J’son & Partners Consulting presents main results of the research on ‘Tendencies and perspectives of market development of picocells in Russia and in the world’. Main purpose of the report is the analysis of world and Russian experience of picocells use - compact low-power base stations, which are often used in places where use of ‘large’ base stations (macrocells) is pointless.

**Definition of picocells**

Picocell is a small base station with a low power of 0.3 – 5 W in the external (outdoor) implementation and less than 300 mW for indoor location. Picocells work in the licensed band and are connected to the transport network by the same network operator who manages picocells within a single network. Picocells are generally used to increase a signal level for large spaces and public places or to increase network capacity.

Picocells relate to so-called small cells, which, apart from general functionality (improvement of mobile coverage, network capacity, various applications for private and business customers), vary in coverage range. Picocells are significantly inferior in ‘long-range capability’ to conventional mobile base stations - macrocells (Fig. 1). Accordingly, ‘small cells’ differ by place of application – household, enterprise, urban or rural areas (Fig. 2). Femtocells are usually used in private and corporate sector, picocells – in large enterprises and closed public places (airports, railway stations, shopping centers), microcells – in cities (in cases introduction of ‘large’ base stations, macrocells, is not necessary), metrocels – also in cities to solve problems of insufficient network capacity in certain areas (‘bottleneck’ problem). Moreover, there are attempts to use ‘small cells’ in country areas.

![Fig. 1. Types of ‘small cells’ and typical coverage range compared to macrocells](source: MarketsandMarkets)
Advantages and disadvantages of picocells

According to forecasts of Informa Telecoms & Media, small cells market will amount to $22 billion by 2016; at the same time 73% of the market will be occupied by small cells used for public places coverage.

Full integration of picocells with macro network allows using existing operators’ infrastructure (base station controllers, network core, transport) without the need to deploy specialized network elements, as in case of femtocells. It allows using picocell in so called heterogeneous networks (HetNet). Picocells are the most effective way to improve coverage and increase network capacity within the premises, remaining under control of the mobile operator and working in a licensed range.

One of the major drawbacks of picocells is high cost, which is still higher than the cost of Distributed Antenna Systems (DAS) components. At the same time, short coverage range of picocells requires its precise placement with the identification of concentration areas of subscribers or places with poor indoor coverage. In construction of heterogeneous networks a single limited frequency resource that works with base stations of macro-, micro- and pico levels will cause the need of constant monitoring and control over the distribution between layers. It will require a high degree of automation of work on initial network setup, its optimization, and troubleshooting in order to improve efficiency of operation and maintenance (O&M) procedures and reduce their cost per one network element.

Main providers

Ecosystem of picocells and small cells in general includes around 70 different vendors, combined under Small Cell Forum. They can be divided into several key categories (Table 1).

<table>
<thead>
<tr>
<th>Segment</th>
<th>Vendors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Completed solutions (End-to-End)</td>
<td>NSN, ip.access, Cisco, Alcatel-Lucent, Huawei, Ericsson/BelAir, ZTE, NEC, Public Wireless</td>
</tr>
<tr>
<td>Access points (Small-cell access-point)</td>
<td>Ubiquisys, ip.access, SpiderCloud, Airvana, Netgear, Juni Global, Airspan, Juni</td>
</tr>
<tr>
<td>Providers of core network elements (Core-network providers)</td>
<td>Kineto Wireless, Axis Technologies, SpiderCloud</td>
</tr>
<tr>
<td>Software and component providers</td>
<td>Picochip/Mindspeed Technologies, Broadcom/Percello, Continuous Computing, Texas Instruments, Freescale, Qualcomm, Radisys, Cavium</td>
</tr>
</tbody>
</table>

Table 1. Key vendors of small cells ecosystem

Source: Small Cell Forum
These are first of all providers of integrated system solutions (end-to-end), starting from base stations, gateways, software development and delivery of other components for full-scale operator’s projects (Alcatel-Lucent, Huawei, Nokia Siemens Networks, ZTE). They are followed by manufacturers of access equipment (ip.access, SpiderCloud Wireless, Cisco/Ubiquisys, Russian company ’Telum’ (trademark Ranberry)\(^1\), as well as South Korean Juni and Contela). Most developers deliver cluster solutions for picocells, while large portion of them (up to 1000 devices) is controlled and configured by a local controller, serving as a single entry point to the core operator’s network for the entire cluster, setting network, its optimization, troubleshooting in order to improve efficiency of O&M procedures and reduce exploitation cost.

**Picocells market: current state, tendencies and forecasts**

**In the world**

Picocells are typically used to enhance mobile network coverage in 2G/GSM and to increase capacity of 3G/LTE networks in places of subscriber’s concentration, in future they will be used in complex heterogeneous solutions. Due to the compact size and ease of installation picocells are often used for mobile network coverage on the so-called ‘teeter’ remote objects connected with the core operator’s network only through satellite channel (ships, airliners, drilling platforms, etc.). The largest projects on implementation of picocells in the world are associated mainly with GSM and partially with 3G. They have already started to actively develop in LTE, especially in countries with high penetration of LTE (South Korea, USA, Japan), where the problem of increase in network capacity became crucial.

Main growth drivers of small cells market, including picocells, include growth of mobile data traffic under the conditions of spectrum deficit, the need of traffic unload and coverage expansion, including indoor coverage (Fig. 3).

![Fig. 3. Key drivers of small cells market](source: Cisco, 2011)

Reduction in cost of picocells may also become a significant factor of picocells market growth. In the end, they should become as affordable as femtocells, retaining full functionality of the operator’s base station. But this can only happen in case of emergence of mass picocells market, cost reduction of component base by transmission to microelectronic technologies and their integration into the BSC (base station-on-chip).

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\(^1\) Russian startup, resident of innovation center ‘Skolkovo’, established in 2010 by the Russian Academy of Science graduates. In the end of 2012 ‘Telum’ company received grand of ‘Skolkovo’ Fund for development of small LTE base station with developed self-organization functions.

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Development of LTE networks becomes technological market driver – with the increase in 4G penetration necessity of increase in network capacity arises. According to forecasts of Mobile Experts, in 2017 LTE segment will equal to up to 2/3 of all deliveries of small cells.

On the other hand, mass introduction of picocells under HetNet networks will lead to a sharp increase in the number of network elements. Even taking into account the functionality of self-organizing networks (SON), it will become uneconomical to manage such multi-layer networks using traditional methods. Therefore apart from full automation of access points, complicated and expensive work on optimization of the whole network, troubleshooting and other actions will be required. At the same time 3G-class indoor picocells are still competing with Distributed Antenna Systems (DAS); various types of repeaters are used to organize indoor coverage (passive, active and smart repeaters).

According to Informa Telecom & Media forecasts, by 2017 small cells market will reach 8.6 mln. units, femtocells will remain the dominating type of equipment, share of picocells will increase greatly, however will still remain insignificant (Fig. 4).

![Fig. 4. Share of picocells in the small cells market structure, 2011 - 2016](image)

According to SpiderCloud Wireless forecasts, picocells segment will start to grow starting from the end of 2013 – beginning of 2014 (Fig. 5), and together with femtocells, microcells and metrocells will reach 18% of the total expenses of operators on radio access network (RAN) by 2016. At the same time starting rapid growth in 2015, share of picocells together with metrocells will occupy more than one third of small cells segment. It is linked to the maturity of LTE ecosystem in the world by that time and the need to move from the initial stage of territorial expansion to the stage of point capacity increase of such networks.

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2 According to a number of experts, technically such systems have different objective niches, therefore this assumption is questionable.

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In the long term in 3G networks segment, small cells will achieve parity in its development with their main current competitor in expansion of indoor coverage - Distributed Antenna Systems (DAS). According to ABI Research, small cells market for enterprises (enterprise small cell), that in 2012 amounted to a third of DAS market, will match it by the end of 2016, reaching a volume of $2 billion per year. At the same time, implementation of DAS solutions will continue to grow with the need to provide mobile services in the indoor areas of over 45 thousand square meters, and enterprise small cell solutions – mostly in areas of less than 30 thousand square meters.

According to ABI Research, developers of DAS solutions are more concerned today with the threats from the part of small cells, than it was a few years ago. And although most of the providers of distributed antenna systems do not see a real threat today, most perspicacious ones start to study potential of small cells, understanding that the future is in them.

However, according to a technical expert in one of the ‘Big Three’ companies, distributed antenna systems serve significantly larger sectors compared to picocells, and in some cases the use of DAS is more preferable. For example, according to him, there may be overload of picocells, serving briefings in one of the building rooms, while other picocells, located on the same floor will be ‘empty’. DAS will not simply ‘notice’ such a migration.

Currently segments of enterprise small cell and DAS are developing in parallel and are aimed at providing coverage in buildings of various areas. However, gaining momentum trend on coverage of various public places such as airports, shopping centers, train stations, stadiums, etc. by small cells could potentially reduce the market share of DAS. However most likely, both segments will steadily penetrate into one another, especially in the middle area buildings. According to ABI Research forecasts, by 2017 small cells will amount to a quarter of DAS elements, apart from traditional repeaters, macro base stations and detached antennas, as they are easy to install, are small in size and are less expensive than other solutions.
Picocells segment will start to grow starting from the end of 2013 – beginning of 2014, and together with femtocells, microcells and metrocells will reach 18% of the total expenses of operators on radio access network (RAN) by 2016. At the same time starting rapid growth in 2015, share of picocells together with metrocells will occupy more than one third of small cells segment.

In Russia

Currently ‘Megafon’ uses picocells to organize network in places where application of macro-base stations is impractical and impossible. Such objects include large trade and business centers, airports, railway stations and other. The company considers that mass implementation of picocells at the current stage of operator’s network development is impractical, as macronetwork resource capacity is enough.

MTS company provides commercial solutions for B2B market – picocells are installed for key business clients, that have a necessity in installment of such solutions.

‘VimpelCom’ has implemented a project on creation of a carpet inside tall business center in Samara. Each floor was equipped with two picobase stations. Capital branch is currently introducing micro-base stations to be installed in places where macro base stations cannot be installed to get good radio coverage.

Russian mobile operators mostly use picocells to improve coverage in public places where the use of macro base stations is impractical (shopping centers, airports, railway stations, sports facilities) or to solve problems with coverage of areas of key corporate customers. Research on implementation of 3G and LTE picocells in Russia are continued, however capacity of established networks is still enough to serve existing traffic volume. From the point of view of network planning such types of projects represent exclusive solution, and picocells market in Russia has not formed yet.

At the same time Russia has a simplified process of introduction of low-power GSM/UMTS/LTE RES standards for indoor areas, including picocells. There is no need to obtain separate decisions of State Committee of Radio Frequencies and permit for the use of radio frequencies or radio frequency channels. Low power RES should operate only on the radio frequencies or radio frequency channels assigned (allocated) to a corresponding base station, and their power is limited. The use of low-power RES is permitted inside buildings, closed offices, warehouses and industrial buildings, tunnels, underground (embedded) structures, in underground haul areas and metro stations. Correlation of permitted ranges and technologies, which use is allowed with limits by power level is shown in the Table 2. Similar ‘soft’ concept of small cells usage is typical for national regulators of majority of countries in the world.

### Table 2. Allowable RES power level for the use without registration indoors by technologies and ranges

<table>
<thead>
<tr>
<th>Technology</th>
<th>Frequency range</th>
<th>Allowable power</th>
</tr>
</thead>
<tbody>
<tr>
<td>2G/GSM/EDGE</td>
<td>890-915 MHz, 935-960 MHz, 1710-1785 MHz and 1805-1880 MHz</td>
<td>2 W</td>
</tr>
<tr>
<td>3G/UMTS/HSPA</td>
<td>1920-1980 MHz, 2010-2025 MHz and 2110-2170 MHz</td>
<td>100 mW</td>
</tr>
<tr>
<td>LTE</td>
<td>791-862 MHz, 890-915 MHz, 935-960 MHz, 1710-1785 MHz, 1805-1880 MHz, 2300-2400 MHz and 2500-2690 MHz</td>
<td>200 mW</td>
</tr>
</tbody>
</table>

Source: J’son & Partners Consulting, 2013
According to J’son & Partners Consulting forecasts, picocells segment will start to develop more actively not earlier than in 2016. It is the period for which peak of 4G/LTE network construction is planned. Ecosystem of small cells, including picocells will be formed in the world by that time; quality and coverage requirements from the part of customers will also increase.

Detailed results on research are presented in the full version of the report ‘Tendencies and perspectives of market development of picocells in Russia and in the world’ (51 pages)

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AeroMobile  Continuous Computing  Netgear  Telkomsel
Airspan  DoCoMo  Nokia Siemens Networks  Texas Instruments
Airvana  Ericsson  OnAir  T-Mobile
Alcatel-Lucent  Freescale  Picocell/Mindspeed Technologies  Ubiquisys
AT&T  GlobeMobile  Public Wireless  Ubiquisys
Axis Tekノロジーズ  Huawei  Qualcomm  UQ Communications
Azal Airlines  IP.access  Radisys  Verizon Wireless
Azerfon  Junic  Ranberry  VIVACOM
BelAir  KDDI  Samsung  Zain Bahrain
Bharti Airtel  Kineto Wireless  SFR  ZTE
Blue Ocean Wireless  Korea Telecom  SK Telecom  Astelit
Broadcom/Percecco  KT  Softbank  Aeroflot
Cavium  LG U+  SpiderCloud  VimpelCom
Cisco  MetroPCS  Sprint  Megafon
Contela  NEC  Telenor  MTS
Transaero

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