



MOBILE BACKHAUL SOLUTIONS FOR LTE-ADVANCED

Turning the Evolution Challenge into an Opportunity

 **ADVA**[™]
Optical Networking

New Backhaul Challenges Emerging with LTE-Advanced

With Long Term Evolution (LTE) being introduced in many mobile networks, eyes are turning towards the next development of a true 4G technology called LTE-Advanced. LTE-Advanced is a major enhancement of the LTE standard developed by the 3rd Generation Partnership Project (3GPP). This new technology is targeting peak data rates up to 1Gbit/s and introduces new concepts with the ultimate goal of designing a system that is drastically enhanced in both cell capacity and coverage.

Higher Data Throughput Rates

LTE-Advanced offers considerably higher data rates than even the initial releases of LTE. There are a number of key technologies that enable this. Multiple Input Multiple Output (MIMO) technology and Orthogonal Frequency Division Multiplexing (OFDM) are two critical base technologies. Along with these, there are a number of other techniques employed to provide such impressive data rates.

Using Carrier Aggregation (CA), it is possible to utilize more than one carrier and increase the overall transmission bandwidth over the capacity supported by a single channel. Coordinated Multipoint (CoMP) turns inter-cell interference into useful signal, especially at cell borders where air interface performance degrades. It enables dynamic coordination of transmission and reception over different base stations and aims at improving overall user experience while increasing network utilization.

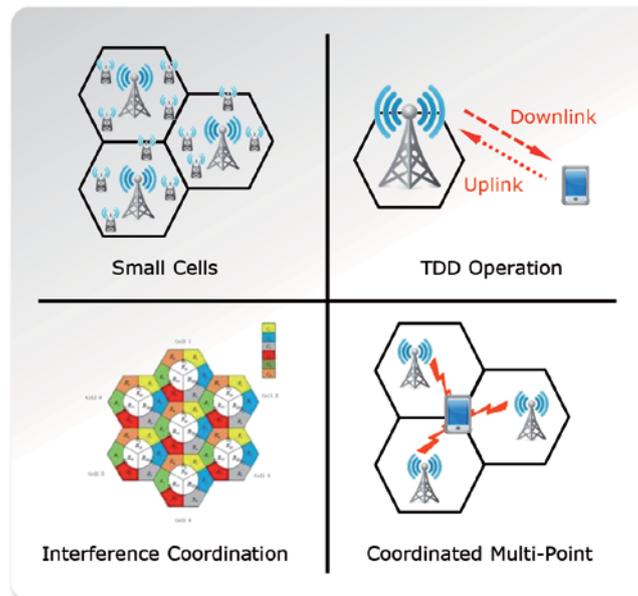
With data rates rising well above what was previously available, it is vital that the mobile backhaul network is also enhanced.

Coordination for Increased Spectrum Efficiency

LTE has been defined to accommodate both paired spectrum for Frequency Division Duplex (FDD) and unpaired spectrum for Time Division Duplex (TDD) operation. TDD has a number of advantages that are of particular interest to the mobile operator. Paired spectrum is not mandatory with TDD operation as both transmit and receive occur on the same channel. As a result, the up- and downlink capacity ratio can be adapted

dynamically to match user demand and increase spectrum utilization.

As adjacent cells use the same frequency spectrum, interference between overlapping cells may prevent users from obtaining sufficient throughput. Enhanced Inter-Cell Interference Coordination (eICIC) techniques present a solution by applying restrictions to the radio resource management and thus attaining high spectral efficiency. Coordinated resource management is achieved through real-time communication with the help of additional inter-cell signaling.



Both TDD operation and eICIC need base stations to be synchronized with respect to the up- and downlink transmission times. If neighboring base stations use different time assignments and share the same spectrum, then interference between cells may occur.

Small Cells Provide Enhanced Coverage

With mobile operators struggling to support the growth in mobile data traffic, many are using mobile data offloading as a more efficient use of radio spectrum. Small cells are a vital element to data off-loading and enhancing mobile coverage in metro areas. They are elementary to managing LTE-Advanced spectrum more efficiently compared to only using macro cells.

The concept of the Heterogeneous Network (HetNet) has arisen from the need of mobile network operators to operate networks consisting of a variety of radio access technologies, formats of cells and many other aspects, and combining them to operate in a seamless fashion. One of the major considerations for heterogeneous cellular networks is backhaul technology. Introducing new forms of base stations will help alleviate Radio Access Network (RAN) congestion, but then the backhaul network can become congested. In addition, there is communication required to organize and configure the network. HetNet therefore is considerably more complex than adding small cells to the network. The HetNet concept requires the whole network to operate in a more efficient and seamless manner.

Etherjack™ Benefits

- Advanced service definition and service intelligence
- Enables performance assured backhaul services with stringent SLAs
- In-service real-time performance monitoring
- Compliant with latest OAM standards including 802.3ah, 802.1ag, Y.1731 and Y.1564
- Remote end-to-end test and turn-up from central locations
- Integration with a wide range of back-office support tools



Performance Assured Backhaul Services

Mobile user experience for wireless telephony has largely been based on voice quality and breadth of coverage, two factors that might not be particularly simple to measure but are at least easy to define. As data usage increases and smart phone sales overtake those of conventional phones, the user experience situation becomes very different and far more complex. The more consumers use advanced data services including web browsing, apps and mobile video, the more factors like broadband quality, network availability and service reliability come into play.

Improved Quality of Experience

Operators are leveraging LTE-Advanced to offer their wireless customers a superior mobile user experience and reduce churn. But operators also need an intelligent mobile backhaul network that provides more than just transporting traffic to translate LTE-Advanced into success. The ADVA FSP 150 Mobile Backhaul Solution goes beyond basic backhaul and provides network intelligence, service differentiation and service assurance in a single platform.

It enables Quality of Service (QoS) support for all mobile data and signaling services, efficiently allocating scarce network resources where required. No matter whether forwarding traffic at sub-millisecond latency for interference coordination between LTE-Advanced base stations or providing large amounts of bandwidth for distributing video content from the core to the RAN. The ADVA FSP 150 Mobile Backhaul Solution flexibly and efficiently allocates network resources while maintaining the QoS required. It therefore provides the necessary backhaul capabilities for enabling mobile network operators to monetize LTE-Advanced investment.

Ethernet Service Assurance

The importance of QoS management across packet-based mobile backhaul networks mandates powerful Operation, Administration and Maintenance (OAM) tools for service performance assurance and simplified network operations. The QoS provided by the backhaul network must be constantly monitored and

reported. In addition to packet loss, performance metrics such as micro-second packet delay and delay variation are important characteristics, ultimately defining mobile user experience. Immediate measures need to be taken when the backhaul network can no longer provide the anticipated QoS.

The ADVA FSP 150 Mobile Backhaul Solution places a strong emphasis on performance assured service delivery and offers a leading implementation of service OAM tools covering the entire service life cycle. The integrated Etherjack™ performance monitoring suite encompasses all important service OAM functions. Etherjack™ is implemented across the entire FSP 150 platform, providing consistent functionality with the same look and feel in service demarcation, aggregation and service hand-over applications.

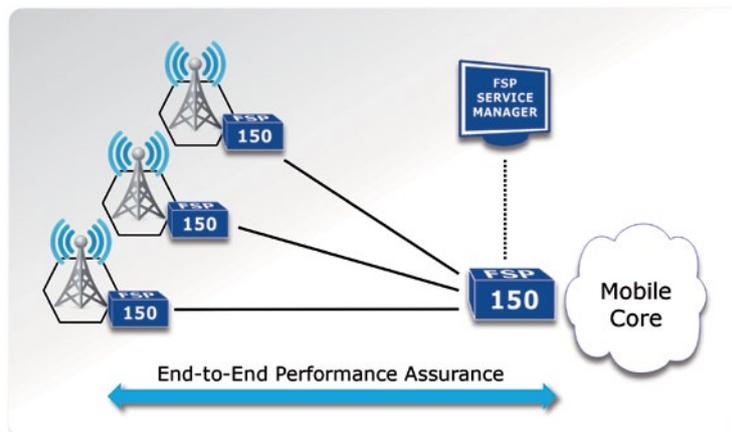
Integrated Service Management

As mobile networks grow with the deployment of small cells, a continuous rebalancing of the RAN and backhaul network can have a major impact on the cost of network ownership. The backhaul network needs to be modified to accommodate changes in capacity requirements. To support this critical business activity, strong network

management tools and processes are needed to control operating expenses. Network management for the ADVA FSP 150 Mobile Backhaul Solution is provided by the FSP Network and Service Manager.

As part of this solution, the FSP Service Manager enables provisioning of end-to-end services using wizards and point-and-click configuration from a single

application without having to configure each device in the service path individually. It greatly reduces the complexity and risk associated with provisioning complex services and provides comprehensive support for fault, configuration and performance management. Features of the LTE-Advanced toolbox can therefore be activated at the mobile operator's own pace, without forklift upgrades in the backhaul network or complex operational tasks.



The ADVA FSP 150
Mobile Backhaul Solution

Precise RAN Synchronization

Mobile base station clocks need to be synchronized to ensure stable operation of the RAN and avoid interference with neighboring cells. Distributing synchronization information inherently across the backhaul network is the preferred solution for most operators. It enables designing synchronization architectures for highest reliability and guarantees independence from external impairments.

Most 3GPP base station clocks are currently synchronized with regard to frequency only. Precise phase synchronization was not a requirement up to now. The new LTE-Advanced functionalities, however, require base station clocks to be in phase with sub-microsecond accuracy to efficiently exploit the benefits from interference coordination and carrier aggregation techniques such as eICIC and CoMP. The TDD operation mode also requires base station clocks to be synchronized with respect to up- and downlink transmission times.

Unified Synchronization

The distribution of timing information for frequency and phase synchronization of the RAN constitutes a particular challenge. Of the variety of different timing solutions that have been developed for packet networks, Synchronous Ethernet and IEEE 1588v2 are the two standards-based solutions that are widely applicable across multiple backhaul architectures. Backhaul networks need to actively contribute to timing distribution and provide on-path support in order to achieve highly accurate phase alignment as required for LTE-Advanced. This is a new requirement and currently not supported by most backhaul network architectures.

The ADVA FSP 150 Mobile Backhaul Solution simultaneously supports a complete implementation of Synchronous Ethernet and IEEE 1588v2. The fully integrated Syncjack™ timing distribution functionality unifies the benefits of both bit-layer and packet-based protocol, enabling precise and stable RAN synchronization under all network load conditions. Syncjack™ is designed as an integral part of the FSP 150 solution, minimizing deployment cost and reducing the number of elements to be deployed in the backhaul network. Costly overlay solutions for network timing distribution can thus be avoided.

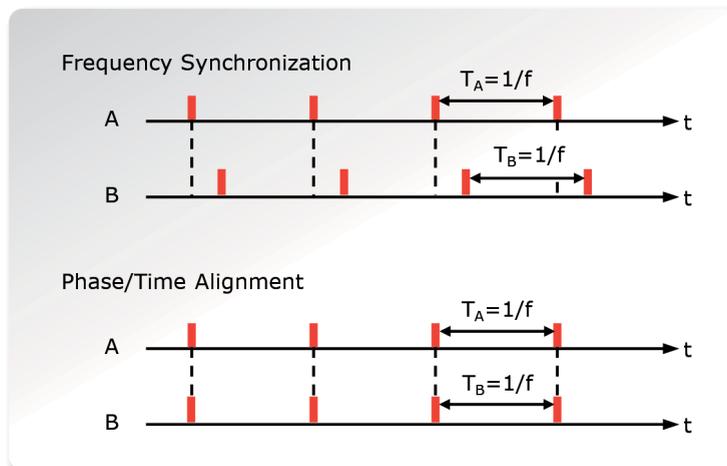
Ensuring Synchronization Performance

Highly accurate synchronization of base station clocks is elementary for stable operation of the RAN. Unlike legacy TDM networks, packet networks are not deterministic with regard to delay and delay variation. Synchronization performance therefore needs to be monitored and assured. Ensuring synchronization performance is a network-wide concept following the principles of Ethernet service assurance.

Syncjack™ as an integral part of the FSP 150 network elements offers a variety of tools for monitoring, verifying and testing clock accuracy across backhaul networks. Frequency and phase accuracy of slave clocks controlled by IEEE 1588v2 can be continuously monitored and measured by comparing the clock signal with alternative internal and external clock sources. Network probe analysis allows characterizing the performance of the backhaul network when transporting

IEEE 1588v2 messages and consequently provides information about clock accuracy.

Combining Etherjack™ technology for performance assured service delivery and Syncjack™ technology for timing distribution, monitoring and testing on one platform makes the FSP 150 a comprehensive and unique solution for mobile backhaul networks, seamlessly supporting the introduction of LTE-Advanced.



Managing Synchronization Networks

The FSP Synchronization Network Manager application is an advanced synchronization measurement and analysis tool with the ability to import and analyze data generated by Syncjack™ in the FSP 150 network elements. It provides a network-wide view of the complete synchronization infrastructure including topology and end-to-end visibility. The FSP Synchronization Network Manager consolidates synchronization measurement data from a variety of sources and performs a wide range of analysis and troubleshooting functions. It therefore enables backhaul service providers to generate new revenues from the delivery of SLA-based synchronization services.

Syncjack™ Benefits

- Integrated technology for timing distribution, monitoring and testing
- Precise clock accuracy measurement and enhanced statistics
- Works in tapping, parallel and testing architecture modes
- Brings IEEE 1588v2 support to legacy packet networks
- Continuous monitoring – in service and alarmed if needed
- Enables new revenue from delivery of SLA-based synchronization services



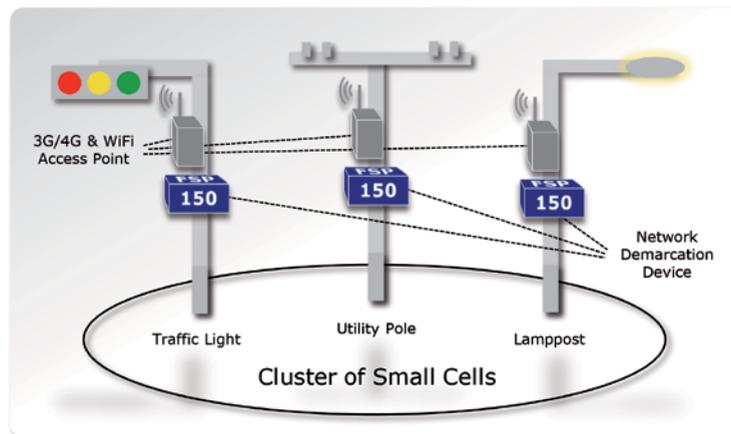
Connectivity Solutions for Small Cells

LTE-Advanced small cells for public access – known as metro, micro and pico cells – are set for widespread deployment in dense urban areas and hot spot locations in order to improve mobile network coverage and provide more capacity by efficiently using the radio spectrum. Implementing smaller cell configurations raises new challenges for backhaul network design and the operations teams. Whereas macro cell backhaul networks are architected to provide scalable capacity at the highest quality of service, operators are generally limited by the need to deploy small cell base stations on telephone poles, lampposts and other structures that have specific limitations on environmental parameters.

Small Footprint, Light Weight and High Security

Backhaul is an even more critical business case component in the public access small cell era compared to traditional macro cell deployment and therefore constitutes a major factor for success. With small cell deployment, the demanding requirements in the last hundred meters call for new alternatives to backhaul. Many small cell use cases will feature outdoor deployment models at street level. This will require network elements to be environmentally hardened and as ergonomically appealing as possible to comply with local planning requirements and support multiple installation options. Small cells also have a completely different security profile compared with macro cells, imposing additional requirements on backhaul solutions.

With the ADVA FSP 150 Mobile Backhaul Solution for small cells, network operators can provide cost-efficient and fully managed small cell backhaul services to any fiber-fed location. It is specifically designed for deployment at street level and includes all Etherjack™ and Syncjack™ performance management and OAM tools that operators need to successfully deliver performance assured services to LTE-Advanced small cell locations.



Increased Need for Coordination

Deployment of a large number of public access small cells overlaying macro cells can create significant interference across the radio spectrum. Adaptive power and frequency coordination schemes such as eICIC therefore become mandatory to limit inter-cell interference, increasing network efficiency and improving mobile user experience for large-scale small cell deployment.

Efficient interference coordination requires small cells to be interconnected at lowest possible latency and requires small cell base station clocks to be synchronized in phase. The faster real-time signaling information can be exchanged between base stations and the more accurately clocks are aligned the less interference negatively impacts user experience.

The ADVA FSP 150 Mobile Backhaul Solution for small cells is designed for lowest-latency connectivity and supports Syncjack™ for highly accurate timing distribution and timing service assurance. Frequency and phase accuracy of small cell base station clocks can be guaranteed within tight limits, enabling superior performance of large-scale small cell LTE-Advanced networks.

Operational Simplicity

Deploying a large number of new devices at the edge of the network is not an easy task. Operators need to evaluate factors such as technology costs, operational expenses and the ease of deployment. Operations staff must be able to effectively deploy backhaul service demarcation devices in multiple locations quickly, reliably and cost-effectively.

A high-end network management system lowers the operational expenses and hides technical complexities, which can be inherent in a small cell backhaul network. Being able to manage hundreds or even thousands of devices and services end-to-end from a single centralized location makes a difference. The FSP Network and Service Manager enable network operators to automate routine tasks and focus on business-critical items. It provides comprehensive end-to-end visibility and manageability of data and synchronization services, therefore enabling operators to have more visibility on what is going on in the network and helping to make the right decisions.

FSP 150 Mobile Backhaul for LTE-Advanced

- Universal end-to-end solution for service aggregation and demarcation
- Syncjack™ for provisioning of SLA-based synchronization services
- Etherjack™ OAM tools for performance assured service delivery
- MEF 2.0 service flexibility for efficient resource utilization
- Low-touch provisioning for simplified backhaul network operations
- Service-based management of data and synchronization network

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About ADVA Optical Networking

At ADVA Optical Networking we're creating new opportunities for tomorrow's networks, a new vision for a connected world. Our intelligent telecommunications hardware, software and services have been deployed by several hundred service providers and thousands of enterprises. Over the past twenty years, our innovative connectivity solutions have helped to drive our customers' networks forward, helped to drive their businesses to new levels of success. We forge close working relationships with all our customers. As your trusted partner we ensure that we're always ready to exceed your networking expectations. For more information on our products and our team, please visit us at: www.advaoptical.com.



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