A Refactoring Approach for Optimizing Mobile Networks

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A Refactoring Approach for Optimizing Mobile Networks
Matteo Pozza, Ashwin Rao, Armir Abujari, Claudio Pallazi, Hannu Flinck, and Sasu Tarkoma
*Under submission* – *Short Paper to ACM CoNEXT 2016*

State Space Analysis to Refactor the Mobile Core
Heikki Lindholm, Lirim Osmani, Hannu Flinck, Sasu Tarkoma, and Ashwin Rao.
*In Proc. of AllThingsCellular Workshop 2015*

Building Blocks for an Elastic Mobile Core
Lirim Osmani, Binoy Chemmegate, Heikki Lindholm, Ashwin Rao, Hannu Flinck, and Sasu Tarkoma
*In ACM CoNEXT Student Workshop 2014.*
Background

- Mobile networks are expecting an influx of verticals with varying demands
  - Low latency e.g., for haptic feedback
  - Gbps uplink/downlink e.g., for high quality video
  - High mobility e.g., for serving high speed trains

Each vertical is expected to arrive with a unique set of requirements
Scaling Mobile Networks

• Why can't current LTE networks meet these demands?
  – Telephony Centric – IP traffic an afterthought
  – Convoluted Control and Data Plane

• Approaches to address this issue
  – Move functionality to the Edge
  – Move functionality to the Cloud (NFV)
4G (LTE) Network

Radio Access Network (RAN) — Mobile Core
- eNodeB
- S-GW
- MME
- HSS
- P-GW
- PCRF
- SPR

Mobile Core
- HSS
- SPR
- PCRF
- P-GW
4G (LTE) Network

How do we move functionality?

How do we refactor LTE networks?
Three Layer Abstractions

- Storage Layer
- Control Layer
- Forwarding Layer
Modularization Objective
Identifying Roles of Network Functions

• Identify *state variables* used by network functions to maintain the UE state

• Study *signals exchanged* between network functions *to update these state variables during procedures*

<table>
<thead>
<tr>
<th>Procedure</th>
<th>#signals</th>
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<tbody>
<tr>
<td>Initial Attach</td>
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<tr>
<td>Active to Idle</td>
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<tr>
<td>Idle to Active (UE)</td>
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<td>17</td>
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<tr>
<td>Handover (S1H)</td>
<td>22</td>
</tr>
</tbody>
</table>
Identifying Modules

Mobile Network

- HSS
- SPR
- MME
- PCRF
- eNB
- SGW
- PGW

[Diagram showing the interconnections between eNB, SGW, PGW, HSS, SPR, MME, and PCRF in a mobile network]
Identifying Modules

Mobile Network

HSS

M07

MME

M05

P-GW(C)

M12

PCRF

M06

S-GW(C)

M13

eNB(C)

M04

eNB(D)

M10

S-GW(D)

M02

P-GW(D)

M03

M01

M08
## Impact of Splitting Control and Data Planes

<table>
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<td>23</td>
<td>29</td>
<td>41</td>
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</table>
Mapping Modules to Layers

- **Control**
  - MME
  - eNB\(^{(C)}\)
  - S-GW\(^{(C)}\)
  - PCRF

- **Storage**
  - HSS
  - SPR

- **Forwarding**
  - eNB\(^{(D)}\)
  - S-GW\(^{(D)}\)
  - P-GW\(^{(D)}\)
Mapping Modules to Layers

What is the impact of coalescing these modules?
Example 1: Thin Edge

Radio Access Network (RAN)

Storage
- HSS
- SPR

Control
- MME
- PCRF
- S-GW(C)
- P-GW(C)

GW
- S-GW(D)
- P-GW(D)

eNB(D)

eNB(C)
Ex2: Intelligent Edge

Radio Access Network (RAN)

Control
- MME
- PCRF
- S-GW(C)
- P-GW(C)

GW
- S-GW(D)
- P-GW(D)

Storage
- SPR
- HSS

eNB(C)

eNB(D)
## Impact of Coalescing Modules

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Summary and Future Work

- Abstract the roles of the network functions
- Modularize the network functions
- Explore scenarios for coalescing the modules
Summary and Future Work

- Abstract the roles of the network functions
- Modularize the network functions
- Explore scenarios for coalescing the modules
  - Modules can become part of solutions for backward compatibility with next generation networks
  - Network in a Box
Thank You!

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