Port Control Protocol in Software-Defined Mobile Networks

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The Problem

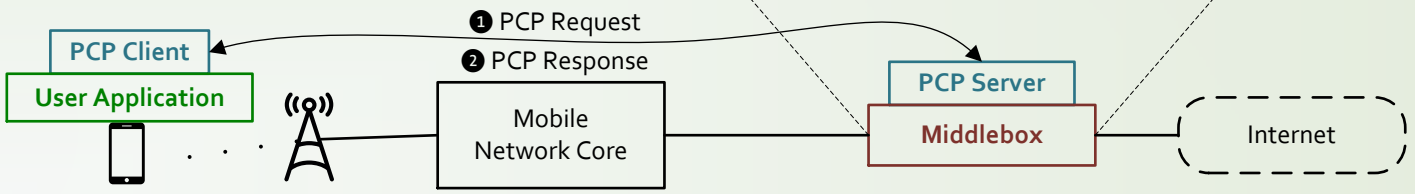
When a user application (online gaming, VoIP call) establishes a connection, middleboxes (firewalls, NATs) create mapping information along with a timer. If the connection is idle, the timer expires and the connection is broken.

Applications prevent the timer expiry by repeatedly sending "keepalive" messages. However, because the applications do not know the timers set on the middlebox(es), they send keepalives in very short intervals, resulting in **increased network load** and **reduced battery life of mobile devices**. These issues have a significant impact in mobile networks.

Port Control Protocol (PCP)

- Facilitates direct communication between applications and middleboxes
- Resolves NAT traversal issues of applications
- Applications can obtain/request the mapping timer and consequently optimize their keepalive interval

Internal IP	External IP	Timer
192.168.100.10	210.20.10.10	20 seconds
...	...	...



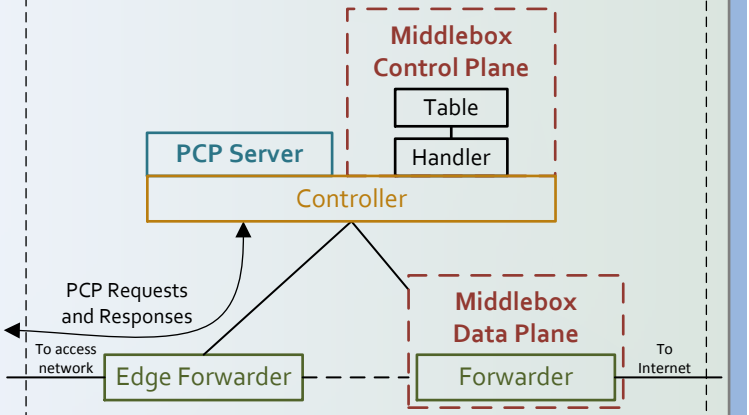
Software-Defined Networking (SDN)

- In a nutshell: "programming the network behavior"
- ✓ Separates the control and data plane of network devices to a controller and forwarders, respectively
- ✓ Allows for greater flexibility and easier management of computer networks
- ✓ Increases vendor device compatibility

Port Control Protocol + SDN

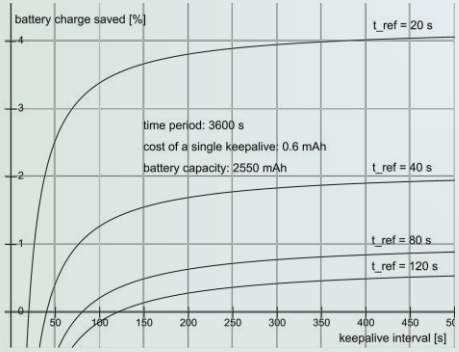
- ✓ Less computation overhead on middleboxes
- ✓ Application does not have to communicate with multiple middleboxes, but rather one node only – the controller
- ✓ Middleboxes remain transparent to the applications
- ✓ Easier to deploy

Mobile Network Core + Middlebox in SDN



Saving Battery Life in 3G WCDMA Networks

If an application originally used a keepalive interval t_{ref}, it can save battery life by increasing the keepalive interval to t_{new}.



The computed battery life saved assumes that only keepalives are sent over the specified time period (3600 s in the graph).

The cost of a single keepalive was obtained from the following paper:

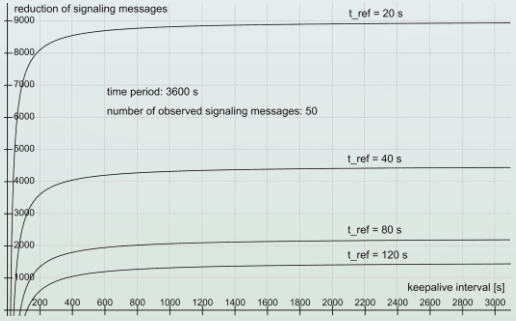
Haverinen, H., et al.: Energy Consumption of Always-On Applications in WCDMA Networks. In: Vehicular Technology Conference, 2007. VTC2007-Spring. IEEE 65th, 2007, pp. 964–968.

Cost: 0.15–0.6 mAh
Time period: 3600 s

Battery Capacity [mAh]	Battery Life Saved
300 (Samsung Gear S – smart watch)	8.5 – 34.2%
2550 (Samsung Galaxy S6 – phone)	1 – 4%
7340 (iPad Air 2 – tablet)	0.35 – 1.4%

Reducing Signaling Traffic in 3G WCDMA Networks

Each message sent over the network generates a large number of signaling (control) messages. By increasing the keepalive interval, fewer keepalives are sent over the network, which considerably reduces the number of generated signaling messages.



The number of signaling messages generated per each packet was taken from the following source:

Signals Research Group, LCC: Smartphones and a 3G network, reducing the impact of smartphone-generated signaling traffic while increasing the battery life of the phone through the use of network optimization techniques. 2010.

Conclusions

- A suitable keepalive interval for 3G WCDMA networks is approx. 1800 seconds. PCP should request a higher mapping timer to allow applications to send keepalives early enough.
- For applications acting as clients (e.g. social media apps), PCP should assign a mapping timer of approx. 2100 seconds.
- For applications acting as servers (e.g. hosting a game server), PCP should assign a mapping timer at least twice as high as the keepalive interval (3600 seconds).