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Fibre-to-Air for Cellular Applications - Improving Network Flexibility & Energy Efficiency

Industry brief

Strategic Business Relevance:

Applied to cellular networks, Fibre-to-air systems use 30% less energy than conventional BTS to mast head solutions and enable fast multi-beam steering and switching. Additional advantages include reduced antenna weight and simplified urban site installation.

Fibre-to-air is a new concept for transporting radio frequency (RF) signals to the air interface within a cellular network system. This can be from either the base station controller (BSC) or base transceiver station (BTS) directly to the antenna element at the air interface. The proposed system has lower transmission losses and greater power efficiency than current state-of-the-art implementations.

Fibre-to-Air can provide significant enhancements to network performance and flexibility, while reducing infrastructure and operating costs. Furthermore, it can be easily integrated into existing systems enabling gradual roll-out where required. It eliminates the requirement of bulky feeder cables from the BTS to the antenna, and within the antenna itself, by replacing them with an optical feed.

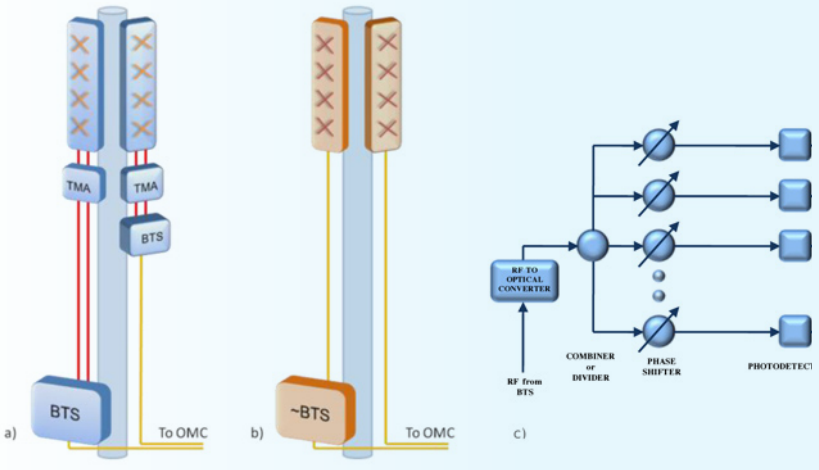

Fig.1:
Typical 3G cellular site configuration with a) conventional BTS and picoBTS connections, b) optical connection to ~BTS and ~OMC and c) a general configuration of a fibre-to-air system

Core Research: Green Radio

Through the perspectives of both architecture and state of the art techniques, the Green Radio research programme is discovering innovative ideas to significantly reduce the power consumption of radio access networks.

The Techniques element spans the protocol stack and when optimally combined seeks to address the aspiration of 100x power reduction.

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Fibre-to-Air for Cellular Applications
Increased Network Operational Flexibility:
Energy Consumption and Capacity

Key aspects of Fibre-to-Air

Industry brief

Architectural

The design concept is distinctly different from other radio-over-fibre solutions as it can be selectively integrated into any existing cellular infrastructure. Fibre-to-air aims to minimise the electronic complexity and operational risk (due to lightening strikes, component failure etc.) of current solutions by not requiring electro-mechanical phase shifters or radio units behind each antenna element.

Increased Capacity

Optical beamforming enables fast multi-beam steering and switching, and adaptive radiation pattern control. Mutual coupling within multiband RET antennas can be reduced.

Transmission Energy Efficient

By eliminating coaxial cable losses from the BTS to the air interface (i.e. feeder cables and within the antenna), transmitter power can be reduced by a third while maintaining the same EIRP.

Overhead Saving

Greater energy and financial savings can be made if the equipment in the BTS is moved back towards the BCS or OMC by enabling sharing of equipment.

Integration and Deployment

Fibre-to-air can be selectively integrated into any existing cellular infrastructure and does not require an upgrade of the BTS, although greater energy savings can be made if the system is directly linked to the OMC. Optical beamforming can be performed either within the antenna or in an optical BTS, BSC or OMC.

Proof of Concept

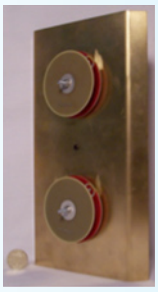

Fig.2:
A two element antenna with optical feed.

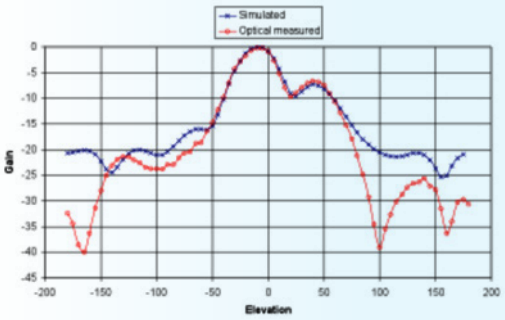

Fig. 3:
A comparison between measured and simulated elevation patterns for the optically fed, two element antenna.

Summary

Fibre-to-air enables direct feeding of RF signals from either the BSC/OMC or BTS directly to the antenna element at the air interface. The proposed system has lower transmission losses and greater power efficiency, using 30% less energy than current state-of-the-art systems. A prototype fibre-to-air antenna has been produced in addition to an electronically controlled optical phase shifter.

Key Points

- Enables fast multi-beam steering and switching (theorectically <1ms)
- Minimises electronic components at the mast head
- Approximately zero RF losses
- Simplifies antenna designs
- Reduces weight of antenna
- Lower network operating costs
- Enhances ease of upgrades
- Can eliminate TMA/TMB
- Simplifies urban site installation
- Uses 30% less energy than current technologies

Industry focused research, innovation & application