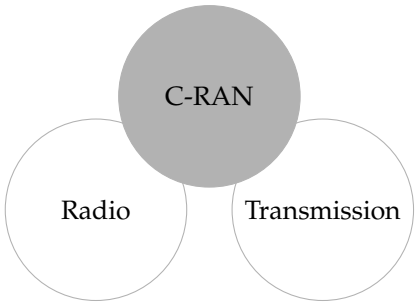
Rational Cloud RAN Architecture

Netonomics provides optimized network architecture designs with unique target accuracy and network efficiency. This is achieved by an integrated method combining novel powerful algorithms, aligning all traffic flows simultaneously on a network level, as opposed to current route-by-route methods. With Netonomics C-RAN architecture optimization, a design with outstanding performance with respect to any chosen target characteristic is provided, that fully complies with technical conditions. The solution may be optimized with respect to utilization, such as radio performance improvement, or cost efficiency. The Netonomics design methodology is largely independent of technology and manufacturer, and solution performance and robustness are verified during the design.

The Netonomics Advantage

Planning for C-RAN is inter-dependent on both the radio network and the access fronthaul transmission network. In order to obtain the best possible result of a C-RAN implementation, a number of parameters are relevant, and changes to the existing network may need to be considered.

Netonomics offers C-RAN optimization to achieve maximum efficiency with respect to cost, resource utilization and reliability.



C-RAN is dependent on characteristics of both the radio and the transmission topologies

Implementation Aspects

In C-RAN, baseband processing resources (baseband units, BBU) are centralized in virtualized BBU pools, or baseband hotels (BBH), serving clusters of remote radio heads (RRH).

The main advantage of C-RAN over dedicated RAN (D-RAN) is twofold. Firstly, pooling resources enables economy of scale through virtualization and statististical multiplexing. Secondly, cooperative signal processing and transmission allows for higher utilization of the radio spectrum and improved service quality.

C-RAN introduces an additional hierarchy into the access network by separating the radio units from the baseband processing equipment. From bottom to top, the logical hierarchies are:

- Clusters of Remote Radio Heads (RRH)
- The baseband pools or hotels (BBH)
- Aggregation layer hubs
- Core network interconnection points

The C-RAN design can on a high level be viewed as selecting base-band hotel locations (which can be stand-alone or co-located with any other node) and determining the clusters of RRHs connected to each BBH.

Design Objectives and Benefits

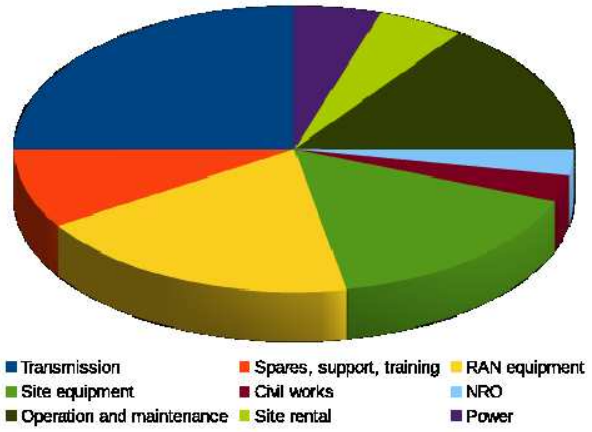
Since there is a number of advantages and technical limitations to be met, an optimal C-RAN architecture is typically based on a number of input data sources e.g. radio statistics, traffic profiles and site costs. Advantages from a C-RAN architecture include:

- Higher spectrum efficiency and throughput on cell edges
- Lower operational site costs, e.g. site rental and power
- Lower site equipment cost for power plants, batteries and air conditioning
- Less baseband equipment, due to function virtualization and statistical multiplexing

The implementation is strongly dependent on the fronthaul transmission network, in particular:

- Higher demand on available bandwidth, limiting feasible transmission media to mostly dark fiber and high capacity microwave links
- Strict latency requirements with distance limitation on feasible paths
- High requirements on transmission resilience

Cost efficiency achievable by optimization targets large cost incurring items within RAN, such as fronthaul transmission and site related costs. The figure below shows a breakdown of costs related to the radio access network, all of which are affected by the C-RAN architecture.



Costs related to the radio access network

The Radio Network

Coordinated multipoint transmission, enabled by the C-RAN, improves coverage of high data rates and higher throughput on the cell edges.

The benefits through cooperative signal processing can be expected to be higher in dense networks, carrying large traffic volumes. Therefore, radio sites can be categorized with respect to preference to be included in a C-RAN implementation. Site cost savings may also be a factor.

Fronthaul Transmission

The widely supported CPRI protocol between the RRH and the BBU requires accurate synchronization, strict latency control and real-time transmission of up to 10 Gbps per access node. Due to the strict requirements, the maximum distance between RRH and BBU must not exceed 20-40 km.

The latency requirement also limits the number of feasible paths which is affected by the location of the baseband hotel. Therefore, the fronthaul transmission network effectively defines maximum possible cluster size for a given BBU hotel location. In addition, there may be relaxing conditions on resilient paths for some sites, or other factors limiting cluster size, e.g. the number of nodes using a link.

The introduction of the new I_r interface between RRHs and the BBU pool requires a resilient transport solution. CPRI has 1+1 path protection features, enabling resilience of radio units in ring configurations.

Design Procedure Flexibility

Netonomics provides optimized C-RAN architecture designs taking all relevant data into account to obtain results with unmatched efficiency. Network data, such as traffic traces and interference data, is verified for integrity and pre-processed, if necessary. Based on this data, one or several optimization metrics are proposed. Heterogeneous networks, based on different technologies and supporting diverse services, need to be modeled realistically in order to achieve reliable results in their analysis. With Netonomics' methods, any network can be represented accurately regardless of the transport technology, physical media or manufacturer in any combination.

The results from the optimization is presented both graphically and in tabular form, including correlations between key optimization factors, sensitivity analyses, and "what if" scenarios.

Success Story

Netonomics performed C-RAN optimization for a major international operator and delivered a detailed design for several thousands of eNodeB, lowering the cost to close to half compared to prior forecast. The design included optimized utilization of exising dark fiber infrastructure, and detailed plans for the most cost effective placement of additional links, baseband hotels and radio clusters.

The Netonomics Method

The starting point is Netonomics receipt of the information described in the NetInput short data input form, in any agreed format. The service consists of pre-study, optimization, reporting to the host organisation premises during a period of a few weeks, and a follow up upon implementation of recommendations reported in the NetOutput form, showing concrete improvements in parameters compared to classical design.

About the Company

Netonomics is based on applied Teletraffic Science where each founding partner has 25 years experience in successful design, buildout, and operations of telecom and IT networks. Broad experience in decision positions has led to a focus on the essential aspects of network efficiency.