# Developing caching techniques using Collaborative Filtering methods in 5G Networks

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# Outline of the Presentation

## Motivation

In fifth generation (5G) networks, increasing the number of mobile users and devices will increase the information that they exchange between each other. As a result, not only finding an appropraite information is time consuming and confusing, but also retrieving the requested information without any delay is impossible.

## Objective

- There should be some mechanisims to help users investigate through the information and figure out the most proper one, based on their prefrences (Collaborative Filtering Algorithms).
- There should be some ways to lower the end-to-end latency (Caching).

## CF caching

- Generating automatic predictions based on user's preferences and similar information from other users
- Storing the predicted information in the caches which are located close the users

# Technical Issues Related to Caching

- **Where to cache?**

| | EPC | RAN |
|---|---|---|
| Hit ratio | Higher | Lower |
| Ease of Maintenance | Higher | Lower |
| Relaxing Backhaul Links | No | Yes |
| Decrease in Latency | Lower | Higher |

- **What to cache?** popular contents, predicting future request, . . .
- **What to release?** FIFO, LFU, LRU, . . .

# Technical Issues Related to Caching ( Related Works )

| Caching methods | Advantages | Disadvantage |
|---|---|---|
| Web caching | ▶ content aware using URL<br>▶ decrease end-to-end latency | ▶ cannot avoid duplicate transmission of same content with different URLs<br>▶ temporary content cannot be cached |
| Byte caching | ▶ save prominent amount of bandwidth<br>▶ decrease end-to-end latency<br>▶ can be applied to all types of Internet traffic | ▶ not proactive |
| P-UPP | ▶ proactive<br>▶ decrease end-to-end latency | ▶ request coming from a user cannot signal another request that will come in a small amount of time |
| Marcov based prefetching | ▶ proactive<br>▶ if use higher order models, have had accurate predictions | ▶ cannot predict the first request |
| Semantic caching | ▶ proactive<br>▶ decrease end-to-end latency<br>▶ able to smartly predict subsequent user requests employing in MEC | ▶ generating additional data traffic<br>▶ based on single user's previous requests |

# Technical Issues Related to Collaborative Filtering

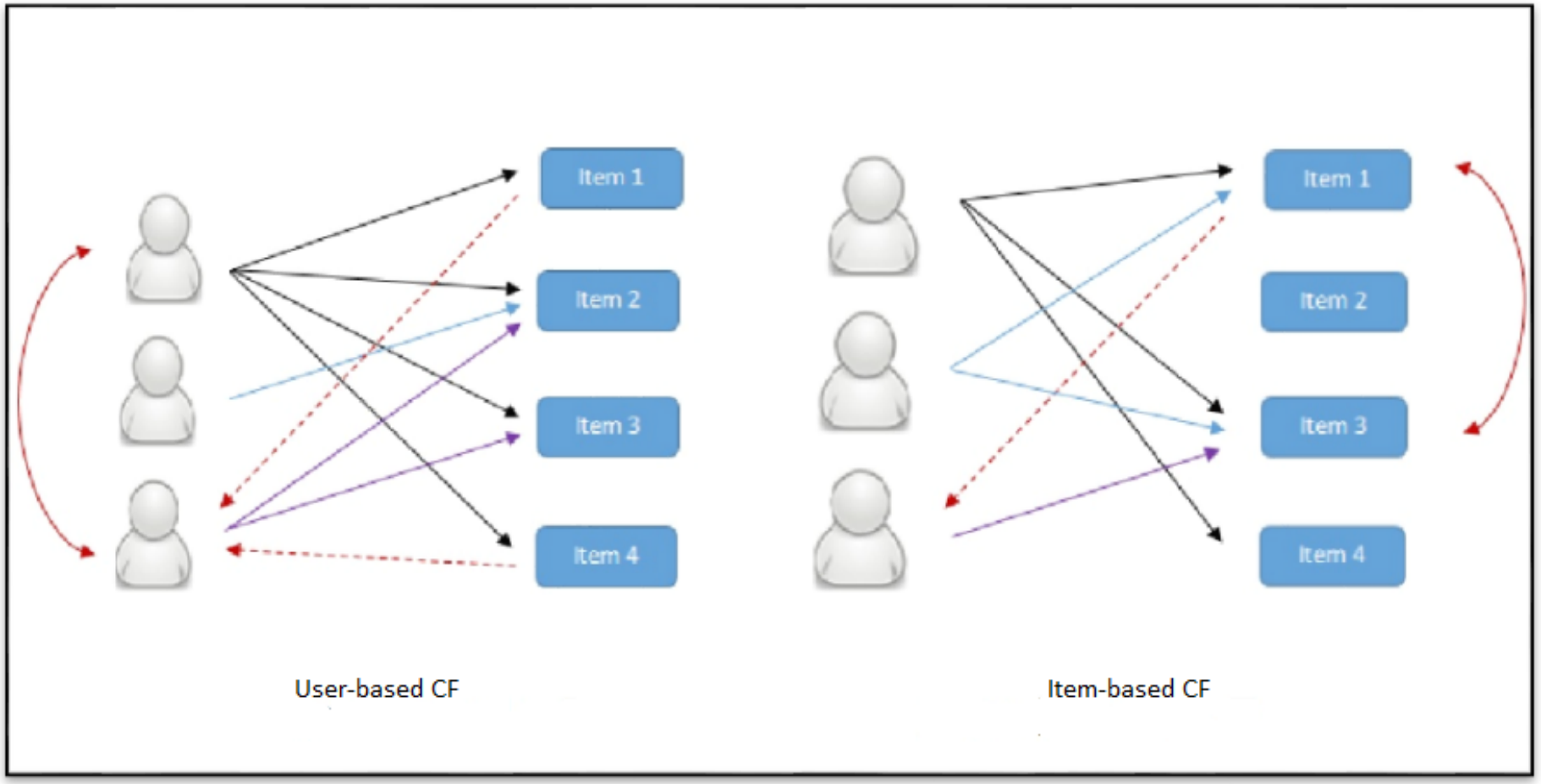



Figure: Memory and model based CF

# Technical Issues Related to Collaborative Filtering

Challenging issues related to user-based CF algorithms

- dealing with large amount of sets
- sparse data base
- scalability

# Technical Issues Related to Collaborative Filtering

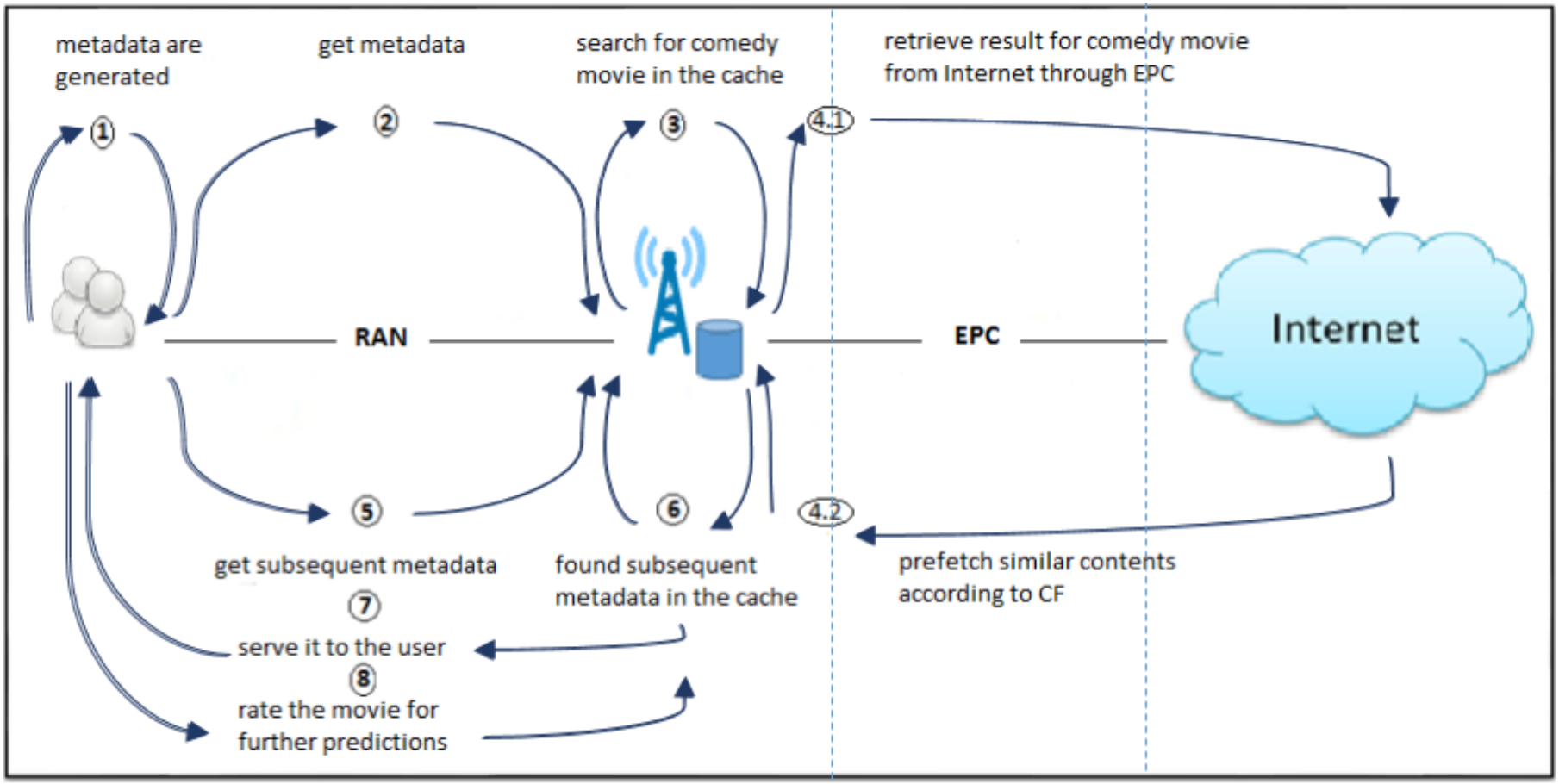
Item-based CF algorithms

- Jaccard
- Cosine
- Centered Cosine (Pearson correlation)

$$sim(i,j) = \frac{\sum_{u \in U}(R_{u,i} - \overline{R_i})(R_{u,j} - \overline{R_j})}{\sqrt{\sum_{u \in U}(R_{u,i} - \overline{R_i})^2}\sqrt{\sum_{u \in U}(R_{u,j} - \overline{R_j})^2}}$$

$$P_{u,i} = \frac{\sum_{similaritems,N}(S_{i,N} * R_{u,N})}{\sum_{similaritems,N}|(S_{i,N})|}$$

# Example scenario



# SDN architecture

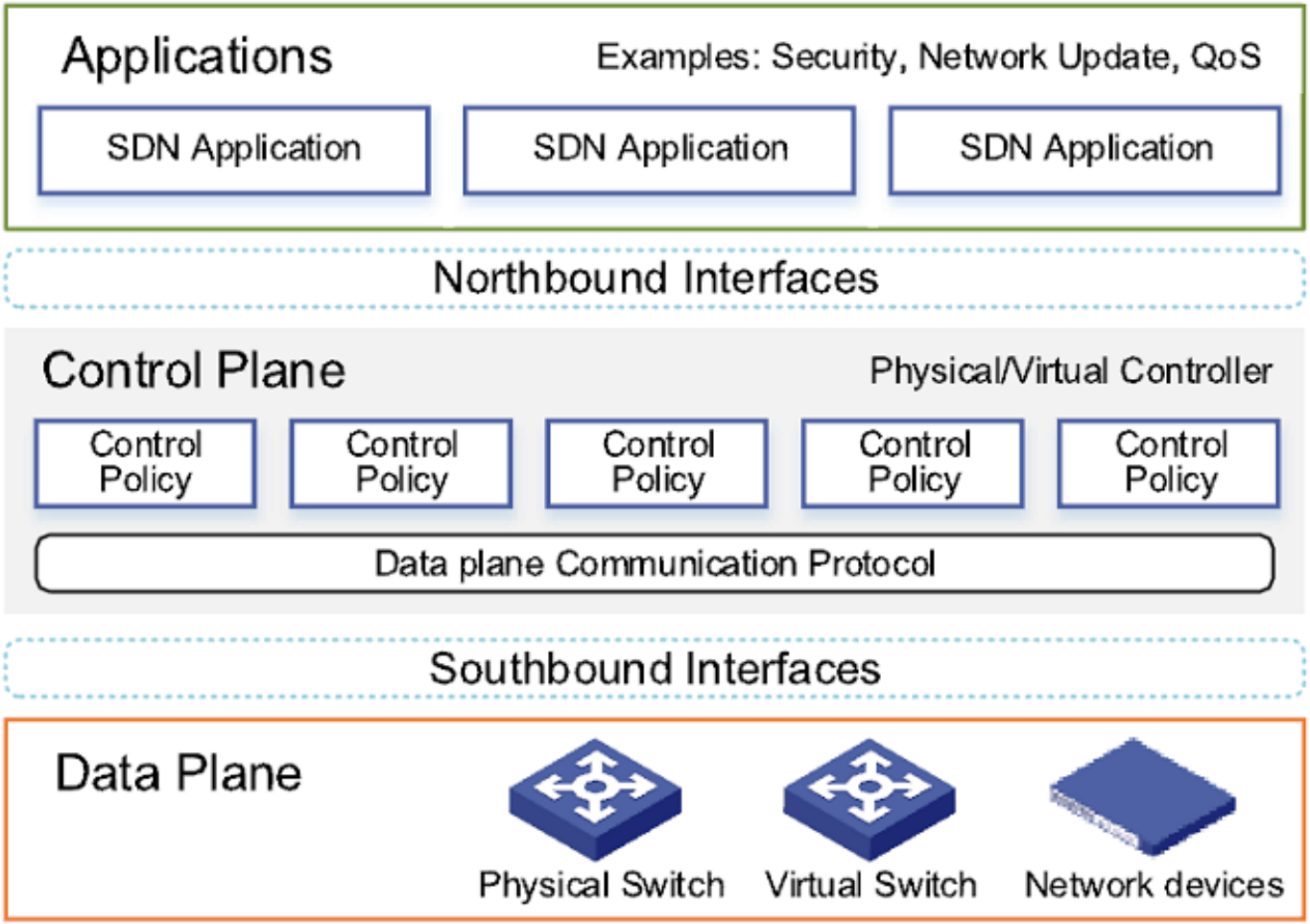



Figure: Software Defined Network architechture

# Network Slicing

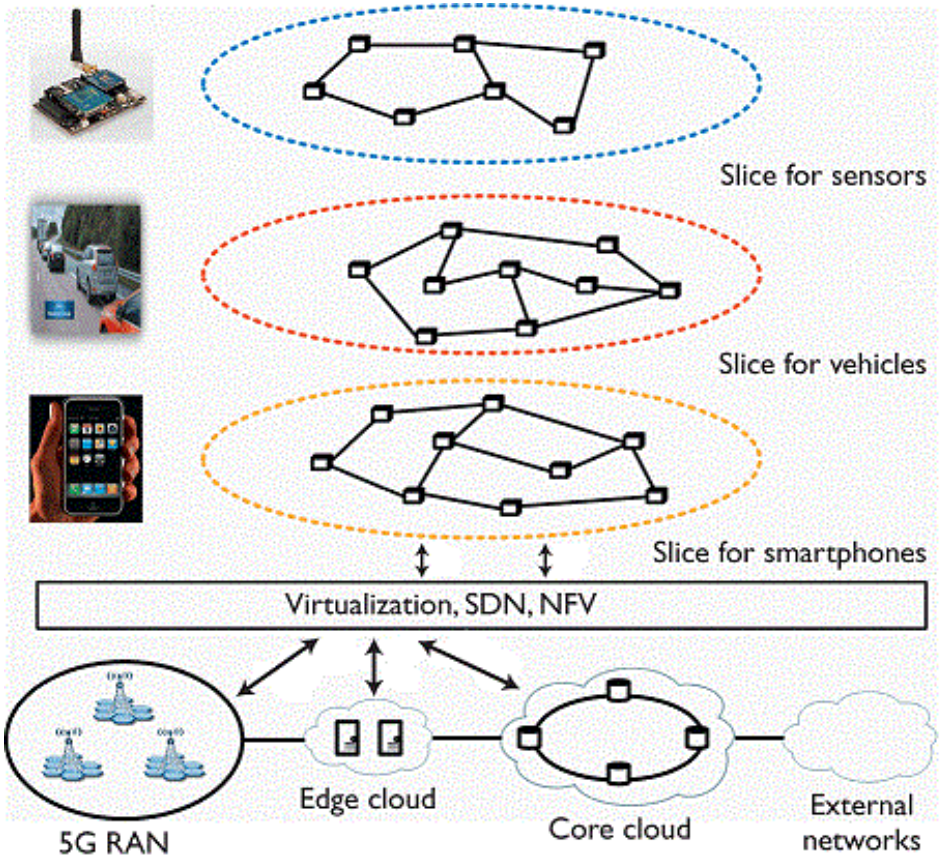



Figure: Network Slicing

# Future Works

- Implementing the example scenario based on SDN architecture
- Optimize the performance of the network by optimization problems

# References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# Questions

THANK YOU

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