The dynamics of our business and personal lives are changing, fuelled by virtualization and cloud services that require ubiquitous internet access, not only in our offices and homes, but also across public places such as train stations, airports, hotels and entertainment venues. With about 80% of mobile traffic (Source: CISCO) already consumed indoors, it is clear that higher capacity and more efficient data communications solutions will be required to support in-building services in the future.

Mobile Network Operators (MNOs) mission is to manage and satisfy these dynamics in order to provide a superior mobile communication experience. For this reason MNOs are urgently seeking solutions to manage these new dynamics. Network technologies are being developed to support efficient and controlled network sharing, such as virtualized topologies, to drive more efficient resource usage. Centralized RAN (C-RAN) is the solution that many mobile operators see as the best way for their macro networks to gain operational efficiency of centralized capacity. The opportunity to efficiently interface within the baseband pool and not to waste idle resources is the key argument for many MNOs to consider C-RAN solutions in their networks. As a result, solutions are urgently required, which also enable centralized RAN at a micro layer. Self Organizing Network (SON) solutions are needed to manage the increasing capacity dynamics within and around buildings. However today’s Distributed Antenna Systems (DAS) are static and fail to provide the required flexibility to adapt to the changing requirements of enterprises or private end-users.

The increasing demand for capacity requires sectorization meaning the option to repeatedly use frequency resources for smaller areas, hence the increase of the resource re-use factor. This happens in macro cells as well as in micro cells within a building or campus. However, capacity in a building is not used constantly over time. For example, traffic demand in a shopping mall is different compared to enterprise usage or private residential areas. As the example in graph 2 shows, capacity gains of over 20% can be achieved by using a micro C-RAN, compared to dedicated BTS capacity for each building area.

The Kathrein K-BOW solution opens up a new solution category for Micro C-RAN, characterized by flexibility, TCO saving and an improved end user experience.
K-BOW gives you fast response times to end-customers. As your enterprise customer wants to move from one to another floor or needs a service upgrade for more mobile broadband capacity in its executive floors, K-BOW MNOs can:

- Remotely run independent single- or multi-operator strategy based on a single platform which is compatible with OEM base station solutions
- Remotely change the capacity by sectorization in a defined area in realtime
- Remotely optimize the coverage and capacity within a building or campus
- Remotely provide macro layer end-user experience by using the system integrated LTE MIMO
- Remotely activate adjacent services (small cells, sensor networks or WiFi access points) by using transparent IP channels available at the RU with up to 700 Mbps
- Eliminate costly system leveling activities of installation teams with automatic calibration
- Eliminate access to premises in order to add new carriers or introduce MIMO, just manage remotely from Network Operations Center
Kathrein K-BOW features a number of innovative optimization options that enable MNOs to increase the signal quality across entire building structures and outdoor areas by controlling each sector output power per band, individually and with very high granularity.

**Improved end-user experience**

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In e.g. LTE, critical cell or sector edges can be controlled and moved into walls to avoid interference. This is achieved by reducing the power of specific carriers. SON functions improve the end-user experience by allocating required capacity where it is required, thereby prohibiting congested areas.

**TCO savings**

Network sharing is one of the key ways to share investment and hence reduce capital expenditure. Kathrein K-BOW supports multi-operator connectivity and offers the opportunity to target dedicated MNO signals at dedicated sectors in specific areas in a building or area.

In traditional systems, a signal cocktail of all connected bands and carriers is transmitted over a distributed antenna arm. With Kathrein's unique K-BOW power saving options, selected bands and carriers can be switched on and off per small cell sector. This feature, for example, enables MNOs to switch on a 1800 MHz base signal overnight to provide basic coverage throughout a building and switch off the remaining small cell amplifiers. This feature saves up to 50 % of the DAS power in the night-time option.

The fast development of telecom standards and features to improve spectral efficiency and network capacity is a challenge for most traditional systems. K-BOW is designed to capture all today’s legacy system requirements such as 2 x 2 MIMO and is prepared for 3GPP release 11 and 12 features to further enhance the end-user experience. Examples of these features include Carrier Aggregation, CoMP etc. K-BOW is built on a highly flexible platform to further develop the K-BOW solution as per industry and MNO needs.

Since all the K-BOW functionality is managed remotely by a node manager, capacity allocation can be delivered on-demand. K-BOW becomes the SON enabler for indoor and campus use-cases to save expensive network resources and reduce the number of field support personnel needed to manage continuous changes.
The K-BOW system consists of the following nodes, which can be placed in a physically separated way:

**Optimization Layer**
- Power adjustment per band per RU

**Distribution Layer**
- Up to 64 E-Hubs and 2048 RUs, up to 3 sectors per E-Hub

**Aggregation Layer**
- Up to 42 analog BTS connections per C-Hub subrack

**Base Station Pool**

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**Aggregation layer – The Central-hub (C-hub)**

At the C-hub, MNO base stations are connected to the K-BOW via standardized analog interfaces. The band selective front end modules support 3 input ports per band and are available for multiple frequency bands. This variety of units provides the flexibility for operators to equip the C-hub just with the bands to be used in the K-BOW system. Since the full spectrum of each band is supported, the C-hub is ready to connect multiple operators as well as MIMO capable BTSs. The C-hub transforms the signals into a digital data-stream. On the digital domain, the K-BOW system can access, condition and route every single sub-band within the K-BOW system. Via configuration the desired signal mix is aggregated and forwarded in the system.
Distribution Layer – The Expansion-hub (E-hub)

The digital signal covering a mobile bandwidth of 240 MHz spectrum per 10 Gbps optical link is forwarded to the E-hub. The digital link allows distances of up to 20 km. Depending on the routing flexibility in a system, between 8 and 64 e-hubs can be connected to one C-hub.

At the e-hub, the signals are converted to analog signals and then allocated up to three sectors. This allocation can be changed remotely via the node manager or standardized SNMP integration to a MNO OSS system.

Optimization Layer – The Remote Unit (RU)

Each RU is equipped with band selective transceivers and LTE MIMO transceivers. The K-BOW RUs also provide transparent IP connectivity with a throughput of up to 700 Mbps, which can be used for a sensor network, a small cell or WiFi access points. The K-BOW RUs are available as wall-mounted versions with integrated broadband antennas and also as hidden ceiling mounted version with external antenna. Since each band is steered separately, the output power per band can be adjusted according to the respective situation. This opens new options for operators to optimize indoor signals by individually controlling the output power per band per RU and not within a DAS tree of connected antennas. The output power of the low-power RU is 23 dBm per band, which is sufficient to support multi-operator scenarios with typical power requirements.

Figure 4: Indoor K-BOW RU with and without integrated antenna

CDS functional layers

<table>
<thead>
<tr>
<th>Indoor and campus solution requirements</th>
<th>Traditional active DAS solution</th>
<th>Micro C-RAN K-BOW solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Micro cell level optimization for improved QoE</td>
<td>Not possible (power increase per antenna tree)</td>
<td>Possible: Per antenna (punctual optimize)</td>
</tr>
<tr>
<td>Integrated IP connectivity</td>
<td>Not integrated (separate cabling required)</td>
<td>Integrated in RU cabling</td>
</tr>
<tr>
<td>Flexible sectorization to increase capacity</td>
<td>Only possible by installation project: Physical change in coax antenna tree cabling</td>
<td>Remote configuration</td>
</tr>
<tr>
<td>SON enabler to reduce TCO</td>
<td>Very limited</td>
<td>Full SON support: Remote configuration of: Power per RU &amp; band, sectorization, carrier routing, night time optimization</td>
</tr>
<tr>
<td>MIMO upgrade for same macro layer experience</td>
<td>Only by installation project: Almost double investment</td>
<td>MIMO supported end to end</td>
</tr>
<tr>
<td>LTE-A compatibility for future proof investment</td>
<td>Very limited</td>
<td>Prepared for carrier aggregation and CoMP solutions</td>
</tr>
</tbody>
</table>

Figure 5: Future requirements demand a new category of solution. K-BOW is designed to comply with these future requirements
Managing dynamics –  
A must to manage mobile data in future

Static DAS solutions will not be able to cope with the future. End-user experience, fast response times to meet enterprise customer requirements, reduced access time to end-user premises, as well as optimized indoor signals will change the service level towards MNO customers. Also, MNOs will be enabled to manage an increased enterprise customer base at a significantly improved service level. All these benefits are reached by maintaining an improved business case driven by site sharing, power saving as well as elimination of lengthy installation projects, since most frequent changes in the system can be done remotely. Kathrein’s K-BOW is the optimal solution to meet these challenges and will be the selection of choice for MNOs who wish to be future proofed from day 1 when deploying state-of-the-art indoor coverage and capacity systems.
ABOUT KATHREIN

Kathrein is a communication solutions specialist. The company group develops, produces, sells and maintains a wide area of antenna systems and electronic components and solutions. Based on its enhanced technology and widely acknowledged high quality, Kathrein belongs to the global leaders within its market segments.

Kathrein group, headquartered in Rosenheim/Germany, covers 22 production facilities globally, out of which four are located in Rosenheim. Kathrein group employs over 6,800 talents with annual revenue of more than 1.36 billion EURO (2013).

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