Open Mobile Edge Computing in 4G LTE

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Outline

● Motivation
● Technical description
● Example scenario
Resilient Network Motivation

- LTE Network Design assumed a few, large network operators
- Enterprise and Gov’t now deploying their own LTE networks

Using those multiple networks is key to resilient networks
Resilient Network Challenges

Connecting Multiple Networks
• LTE networks managed by Evolved Packet Core (EPC)
• Monolithic system that controls access, priority, connection to Internet, etc.
• Elastic EPC project makes EPC more resilient

This Talk: Using Local Services
• We use networks to communicate and use services.
• Need those services even if the network is disrupted
• Mobile Edge Cloud
Just Enough LTE Network To Understand The problem
Services can be close....
Packet Gateways Can Be Far Away
What is the impact?

- Packet Gateways (PGW) can be 1000s of miles away.
- Faster communication may be necessary.
- Especially for localized information.
- What if Chicago is down?

Image Source: https://www.travelers.com/resources/auto/safe-driving/winter-driving-safety-tips
One Solution: Mobile Edge Cloud

- Part of this (MEC) is defined by 3GPP standards
- But, this assumes the service is run by the network operator
- We want to use our local services...on multiple networks
ESP -- Edge Service Provider
MNO -- Mobile Network Operator
Multi-Mobile Edge Cloud Challenges

Mobile Network Operator (MNO)
- MNO does not want to expose network structure
- But, we need to handle roaming UE’s
- And, connect to “best” edge service

Edge Service Provider (ESP)
- ESP needs to work with multiple MNO’s
- Has to identify UE and ESP pairings
- Has to identify the “best” ESP node
Multi-Mobile Edge Cloud - Prototype System

The MEC Switch – A software-defined switch using P4
We use and contribute to the NextEPC project
Within the switch are Match-Action tables that specify the matching and forwarding actions of the switch.
Sample Packet Intercepted by the MEC

Dest. MAC

Dest. IP

UDP Port

MEC Switch

Port 2

Sample Packet

Dest. MAC

58:8a:5a:14:6f:74

ab:ac:ad:ae:af:aa

123.1.1.1

Cell Phone IP

MEC Flow Table Rule

<table>
<thead>
<tr>
<th>MATCH</th>
<th>ACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>src=45.45.0.21, dst=8.8.8.53</td>
<td>eth_dst=ab:ac:ad:ae:af:aa</td>
</tr>
<tr>
<td>ip_dst=123.1.1.1</td>
<td>forward_port: 2</td>
</tr>
</tbody>
</table>
Who tells MEC switch what to do?

1. MNO
2. ESP
1 of 2 Necessary Protocols

ESP  →  MNO

SubID

Service1  Service2  Service3

ServerX  ServerY  ServerZ  ServerQ

Example

Max

NYTIMES  GeoMap  Streaming

12.1.1.1  32.1.1.1  27.2.1.1  12.1.1.2
1 of 2 Necessary Protocols

Relation Example

UEs

Subscriptions

Servers

10.1.1.1, Max

nytimes

cnn

fox

12.1.1.1

12.1.1.2

12.1.1.3

12.1.1.4

12.1.1.5
## 2 of 2 Necessary Protocols

<table>
<thead>
<tr>
<th>UE’s IP</th>
<th>Service Name</th>
<th>List of dest IPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;45.45.0.21</td>
<td>nytimes</td>
<td>[8.8.8.1, 8.8.8.2, 8.8.8.7]</td>
</tr>
<tr>
<td>&lt;45.45.0.21</td>
<td>cnn</td>
<td>[8.8.8.1, 123.12.3.9]</td>
</tr>
<tr>
<td>&lt;45.45.0.21</td>
<td>fox</td>
<td>[8.8.8.1, 5.5.8.2, 1.1.1.2]</td>
</tr>
<tr>
<td>&lt;45.45.1.2</td>
<td>fox</td>
<td>[8.8.8.1, 5.5.8.2, 1.1.1.2]</td>
</tr>
</tbody>
</table>
Public Safety Scenario
Public Safety Scenario
Scenario 1
UE travels from Cell1 to Cell2

Scenario 2
UE travels from MEC 1 to MEC 2
Scenario 1
UE travels from Cell1 to Cell2

MEC
- Knows UE’s
  - IP
  - Assoc. Cell1
- Maps <UE IP, Cell>
- Matches traffic for reroute:
  - 1st - UE’s IP
  - 2nd - Dest IP and port

EPC
- EPC to MEC (REST API)
  - Notify new Assoc. Cell2

MEC
- Update mapping
- Route Downlink to Cell2
Scenario 2

UE travels from MEC 1 to MEC 2

- MEC 1
  - Knows UE’s
    - IP
    - Assoc. CellID
  - Maps <UE IP, Cell>
  - Matches traffic for reroute:
    - 1st - IP
    - 2nd - Dest IP and port

- EPC
  - EPC to MEC 2 (REST API)
    - IP
    - Assoc CellID

- MEC 2
  - Continues service
Project status

• Current system is “bump in the wire”
• Measures latency to different ESP servers
• Only redirects data for designated UE
• Edge Service Provider does not need to know about GTP

• Come see demo!
Thank You!
Come back for the
Next
Session
2:40 PM