PtP Microwave (DSL, Optical Fibre)
Urban	Macro-BTS	PtP Microwave with Mesh (DSL, Optical Fibre)		
	Micro-BTS			
	Pico-BTS	Outdoors – PtP Microwave with Mesh		
	WiFi Pico-BTS	Indoors – DSL		

Green = Technically feasible now

Amber = On technology roadmaps

Red = Technical development needed





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