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# Random Network Coding for multimedia streaming in LTE-A

Industry brief

## Strategic Business Relevance:

Hybrid ARQ (HARQ) is the state-of-the-art approach to recover erroneous packets in wireless networks. However, HARQ may not provide optimal performance especially for transmission to subscribers at cell-edge. Random Network Coding (R-NC) offers a viable alternative to HARQ for optimal energy efficient cell edge performance. The feasibility of future network access platforms supporting this technique should be considered.

High-quality video telephony and multimedia streaming are becoming part of the daily subscriber experience both in business applications and personal entertainment. IMT-Advanced technologies such as LTE-Advanced (LTE-A) are promising improved capacity and low end-to-end delays to meet increased wireless capacity demands.

LTE deploys standard retransmission schemes such as Hybrid ARQ (HARQ); with shortcomings of high signalling overhead and delays. These shortcomings result in the risk of significant performance degradation, in terms of energy efficiency and data rates, under delay-constraint applications. R-NC is a simple alternative to HARQ that if supported in future networks could enable improvements of energy efficiency, network throughput, reliability, delay, and robustness.

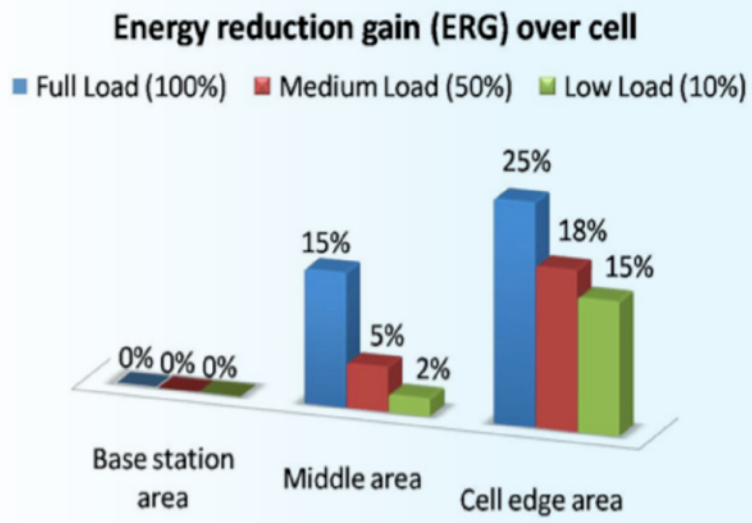


**Fig.1:**
Average ERG for R-NC vs. HARQ in downlink LTE-A with different traffic load.

## Core Research: Green Radio

Through the perspectives of both architecture and state of the art techniques, the Green Radio research programme is discovering innovative ideas to significantly reduce the power consumption of radio access networks.

The Techniques element spans the protocol stack and when optimally combined seeks to address the aspiration of 100x power reduction.

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# *Key aspects of R-NC over state-of-the-art Hybrid ARQ (HARQ) scheme in LTE-A*

Industry brief

### Architectural

Random network coding (R-NC) is a rateless error correction mechanism. R-NC would be integrated into the radio link control (RLC) layer in the LTE protocol stack.

### R-NC reduces signaling overhead compared to HARQ

HARQ incurs signalling overheads with its retransmissions and multiple ACK/NACK messages, required for all transmitted packets. In R-NC only one ACK message is sent once the subscriber decodes all received packets.

### R-NC handles packet errors and channel changes more robustly than HARQ

R-NC behaves as a capacity-approaching forward-error-correction (FEC) solution over lossy packet networks. It dynamically adapts the transmission rate to the channel conditions to achieve optimum throughput. In the HARQ case, retransmissions are sent at the same rate as the first packet reducing efficiency.

### R-NC reduces delay

Current LTE specifications can require transmission of up to 8 packets in series, leading to significant delays in transmission in the case of a packet error. For erroneous packets there is an 8msec delay between retransmission attempts. Multiple packet errors lead to timeouts causing potential loss of QoE. For R-NC, the feedback delay can be reduced to as low as 1-2 msec and timeouts are not necessary.

### R-NC is suitable for multi-hop relaying techniques

HARQ is most suitable for point-to-point transmission. Due to the increased overhead signalling over multi-hop links, R-NC is a simpler solution for end-to-end links involving relays. The R-NC solution is more suitable for real-time applications (e.g. low latency interactive broadcast services) than the HARQ scheme, since it avoids the high retransmission delays built into the HARQ scheme.

### R-NC is suitable for multimedia streaming applications

Due to the large delay between retransmission attempts, the HARQ performance in time-delay limited applications is inferior to that of the proposed R-NC solution. Fig. 1 shows significant energy reduction gains (ERG) for R-NC versus HARQ under high traffic, especially for subscribers close to the cell-edge, e.g., at full load R-NC offers an ERG equal to 25% for cell-edge subscribers with a time-delay limit of 16 msec. At the cell-edge, high packet loss may occur more frequently causing HARQ retransmissions to exceed the maximum four attempts, and all retransmitted copies of a packet to be discarded. This causes energy loss and extra delay. On the contrary, under R-NC the receiver needs only to collect any set of encoded packets of size slightly larger than the size of the transmitter message.

### Summary

The R-NC technique can reduce delay and offer more energy efficient transmission of delay critical traffic. The energy gains are most significant for cell- edge subscribers under high traffic load.

## Key Points

- Reduced ACK/NACK overhead will reduce the required System signalling energy.
- The ACK/NACK delay for a single failed message transmission has considerable effect on the spectral efficiency of the transmission process
- R-NC can handle packet errors and channel gain changes more robustly and with reduced delays compared to HARQ
- R-NC is suitable for multi-hop relaying in cellular networks and can be performed efficiently on the end-to-end link

An in depth treatment of this topic is available to MVCE members in **TR-GR-0051**
*Performance Analysis and Energy Efficiency of Random Network Coding in LTE-Advanced*
**www.mobilevce.com/dloads11/GRR00351.pdf**

Industry focused research, innovation & application