ALCATEL-LUCENT METRO CELLS

PLACING COVERAGE AND CAPACITY WHERE IT'S NEEDED

ALCATEL-LUCENT METRO CELLS

As a key component of Alcatel-Lucent lightRadio™ Network or any heterogeneous (HetNet) architecture, Alcatel-Lucent metro cells enable mobile service providers (MSPs) to deliver cost-effective capacity to urban hotspots, as well as affordable coverage to rural locations. They also enhance the quality of experience (QoE) for end users by enabling faster, more reliable data connections and higher data throughput on both 3G and 4G networks. In addition, some Alcatel-Lucent metro cells offer seamless, secure Wi-Fi® access to an MSP's services. The cells integrate easily into any W-CDMA or LTE network, without impacting the current RAN design, and their advanced interference management features minimize any impact on macro network performance. Metro cell configuration and optimization is automated, using Alcatel-Lucent self-organizing network algorithms – a Bell Labs innovation – to keep network deployment and operation costs low.

A RAPIDLY CHANGING ENVIRONMENT

The wireless industry is experiencing unprecedented demand for wireless capacity, and that growth is not about to subside soon. More people are accessing the Internet over mobile broadband connections, and an increasing number use sophisticated devices, such as smartphones and tablets, which consume far more bandwidth than simpler phones. A smartphone generates as much data traffic as 20 feature phones, and a tablet generates 100 times as much traffic. By 2015, the number of mobile broadband connections is expected to triple, with smartphone connections increasing five times over today's level. The data generated by all types of wireless devices is also predicted to increase, with smartphone data increasing up to 18 times, over today's levels. As a result, MSPs can expect to see 30 times as much data on their networks as they carry today.

Moreover, mobile subscribers have grown accustomed to the high speeds and fast, reliable data connections provided by fixed broadband connections, and they now expect this same experience, no matter where they are – or what type of access they are using.

... DEMANDS A NEW KIND OF NETWORK

It won't be easy for today's macro-only networks to accommodate subscribers' capacity and QoE expectations. Traditionally, growing capacity demands are met by infilling or splitting existing macro cells, but this option is reaching its saturation point. In many dense urban areas, spectrum is becoming exhausted. Macro cells are very close to one another, making it nearly impossible to add more towers. Growing concern over radiation and unsightly cell towers is also leading many municipalities to restrict new tower placements, further limiting where macro sites can go.

MSPs will have to deploy and maintain 10 times the number of macro cells in existence today to meet projected demand, a feat that is economically and operationally challenging. Even if it was feasible to deploy enough macro sites to accommodate accelerating growth, today's macro-only networks could still not handle the extra traffic efficiently or economically. While carrier capacity is distributed uniformly across all macro sectors, traffic is not. The sector with the heaviest load usually carries more than 50 percent of traffic, but has only one-third of the cell's capacity.

Macro-only networks do not provide ubiquitous coverage. They were built mainly for outside coverage of urban areas and major highways. The majority of cell phone usage today occurs in indoor locations that can be challenging to cover. Macros are also not cost-efficient for rural locations, leaving these areas largely without coverage.

Figure 1. Heterogeneous networks combine multiple technologies and radio access options
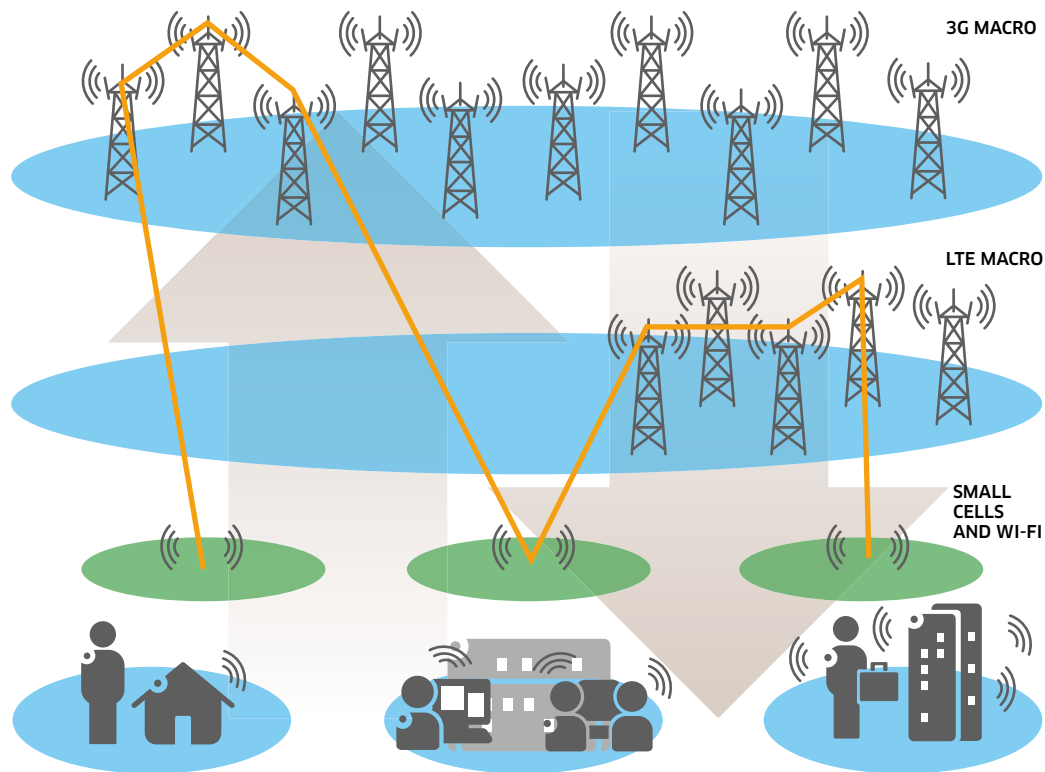
Mobile subscribers' growing demand for better QoE also cannot be addressed simply by adding more macro sites. Low data throughput will still be an issue, as more data users compete for spectrum. In addition, weak signal strength at the periphery of the coverage area will limit data service quality in those locations.

A new kind of network is required that can cost-effectively provide ubiquitous coverage, along with the high-bandwidth capacity to deliver a superior QoE. The heterogeneous network, or HetNet, provides this kind of next-generation network. As shown in Figure 1, it combines a broad arsenal of wireless technologies, such as W-CDMA, LTE and Wi-Fi, along with flexible radio access options, such as macros, small cells and Wi-Fi. This mix of technologies and access options can cost-effectively satisfy capacity and coverage needs in all environments. Highly effective HetNets, such as Alcatel-Lucent lightRadio Network, also support a multi-vendor environment, mitigate interference and incorporate intelligent traffic management features, as well as provide a seamless end-user experience.

Alcatel-Lucent metro cells, small cells used in public or open access areas to cost-effectively augment the macro network's capacity and coverage, are a vital component of Alcatel-Lucent lightRadio Network or any HetNet architecture. Being low-powered, small form factor devices, metro cells can be deployed almost anywhere, both indoors and out, that requires a boost in coverage or capacity. Metro cells are also owned and managed by MSPs, which simplifies network planning, maintenance and optimization.

Alcatel-Lucent metro cells deployed where capacity is needed

PLACE COVERAGE AND CAPACITY WHERE IT'S NEEDED

Metro cells enable MSPs to place capacity where it is needed fast. Because they are small, unobtrusive devices, metro cells can be deployed in almost any location without the visual pollution caused by traditional towers. Alcatel-Lucent metro cells can be mounted easily on walls, lamp posts, poles or even the side of a building. Since metro cells have much lower transmit power than macros, they do not need site permits, which enables MSPs to meet capacity demands quickly. Metro cell are well-suited for providing dedicated capacity to high-use urban hotspots, such as hotel lobbies, restaurants, malls, train stations, airports and city streets. Metro cells are also ideal for filling in coverage holes within the macro network – and for extending coverage to remote rural locations where macros are not cost effective.

Alcatel-Lucent offers a wide variety of metro cells that can cover all types of locations. They include indoor and outdoor metro cells, as well as cells that are deployed outdoors for easy accessibility, while extending coverage and capacity to indoor locations. Alcatel-Lucent metro cells range in power from 250 mW to 5W, making it easy to cover any hotspot, whether small or large. To provide high capacity in dense urban areas, some Alcatel-Lucent metro cells have integrated directional antennas, including antennas based on Alcatel-Lucent Bell Labs groundbreaking lightRadio cube technology. For more widespread coverage, in either urban or rural areas, others metro cells have omni-directional antennas.

Metro cell capacity expansions can involve more than one technology. Certain hotspots may require metro cells to augment both W-CDMA and LTE capacity. In very high traffic hotspots, MSPs may also want to deploy Wi-Fi access points to help offload the macro network. For deployments such as these, Alcatel-Lucent offers multi-standard and single standard Wi-Fi integrated metro cells. Multi-standard metro cells integrate W-CDMA, LTE, and optionally Wi-Fi into a single unit, while single standard metro cells integrate W-CDMA and Wi-Fi. Only one site and one installation are required, greatly simplifying multi-technology deployment.

IMPROVE QUALITY OF EXPERIENCE (QOE)

Alcatel-Lucent metro cells dramatically improve end-user QoE. By moving the base station closer to the user equipment, a higher quality air interface can be delivered, which provides faster, more reliable data connections and higher data throughput. In addition, the metro cells' flat IP architecture can deliver a low-latency, full-speed experience, so that high-bandwidth services, such as streaming videos and mobile TV, can be enjoyed comfortably at any metro hotspot, indoors or out, with no quality degradation. With metro cells' excellent coverage, mobile subscribers also experience crystal clear voice with no dropped calls due to dead zones. Mobile device battery life can now be extended, too, by transmitting at a very low power.

As more Wi-Fi-enabled end-user devices become available, end users are turning to Wi-Fi for Internet access, for its higher speeds and lower costs. Alcatel-Lucent Wi-Fi integrated metro cells, along with Alcatel-Lucent lightRadio™ Wi-Fi®, allow MSPs to offer Wi-Fi to enhance the overall user experience, with integrated billing included. Like W-CDMA and LTE, Wi-Fi then becomes another automatic and secure technology for accessing the MSP's mobile services.

Metro cells also improve QoE for users of the macro network. By offloading heavy data users from the macro network, the metro cells free up limited macro resources for subscribers on the move. With fewer users per macro cell, more bandwidth is available for all.
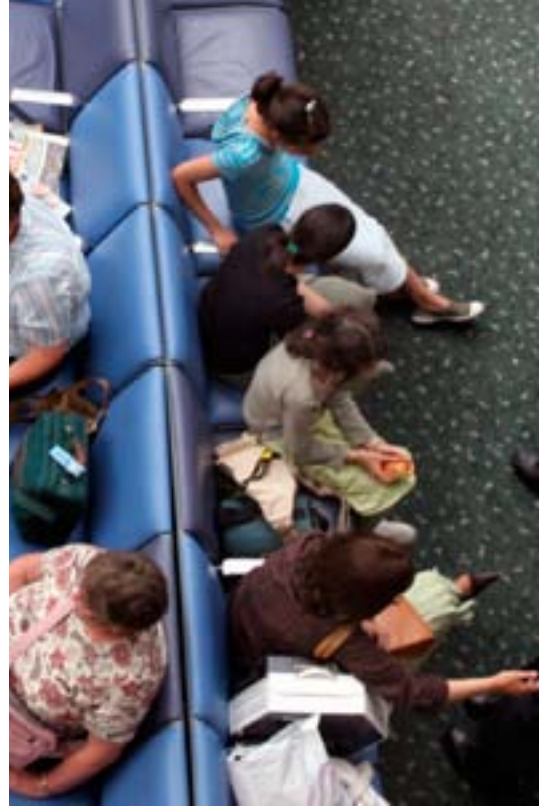
INCREASE REVENUE

Alcatel-lucent metro cells can increase revenue from both new and existing services: When coverage is excellent in indoor and outdoor hotspots and rural locations, more mobile calls can be completed. Higher throughput and faster, more reliable data connections can also increase usage of mobile TV, gaming and customer-specific TV clips, such as football or soap operas – while driving the uptake of value-added 3G and 4G multimedia services.

PROVIDE MORE CAPACITY FOR LESS

As small, low-cost access points, easily installed by a single person, metro cells offer MSPs a cost-effective alternative to macro-only deployments for meeting growing capacity demands. A recent study conducted by Bell Labs in North America showed that adding capacity with LTE metro cells in planned shared carrier deployment can provide a 31 percent cost savings over macro-only deployments (see Figure 2).
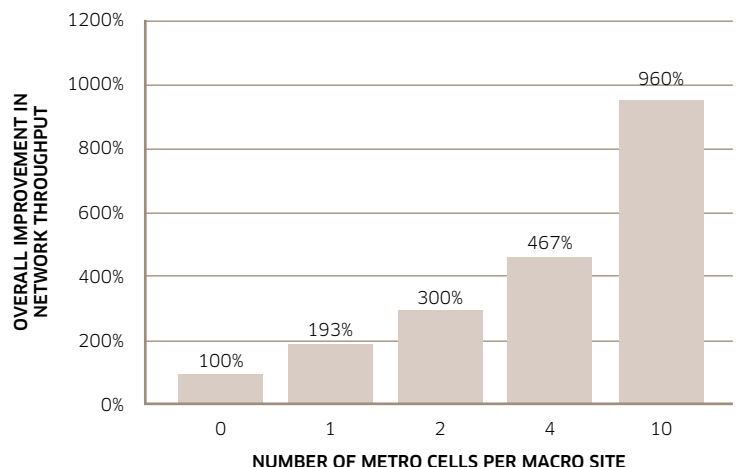
Figure 2. Macro + metro cells vs. macro-only business case

OVER 5 YEARS	NUMBER OF MACRO CELL SITES	NUMBER OF METRO CELLS	CAPEX (USD)
MACRO ONLY	44K	0	5.1B
MACRO + METRO	26K	72K	3.5B
COST SAVINGS			1.6B

Placing metro cells in urban hotspots can also result in substantial traffic offloads from the macro network and significant improvement to overall network throughput. The study showed that urban hotspots deploying only a single metro cell per macro site in a planned shared carrier deployment could improve the network throughput for a median user by over 190 percent. Deploying 10 metro cells per macro could boost the median user's throughput by over 900 percent (see Figure 3).

With Alcatel-Lucent Wi-Fi integrated metro cells, MSPs can augment their W-CDMA and LTE networks with affordable Wi-Fi capacity for their own subscribers – and gain visibility into their data usage patterns. In addition, they can catch other operators' Wi-Fi users on their network.

Figure 3. Network throughput improvement with the addition of metro cells to urban hotspots

OVERALL IMPROVEMENT IN NETWORK THROUGHPUT

Number of metro cells per macro site	Improvement
0	100%
1	193%
2	300%
4	467%
10	960%

NUMBER OF METRO CELLS PER MACRO SITE

COORDINATE WITH MACRO NETWORK

Alcatel-Lucent metro cells support a multi-vendor metro and macro network architecture, vital to the implementation of any HetNet architecture, without impacting an MSP's deployed RNC design. With 3GPP Iuh-compliant interfaces, Alcatel-Lucent W-CDMA metro cells (as well as home and enterprise cells) interconnect to an MSP's core network through the Alcatel-Lucent Small Cell Gateway. This gateway enables massive metro cells rollout by concentrating signaling from the metro cells into a single 3GPP compliant Iu CS and PS interface to the core network. Although Alcatel-Lucent LTE metro cells may connect directly to the MSP's LTE core network through the s1/x2 interface, using the Alcatel-Lucent Small Cell Gateway enables an architecture with more efficient signaling and PS core offloading at the gateway using selected IP traffic offload (SIPTO).

To improve spectral efficiency and increase capacity, metro cells must manage interference from macro cells and other nearby metro cells. Alcatel-lucent W-CDMA metro cells use advanced features, such as automatic power control, automatic receiver gain control and uplink (UL) interference management to effectively manage interference. Alcatel-Lucent LTE metro cells can take advantage of a unique frequency selective scheduler and a Bell Labs innovative enhanced inter-cell interference coordination (eICIC) feature. As a result, both Alcatel-Lucent W-CDMA and LTE metro cells may be successfully deployed using either dedicated or shared carriers.

As part of Alcatel-Lucent lightRadio Network or any HetNet architecture, metro cells must provide users with a seamless mobility experience. Alcatel-Lucent metro cells fully support incoming and outgoing handovers with the macro network, as well as with other metro cells. With Alcatel-Lucent lightRadio Wi-Fi, seamless mobility is also supported between the Wi-Fi and macro networks.

To optimize cell usage and end user QoE, the various layers of Alcatel-Lucent lightRadio Network and other HetNet architecture must support intelligent traffic management features. For example, Alcatel-Lucent W-CDMA metro cells support traffic segmentation based on service redirection, enabling metro cells to be used as a data-only layer by redirecting voice and simultaneous voice and data calls to the macro network. In addition, hierarchical cell structure (HCS), an Alcatel-Lucent macro feature, can be used to redirect static and pedestrian traffic to the metro layer, while allowing high-speed traffic to remain on the macro network. Alcatel-Lucent intelligent traffic management also supports seamless Wi-Fi offloading.

ALCATEL-LUCENT METRO CELLS

MULTIPLE ACCESS TECHNOLOGIES

Alcatel-Lucent Metro Cells
and Metro Radios

The Alcatel-Lucent portfolio of metro cells includes single standard W-CDMA and LTE metro cells, along with multi-standard metro cells that integrate W-CDMA and LTE into a single deployable unit. Some metro cells may also include Wi-Fi as an option. With Alcatel-Lucent metro cells, MSPs can cost-effectively take advantage of all available access technologies, including Wi-Fi, to meet capacity demands in urban hotspots, while reducing the number of required sites, installation time and backhaul deployment requirements by as much as two thirds.

ALL-IN-ONE AND DISTRIBUTED METRO CELLS

Alcatel-Lucent metro cells may be either all-in-one or distributed. The all-in-one metro cell integrates the antennas, amplifier, transceiver, remote radio head (RRH) and baseband unit (BBU) into a single unit that is easy to deploy. The distributed metro radio, on the other hand, integrates the antennas, amplifier, transceivers and the RRH into a compact unit that connects to an external macro BBU, either conventional or clustered, to deliver macro-like capacity to dense urban hotspots, such as sports stadiums and shopping malls. Alcatel-Lucent metro radio also optimizes the use of the MSP's BBU digital assets, by sharing the BBU with other macro and metro cells.

FLEXIBLE COVERAGE RANGE WITH MULTIPLE ANTENNA AND POWER OPTIONS

To ensure excellent and cost-effective coverage for all types of hotspots, Alcatel-Lucent metro cells support a variety of antennas and output power levels. They support both omni-directional antennas, ideal for areas needing coverage in all direction, and directional antennas for areas requiring more focused coverage. Omni-directional antennas may be integrated in the unit or externally supported through connectors. Directional antennas, however, are all integrated, and some are based on Alcatel-Lucent Bell Labs lightRadio cube technology, which brings together the latest innovations in antennas, amplifiers and transceivers, minimizing size and improving radio frequency (RF) performance. Maximum output power levels from Alcatel-Lucent metro cells range from 250 mw to 5 W at each antenna.

RECEIVE (RX) DIVERSITY AND MULTIPLE INPUT AND MULTIPLE OUTPUT (MIMO)

All Alcatel-Lucent metro cells support Rx diversity with two receive antennas, which improves signal quality and enables more users to be supported. In addition, some Alcatel-Lucent metro cells also support MIMO, which enhances data throughput by increasing spectral efficiency and reducing sensitivity to fading.

REDUCED OPERATIONAL COSTS WITH SELF-ORGANIZING/ SELF-OPTIMIZING NETWORKS (SON)

Metro cells can quickly increase capacity, as well as the number of cells in the MSP's network. To decrease operational costs, Alcatel-Lucent metro cells support SON technology, powered by our W-CDMA and LTE experience and Alcatel-Lucent Bell Labs

Alcatel-Lucent innovative service module design

RF Box

Connection Box

Assembled Unit

research and development. SON significantly reduces network planning, deployment and optimization costs. Alcatel-Lucent metro cells use SON to automatically configure themselves to the surrounding network and to periodically monitor, update and optimize their neighbor relation lists and handover parameters. With SON, Alcatel-Lucent metro cells also have the capability to intermittently adjust their transmit power and the scheduling of resource settings to avoid inter-cell interference.

INNOVATIVE SERVICE MODULE DESIGN

Second-generation Alcatel-Lucent metro cells include a service module design innovation that separates the mechanical, electrical and backhaul components into a connection box and the RF components into an RF box that plugs into the connection box, allowing for greater deployment flexibility and easier frequency swaps and technology upgrades. With this design, the site may be prepared separately from the W-CDMA, LTE or multi-standard technology rollout. During site preparation, the connection box is mounted on a pole, lamp post or the side of a building and connected to power and backhaul. Then, during rollout, the RF box is plugged into the power connector, slid over the connection box and locked. Alcatel-Lucent's innovative design simplifies later frequency swaps and technology upgrades. The MSP simply removes the RF box and replaces it with another RF box for the desired frequency or technology.

Because hotspots can occur anywhere, Alcatel-Lucent metro cells are designed to meet capacity demands whether indoors or out. Both indoor and outdoor versions of Alcatel-Lucent metro cells come with a secure, tamper-resistant outer casing to ensure safe deployment in public areas. Outdoor metro cells are also ruggedized to withstand extreme outdoor conditions.

FLEXIBLE DEPLOYMENT OPTIONS

Alcatel-Lucent metro cells offer flexible mounting options for easy placement in any location. Indoor metro cells may be mounted on walls or columns, while outdoor versions may be mounted on lamp posts, poles, train or bus stop enclosures – or even on the side of a building. Additionally, many Alcatel-Lucent metro cells blend easily into their environment, becoming virtually invisible.

Although metro cells may be deployed just about anywhere, powering them in certain locations may be challenging. Alcatel-Lucent metro cells support several powering options, including electric cords, power adaptors, power injectors and power over Ethernet (POE+), enabling an MSP to take advantage of readily available power supplies.

The availability of backhaul must also be considered when deploying metro cells. Alcatel-Lucent metro cells support a variety of backhaul options, so MSPs can take advantage of existing backhaul. With options such as Ethernet and Gigabit Ethernet (GE) over copper or fiber and Gigabit Passive Optical Network (GPON), MSPs can lower the cost of metro cell backhaul by using their existing wireline or wireless backhaul infrastructure, including Fiber to the Node (FTTN), Fiber to the Home (FTTH), Very-high-speed Digital Subscriber Line (VDSL) street cabinets, and DSL backbone. Some Alcatel-Lucent metro cells also support integrated Wi-Fi backhaul for areas with no existing suitable backhaul, as well as the daisy-chaining of backhaul to reduce connectivity costs.

NEW INNOVATIVE SERVICES WITH APPLICATIONS ENABLEMENT

Some Alcatel-Lucent metro cells enable MSPs to leverage unique network capabilities, such as location, presence, Quality of Service (QoS) and trusted security for applications development. This can be done by either the service provider or third parties.

Through the use of the following APIs, some Alcatel-Lucent metro cells can significantly enhance the potential for creating innovative services, such as mobile guided tours, premium broadband for pay and special offers or coupons:

- Locate enables localized services by providing mobile location updates.

- Inform delivers presence information associated with one or more users.

- Intelligent Notification enables audio, text or video notification messages to be sent, based on presence.

Alcatel-Lucent also provides a developer platform and program that simplifies application creation by allowing developers to leverage the unique assets of multiple service providers in one place. This eliminates the inconsistent policies, practices, capabilities and requirements across multiple networks that make application development costly and lengthy.

As part of this service, developers conveniently enter into a single contractual agreement with Alcatel-Lucent, receive technical support for connecting to applications servers and gain secure access to easy-to-use APIs. For MSPs, this program eliminates the expense of registering, provisioning and supporting a diverse array of developers.

For more information on Alcatel-Lucent Small Cells products please go to:
www.alcatel-lucent.com/wireless/femto_small_cells.html

For more information on Alcatel-Lucent lightRadio Network please go to:
www.alcatel-lucent.com/lightradio-network

For more information on Alcatel-Lucent lightRadio Wi-Fi please go to:
www.alcatel-lucent.com/lightradio-wifi

THE ALCATEL-LUCENT ADVANTAGE

With Alcatel-Lucent metro cells, the mobile service provider is well positioned to implement Alcatel-Lucent lightRadio Network or any other HetNet architecture. Alcatel-Lucent metro cells deliver cost-effective coverage and capacity where it is needed fast. They provide a better user experience by enabling faster, more reliable data connections and higher data throughput on the operator's 3G and 4G networks, while also offering users seamless, secure Wi-Fi access to the MSP's services. Alcatel-Lucent metro cells simplify the implementation of a HetNet architecture by easily integrating into any MSP's network with no impact on the current RAN design, and they support advanced interference and traffic management features that simplify coordination between the metro and macro cells for optimal network performance.

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