NC-CELL: Network Coding-based Content Distribution in Cellular Networks for Cloud Applications

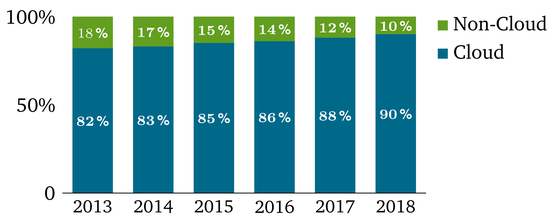
Claudio Fiandrino*, Dzmitry Kliazovich*, Pascal Bouvry* and Albert Y. Zomaya†

*University of Luxembourg - †The University of Sydney

Introduction

Mobile cloud applications is one of the fastest growing markets:

- Mobile data traffic will rise up to 15 EB per month by 2018
- By 2017 4.4 billion people will use mobile cloud applications
- $ 45 billion market
- 90% of all mobile data traffic by 2018



Source: Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2013-2018

Network Coding in Cellular Networks

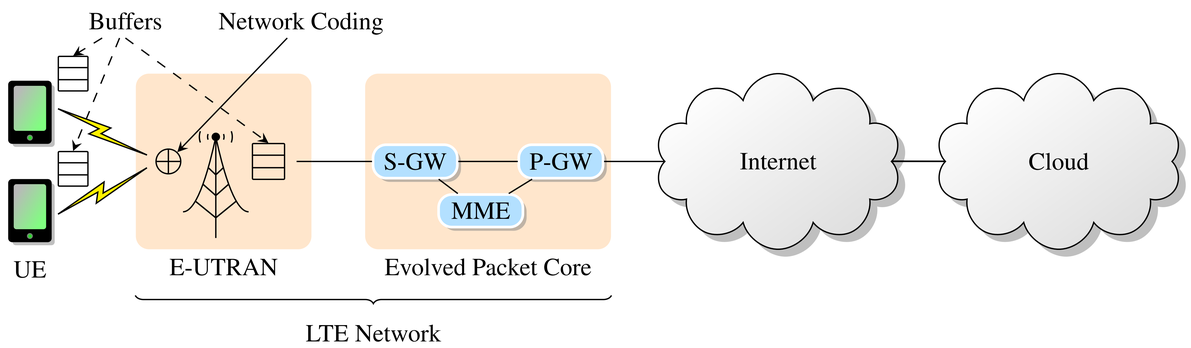
Optimizing information delivery of flows with overlapping or partially overlapping content.

Important Facts

- Geographically co-located users
- Mobile cloud applications' content
  - Advertisement
  - Maps
  - Meteo
  - Google Now

Network coding to combine information flows

The NC-CELL Technique



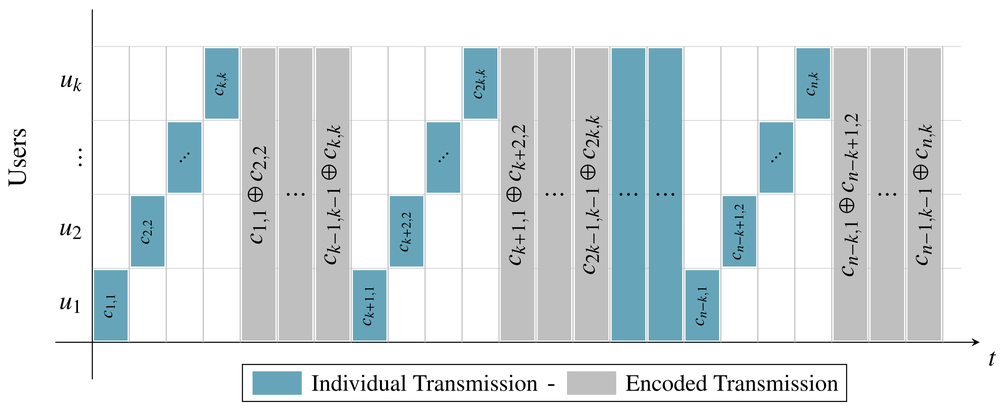
Key aspects:

- Monitor and cache in transit traffic
- Identify coding opportunities
- Use of network coding to combine packets

Coding opportunities

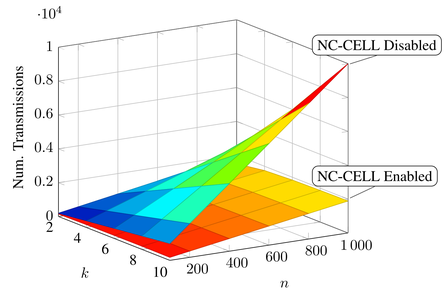
eNodeBs can distribute information needed by two or more users with a single coded transmission.

Optimal allocation for content distribution

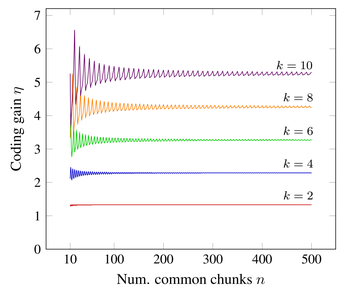


Results

Number of transmissions at eNodeB: measuring throughput improvement



Coding gain: measuring the benefit of network coding



Conclusion

NC-CELL provides efficient content distribution for cloud applications in mobile cellular networks. It enables eNodeB nodes to monitor and cache in transit traffic and exploits network coding to combine packets.

Acknowledgements

The authors would like to acknowledge the funding from National Research Fund, Luxembourg in the framework of ECO-CLOUD project (C12/IS/3977641).

NC-CELL: Network Coding-based Content Distribution in Cellular Networks for Cloud Applications

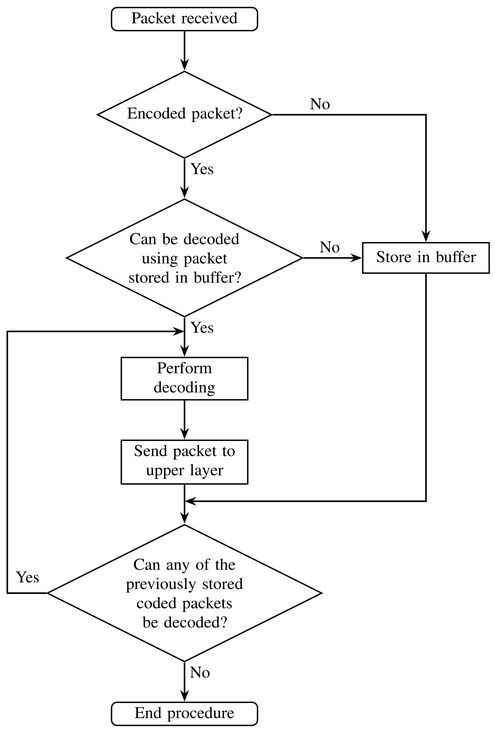
Claudio Fiandrino*, Dzmitry Kliazovich*, Pascal Bouvry* and Albert Y. Zomaya†

*University of Luxembourg - †The University of Sydney

Encoding and Decoding Procedure

Encoding

- At eNodeB
- Combining only content not packet headers
- Delivery to all interested users through PDSCH (primary and secondary users)

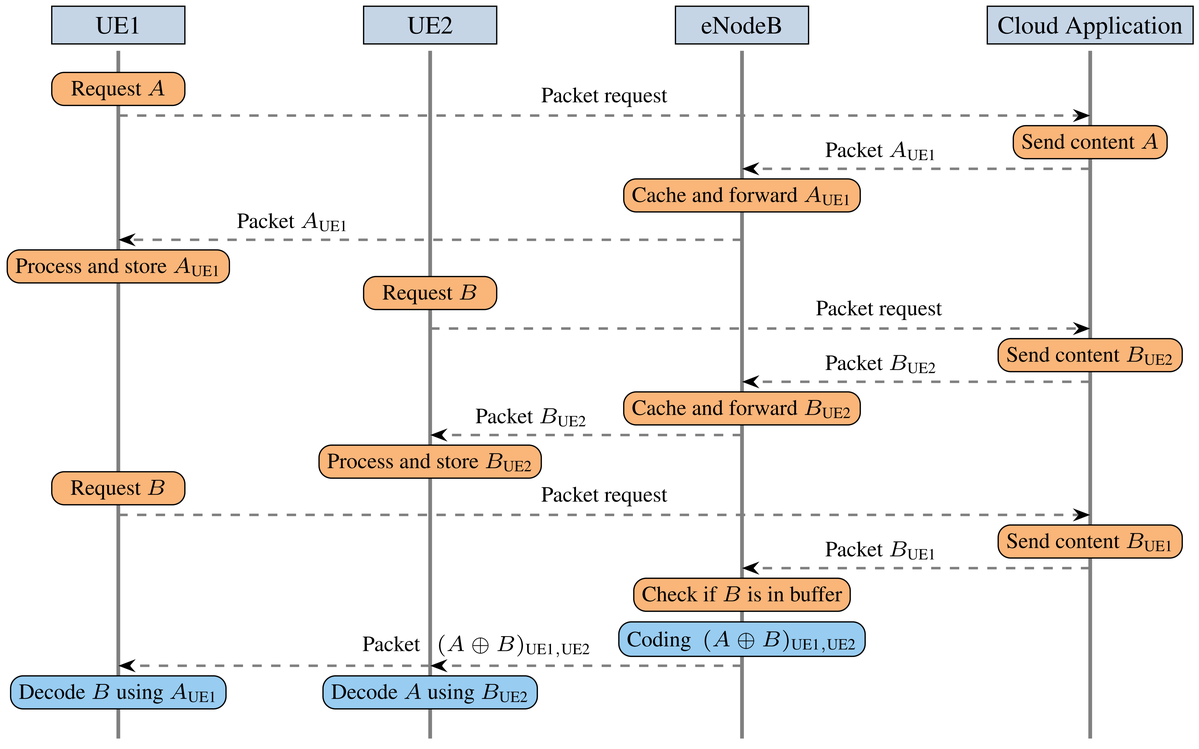


Decoding

- At users' side
- Immediate if one of the two content packets is already available

NC-CELL Operation

- Two users: UE1 and UE2
- Need to retrieve content A and content B from cloud application
- eNodeB exploits coding opportunity



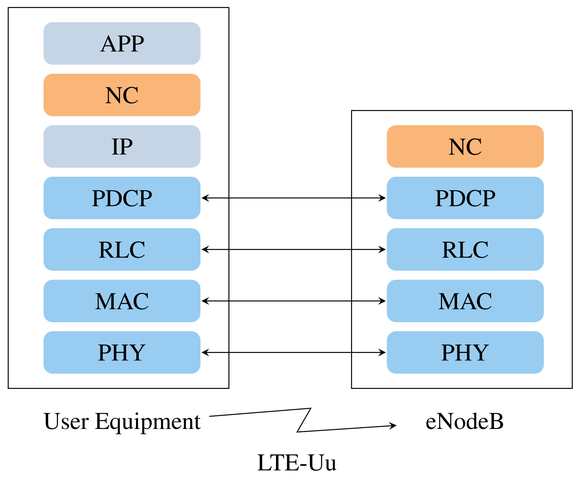
Protocol Stack

Encoding

- After GTP header removal
- Before PDCP performs IP header compression

Decoding

- Primary users receive and decode immediately
- Secondary users do not discard frame



Contact Information

- Claudio Fiandrino
- Email: claudio.fiandrino@uni.lu
- Phone: +352 46 6644 5531

ECO-CLOUD

Fonds National de la Recherche Luxembourg

NC-CELL: Network Coding-based Content Distribution in Cellular Networks for Cloud Applications

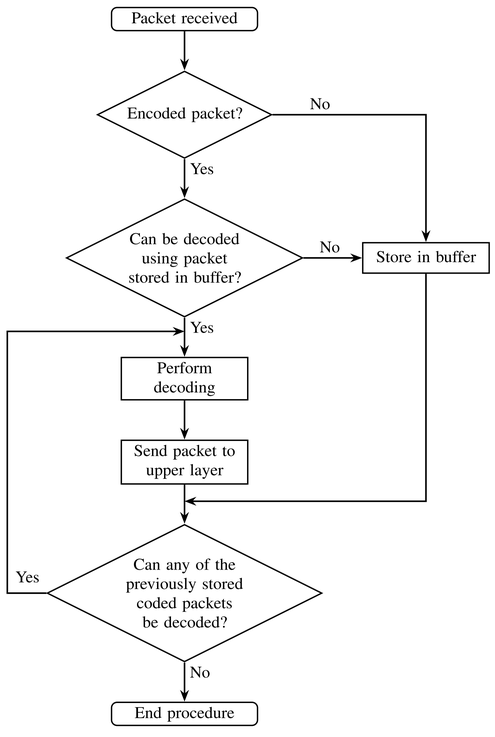
Claudio Fiandrino*, Dzmitry Kliazovich*, Pascal Bouvry* and Albert Y. Zomaya†

*University of Luxembourg - †The University of Sydney

Encoding and Decoding Procedure

Encoding

- At eNodeB
- Combining only content not packet headers
- Delivery to all interested users through PDSCH (primary and secondary users)

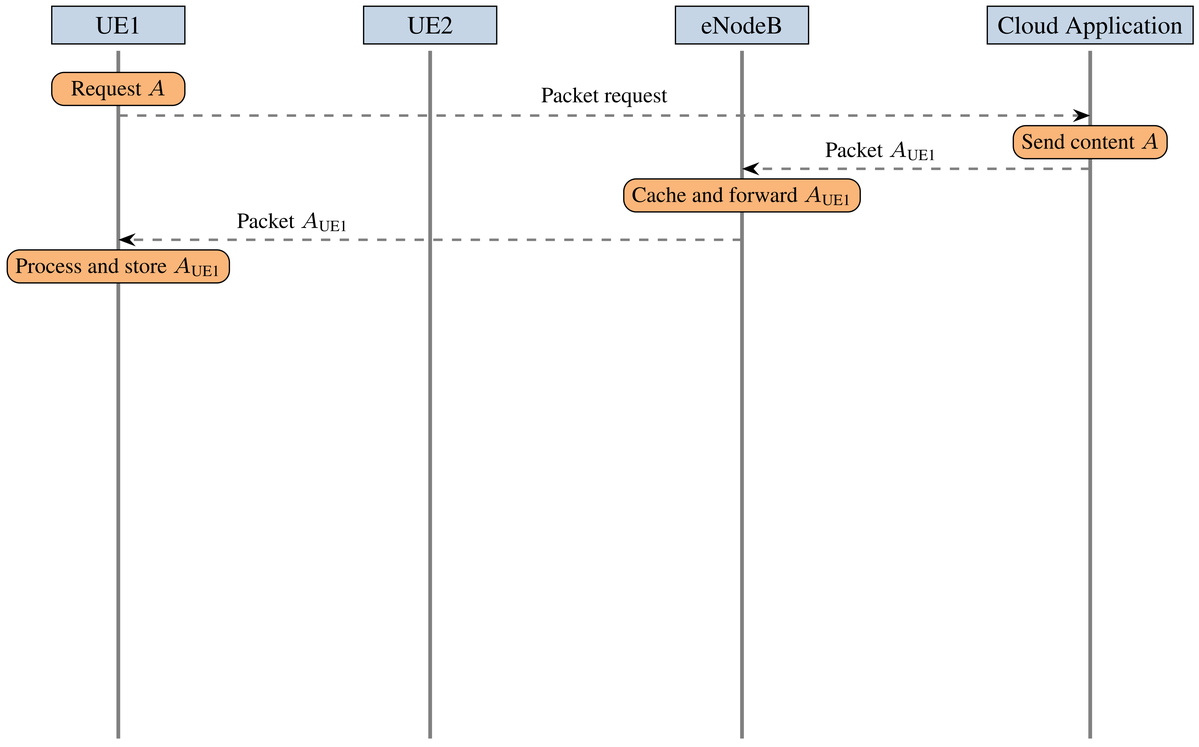


Decoding

- At users' side
- Immediate if one of the two content packets is already available

NC-CELL Operation

- Two users: UE1 and UE2
- Need to retrieve content A and content B from cloud application
- eNodeB exploits coding opportunity



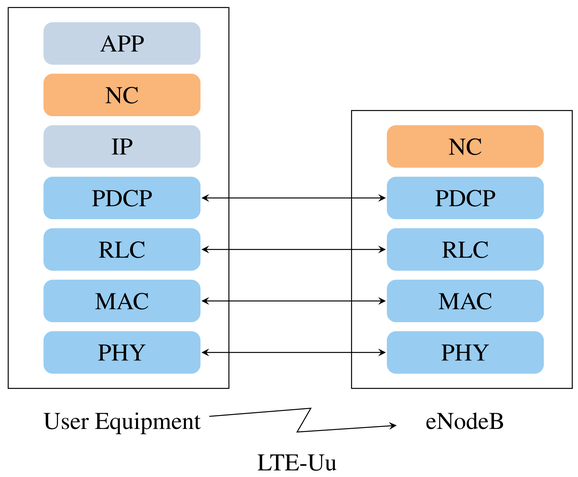
Protocol Stack

Encoding

- After GTP header removal
- Before PDCP performs IP header compression

Decoding

- Primary users receive and decode immediately
- Secondary users do not discard frame



Contact Information

- Claudio Fiandrino
- Email: claudio.fiandrino@uni.lu
- Phone: +352 46 6644 5531

ECO-CLOUD

Fonds National de la Recherche Luxembourg

NC-CELL: Network Coding-based Content Distribution in Cellular Networks for Cloud Applications

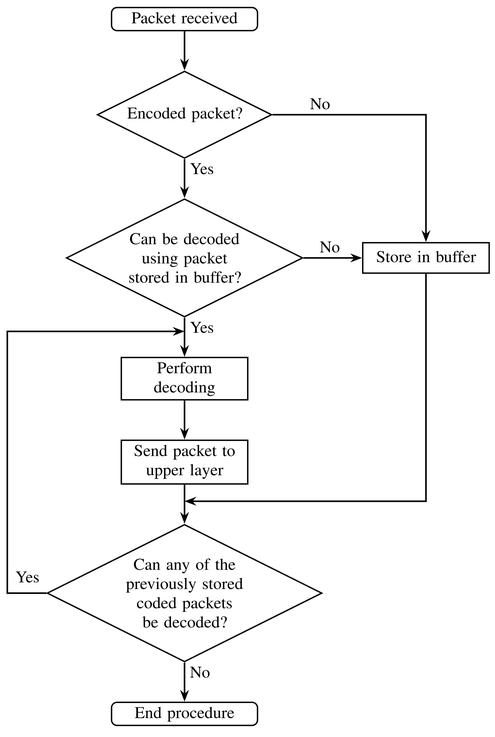
Claudio Fiandrino*, Dzmitry Kliazovich*, Pascal Bouvry* and Albert Y. Zomaya†

*University of Luxembourg - †The University of Sydney

Encoding and Decoding Procedure

Encoding

- At eNodeB
- Combining only content not packet headers
- Delivery to all interested users through PDSCH (primary and secondary users)

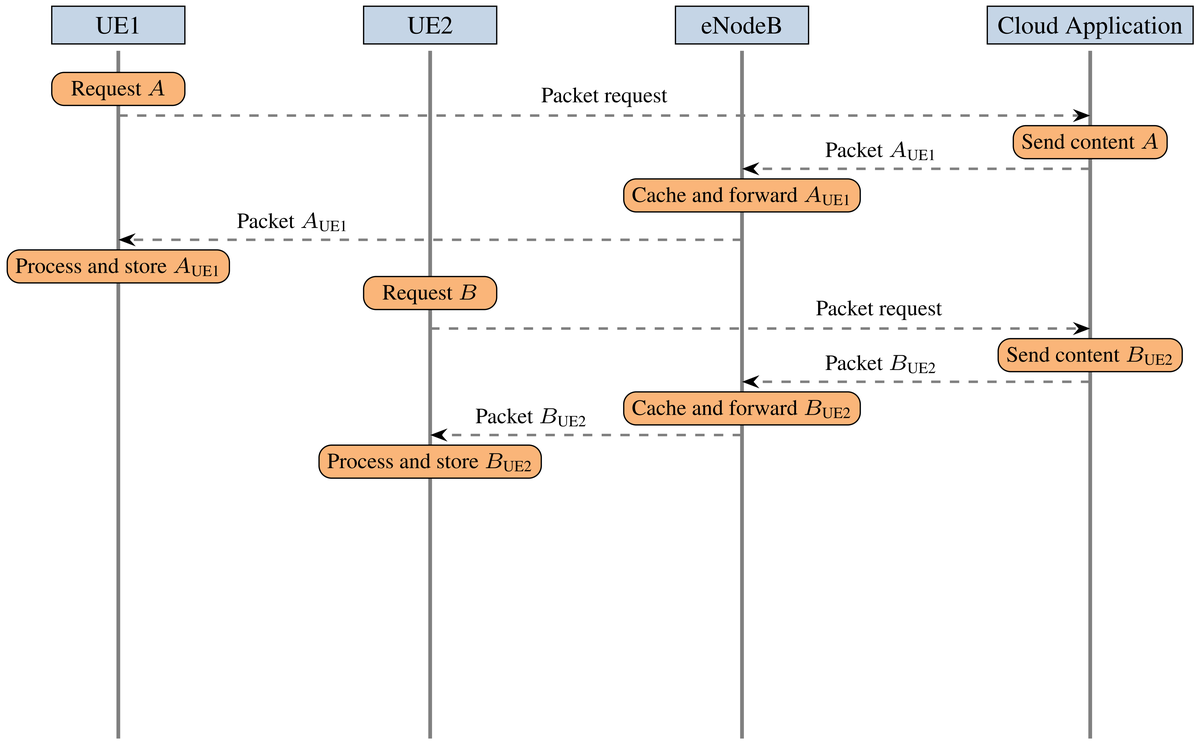


Decoding

- At users' side
- Immediate if one of the two content packets is already available

NC-CELL Operation

- Two users: UE1 and UE2
- Need to retrieve content A and content B from cloud application
- eNodeB exploits coding opportunity



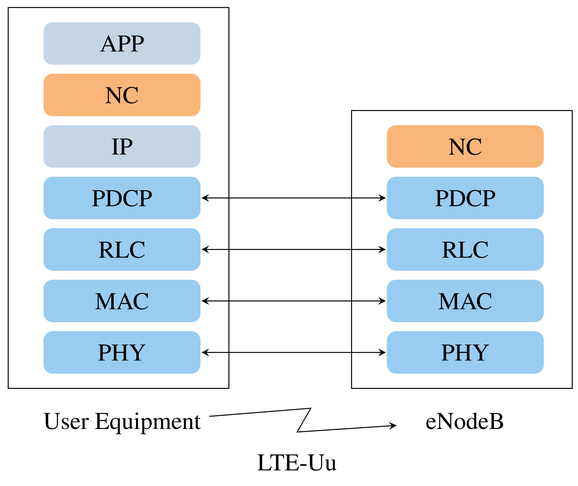
Protocol Stack

Encoding

- After GTP header removal
- Before PDCP performs IP header compression

Decoding

- Primary users receive and decode immediately
- Secondary users do not discard frame



Contact Information

- Claudio Fiandrino
- Email: claudio.fiandrino@uni.lu
- Phone: +352 46 6644 5531

ECO-CLOUD

Fonds National de la Recherche Luxembourg

NC-CELL: Network Coding-based Content Distribution in Cellular Networks for Cloud Applications

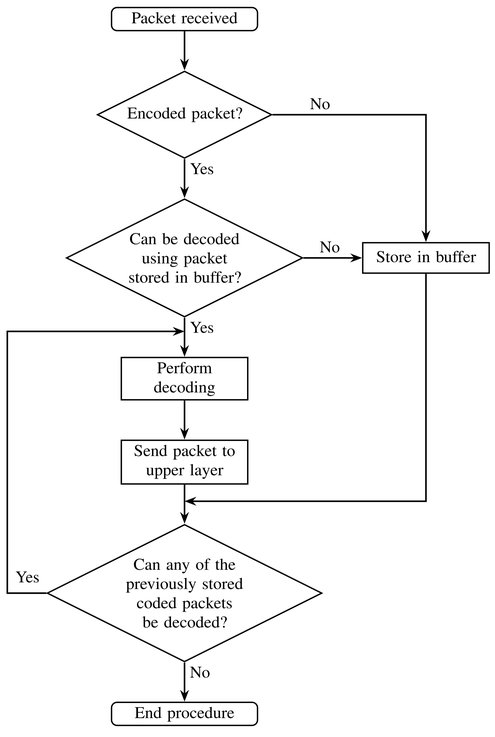
Claudio Fiandrino*, Dzmitry Kliazovich*, Pascal Bouvry* and Albert Y. Zomaya†

*University of Luxembourg - †The University of Sydney

Encoding and Decoding Procedure

Encoding

- At eNodeB
- Combining only content not packet headers
- Delivery to all interested users through PDSCH (primary and secondary users)

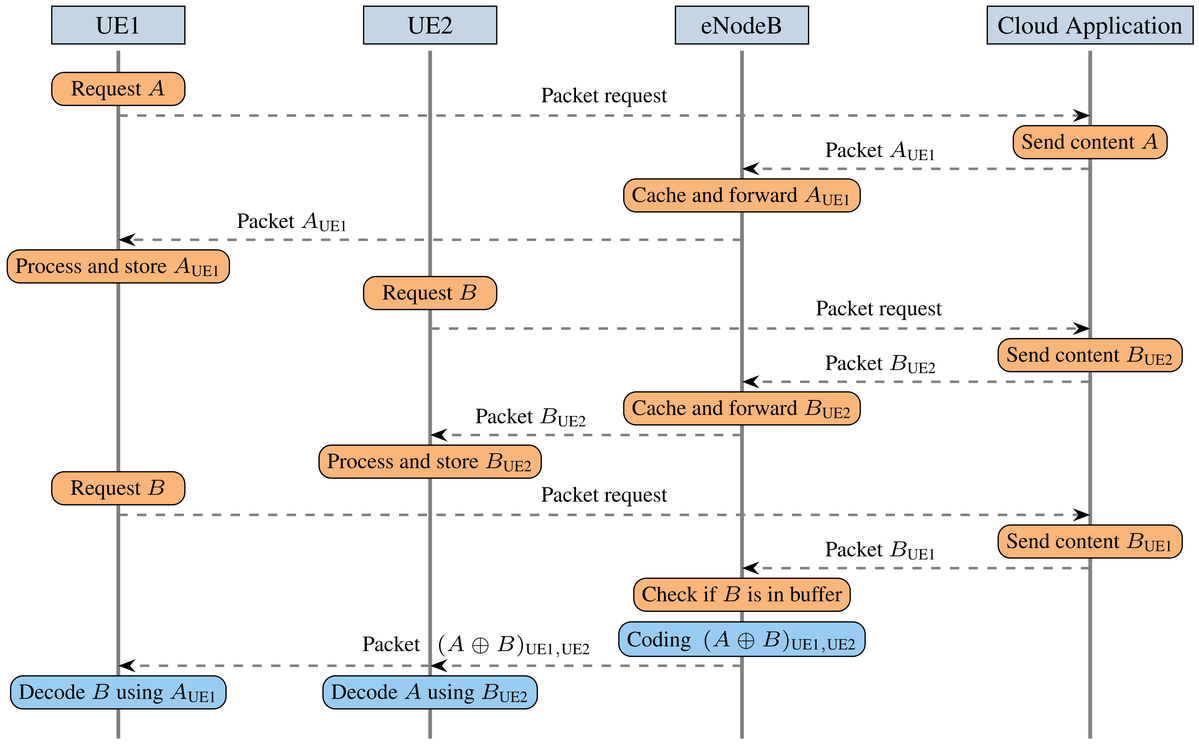


Decoding

- At users' side
- Immediate if one of the two content packets is already available

NC-CELL Operation

- Two users: UE1 and UE2
- Need to retrieve content A and content B from cloud application
- eNodeB exploits coding opportunity



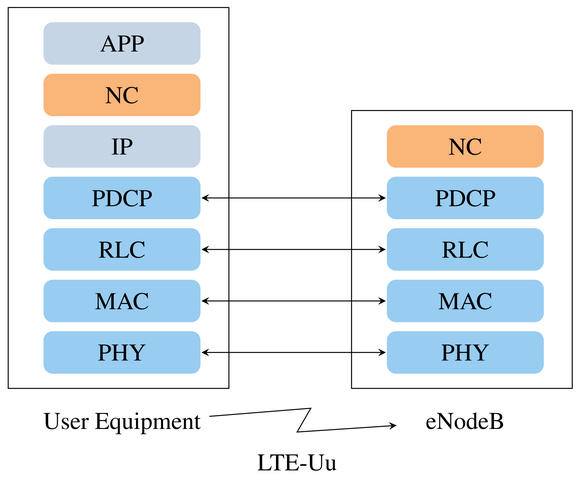
Protocol Stack

Encoding

- After GTP header removal
- Before PDCP performs IP header compression

Decoding

- Primary users receive and decode immediately
- Secondary users do not discard frame



Contact Information

- Claudio Fiandrino
- Email: claudio.fiandrino@uni.lu
- Phone: +352 46 6644 5531

ECO-CLOUD

Fonds National de la Recherche Luxembourg