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Prof. Ivan GANCHEV

IEEE Senior Member
URSI Senior Member
ITU-T Invited Expert
IET Invited Lecturer

5. Smart Recommendation of Telecommunication Services

Ivan Ganchev^{1,2,3}, Haiyang Zhang⁴, Máirtín O'Droma¹

¹ Telecommunications Research Centre (TRC), University of Limerick, Limerick, Ireland

² University of Plovdiv “Paisii Hilendarski”, Plovdiv, Bulgaria

³ Institute of Mathematics and Informatics – Bulgarian Academy of Sciences, Sofia, Bulgaria

⁴ Xi'an Jiaotong-Liverpool University, Suzhou, China

ivan.ganchev@ul.ie

Presentation Outline

- ❑ Introduction
- ❑ Related work
- ❑ Service recommendation framework
(*proposed*)
- ❑ Smart service recommendation system
(*work in progress*)
- ❑ Conclusion

- ❑ Recommendation systems are vital for consumers to solve the information overload problem and assisting them in navigation through the vast 'information oceans' in order to find the information, item, app, service, or thing needed.
- ❑ The goal is to provide consumers with accurate recommendations as fast as possible.
- ❑ This is a highly dynamic process, with the increasing number of items, apps, services, and things emerging.
- ❑ The R&D efforts have been mostly focused on *item* recommendations, whereas *app* recommendations and *service* recommendations are left behind.

Related Work: **Item Recommendations**



- ❑ The most explored sub-area!
- ❑ (e-)Commerce examples for recommending items:
 - Right at the spot, e.g., by means of digital menus for food recommendations at restaurants.
 - For online shopping at a retailer web site, or through a mediator, e.g., a video game or a social media (a.k.a. social commerce).
- ❑ Entertainment examples:
 - Recommendation of TV programs, streaming items (over social communities), photos, music, etc.
- ❑ (e-)Learning examples:
 - Recommending personalized online test questions for students.

Related Work: App Recommendations

❑ Academic research examples:

- Recommending mobile apps that other consumers have installed/used frequently in the same *location*.
- Recommending mobile apps, based on their *version* description.
- Personalized app recommendations by combining *collaborative filtering* (*CF*) with mobile apps' usage data and utilizing (implicit) *consumer feedback*.

❑ Commercial examples:

- Providing a list of similar apps (in the recommendation section of another app, used by the consumer), e.g., Google Play, Apple Store, etc.
- Recommendation algorithms are NOT public!
- "Forgotten majority" problem!

Related Work: Service Recommendations

- ❑ Great attention in the last few years!
- ❑ Examples:
 - Recommending a specific aspect/parameter/feature/component of a single service, e.g., adaptive video streaming recommendations such as SDNDASH.
 - Recommending a new instance of the same service, e.g., discovery and selection of IaaS cloud offerings, by utilizing a multi-criteria decision-making technique, based on real-time E2E QoS parameters for meeting SLAs.
 - Recommending a completely new service.
 - Recommending a service provider, e.g., based on similarity computation and ranking of service providers based on consumer feedback.
 - Knowledge-based recommendations for dynamic, runtime, proximity-based service compositions for mobile devices.
- ❑ Lack of a global solution applicable to all types of telecommunication services, as well as many Internet services and the newly emerged types of IoT services!

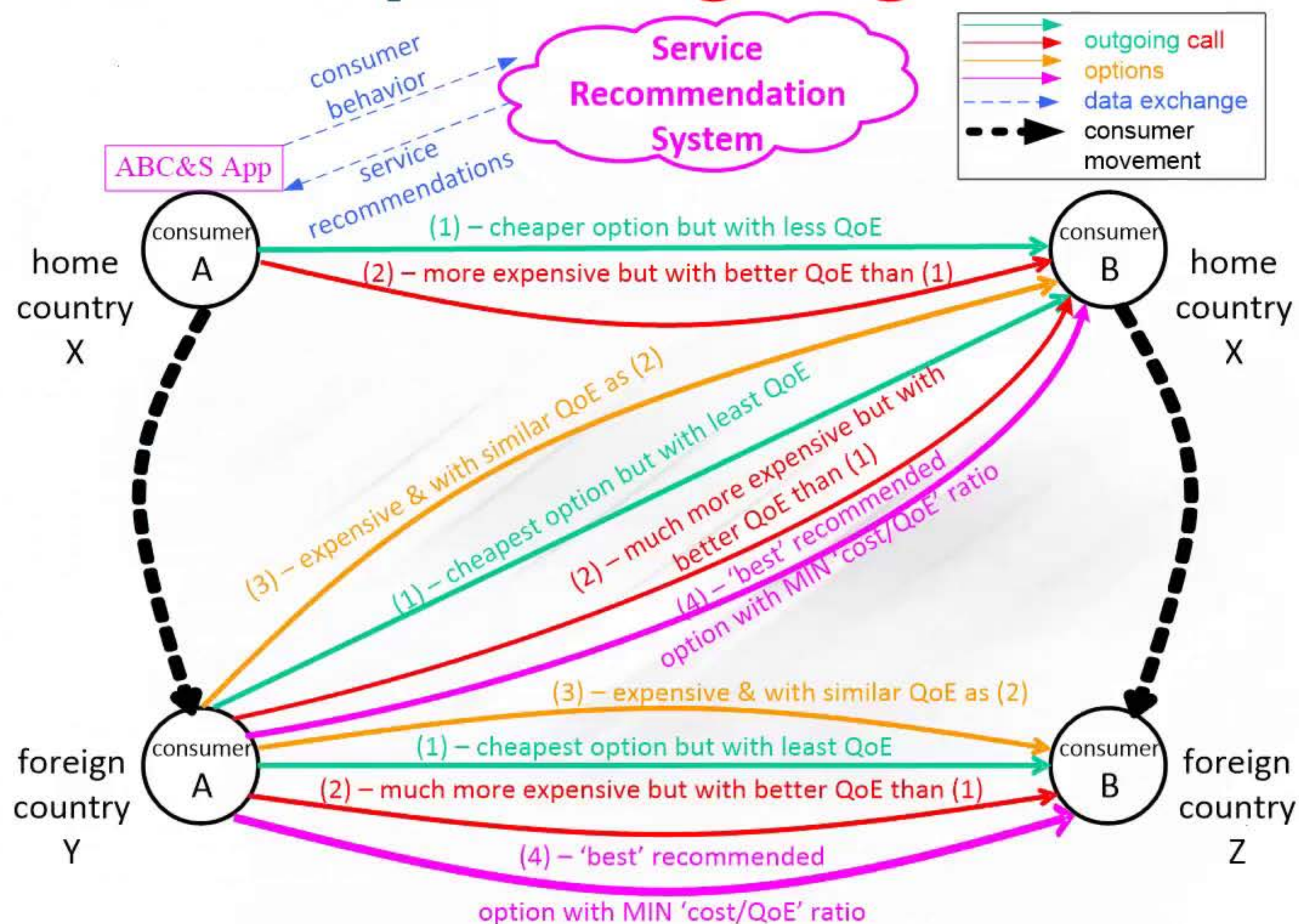
Proposed Service Recommendation Framework:

- ❑ Scalable and efficient solution for real-time service recommen
- ❑ Managing big semantic data in real time for highly contextualized, customized, and personalized service recommendations.
- ❑ Automatically finding the usefulness of available services (instances) and recommend the 'best' one.
- ❑ Dynamically providing to consumers an ordered list of ranked services (instances) addressing specific consumer needs.
- ❑ Ranking of services, based on consumer-, network-, and service context.
- ❑ Adopting a Neo4j graph database for storing and managing the information about services and consumers as a heterogeneous service network (HSN), based on a given network schema.
- ❑ Discovering consumers' features accomplished by utilizing the 'betweenness centrality' within the scope of HSN – a novel approach for consumer profiles' generation based on the meta-paths concept.

Application Example: Outgoing Voice Call Se

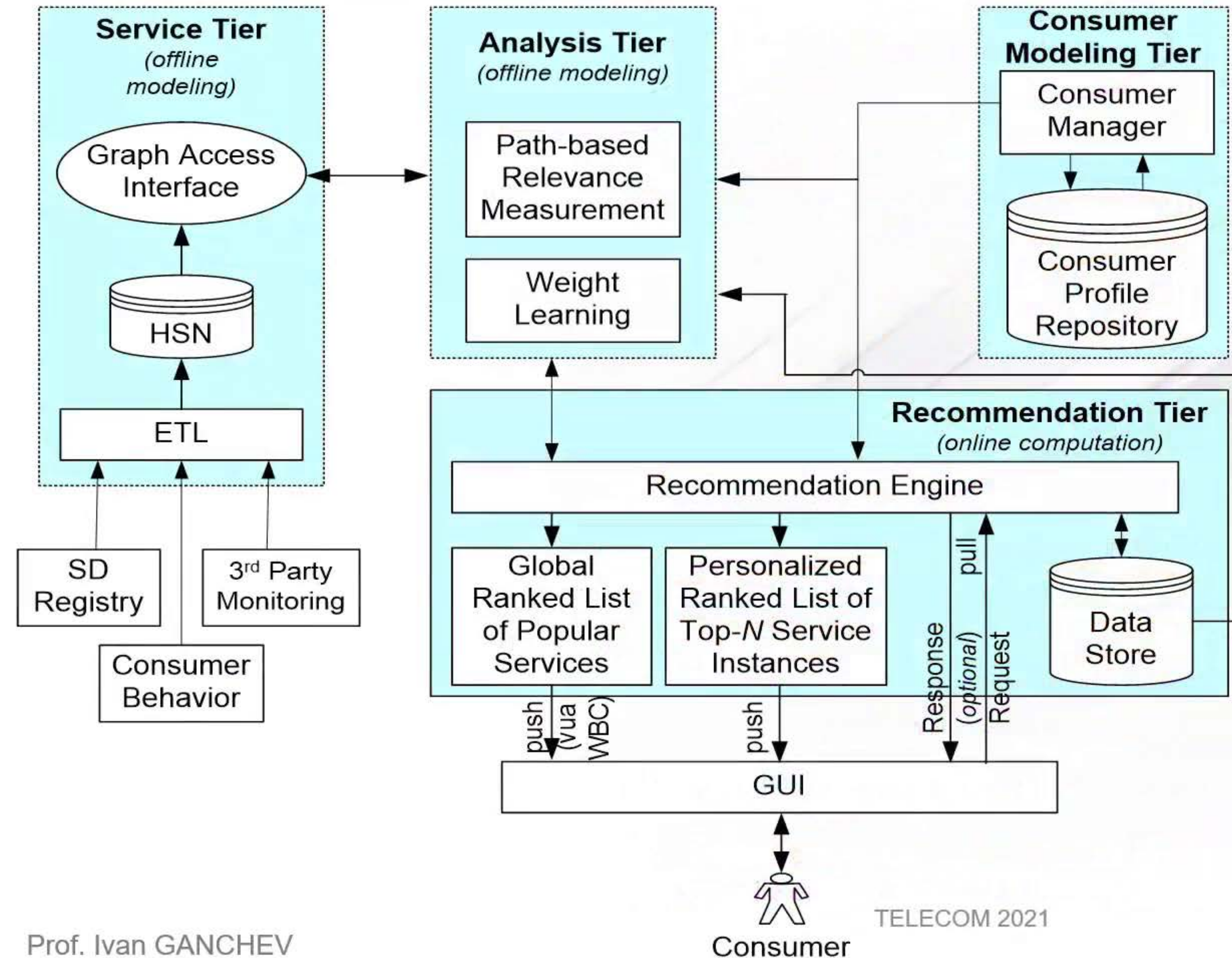
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- (1) VoIP call (free or paid) over Wi-Fi (free or paid)
- (2) mobile call (paid) via home physical SIM
- (3) mobile call (paid) via foreign eSIM
- (4) mobile call (paid) via global eSIM

Intelligent Service Recommendation Framework:



- Facilitates the recommendation of services between service providers and consumers by allowing the latter to specify their demands for services, or by guessing these demands on behalf of the consumers when authorized to do so.
- Service recommendations' personalization** – a personalized ranked list of top-N recommended 'best' services (instances) delivered to each consumer by taking into account the current context and consumer's preferences.
- Service popularization** – a global ranked list of popular services provided to all consumers, e.g., via wireless billboard channels (WBC).

Service recommendations' personalization

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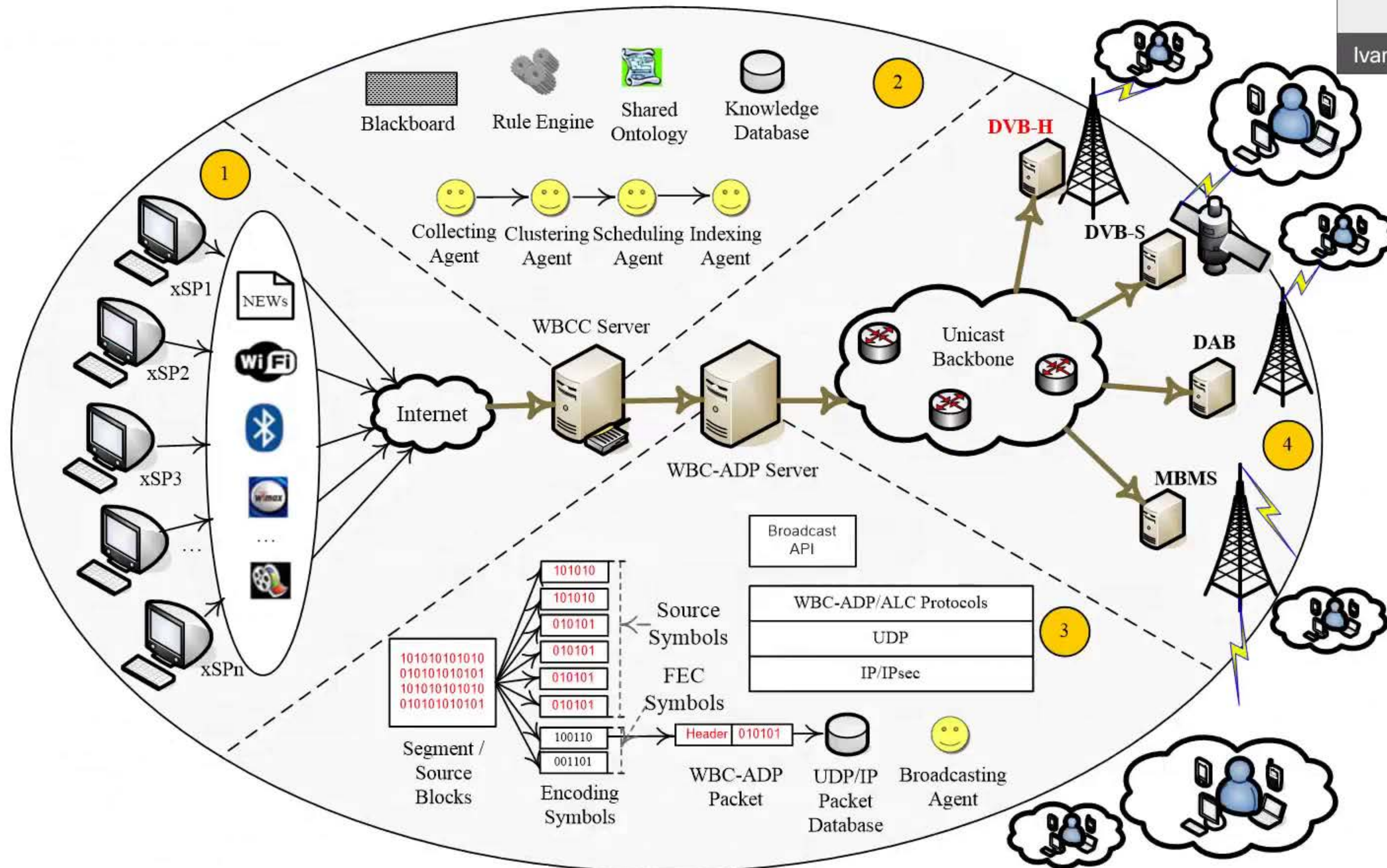
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- ❑ *Hybrid* context-aware approach
- ❑ 3 stages:
 - ***Pre-filtering*** – using contextual information to pre-filter the recommendation candidates.
 - ***Semantic recommendation*** – using semantic ratings obtained from the knowledge-based part to enhance the effectiveness of recommendation.
 - ❖ Matching factor – representing similarity/relevance between the consumer's interests and the available services.
 - ❖ Trust factor – considering consumers' satisfaction and services' availability, reliability, security, responsiveness, etc.
 - ***Post-filtering*** – based on additional information, e.g., how old or new is a particular service instance recommended and the willingness or hesitation of the consumer to use such old or new service instances.

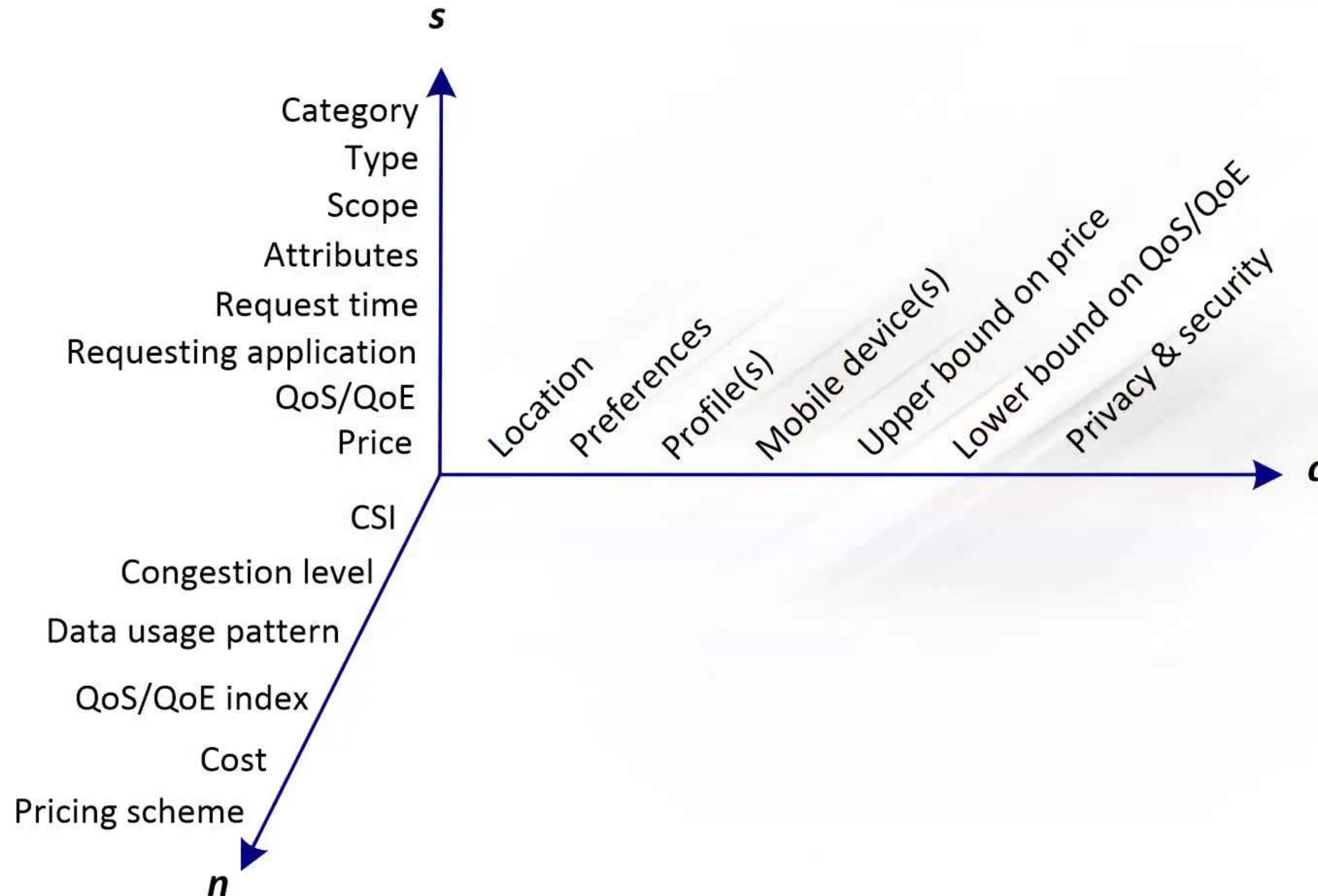
Service popularization via WBC

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Context Awareness

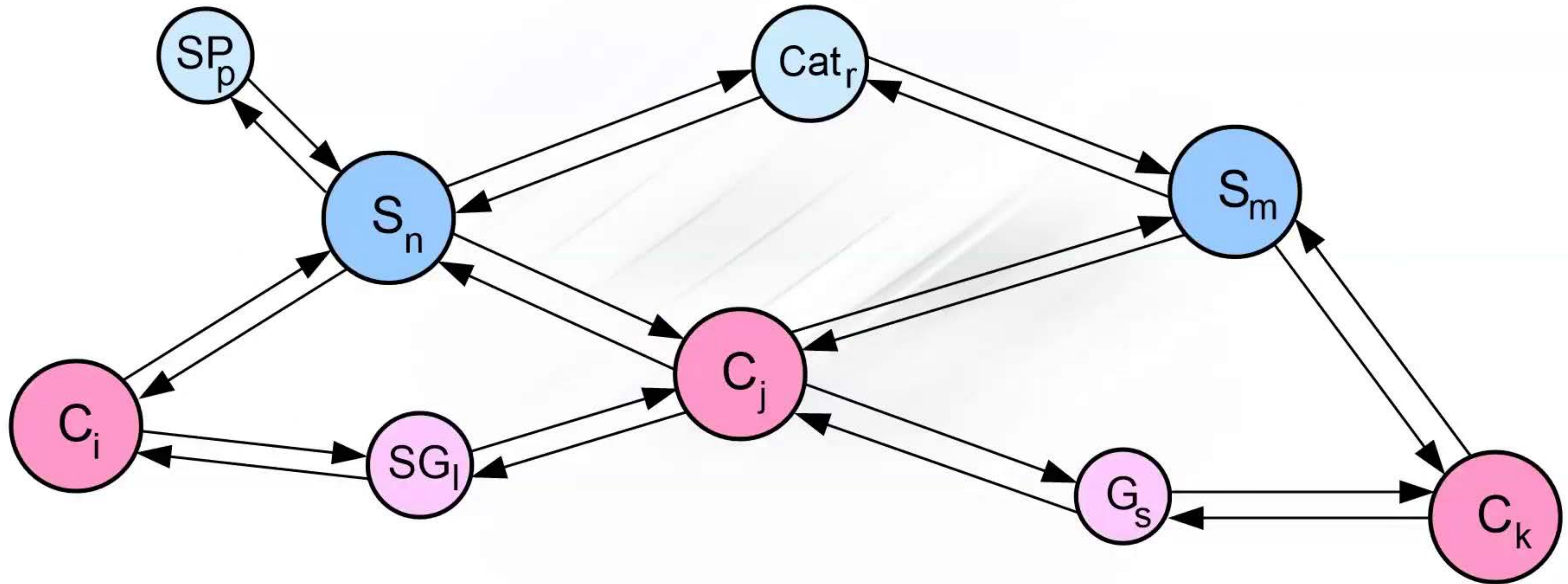


Defining the 'best' service (instance) at any moment for a particular consumer depends on a set of *context* parameter values, categorized in three groups – consumer-related (c), service-related (s), and (access) network-related (n) –, forming a 3D context space (c, s, n) .

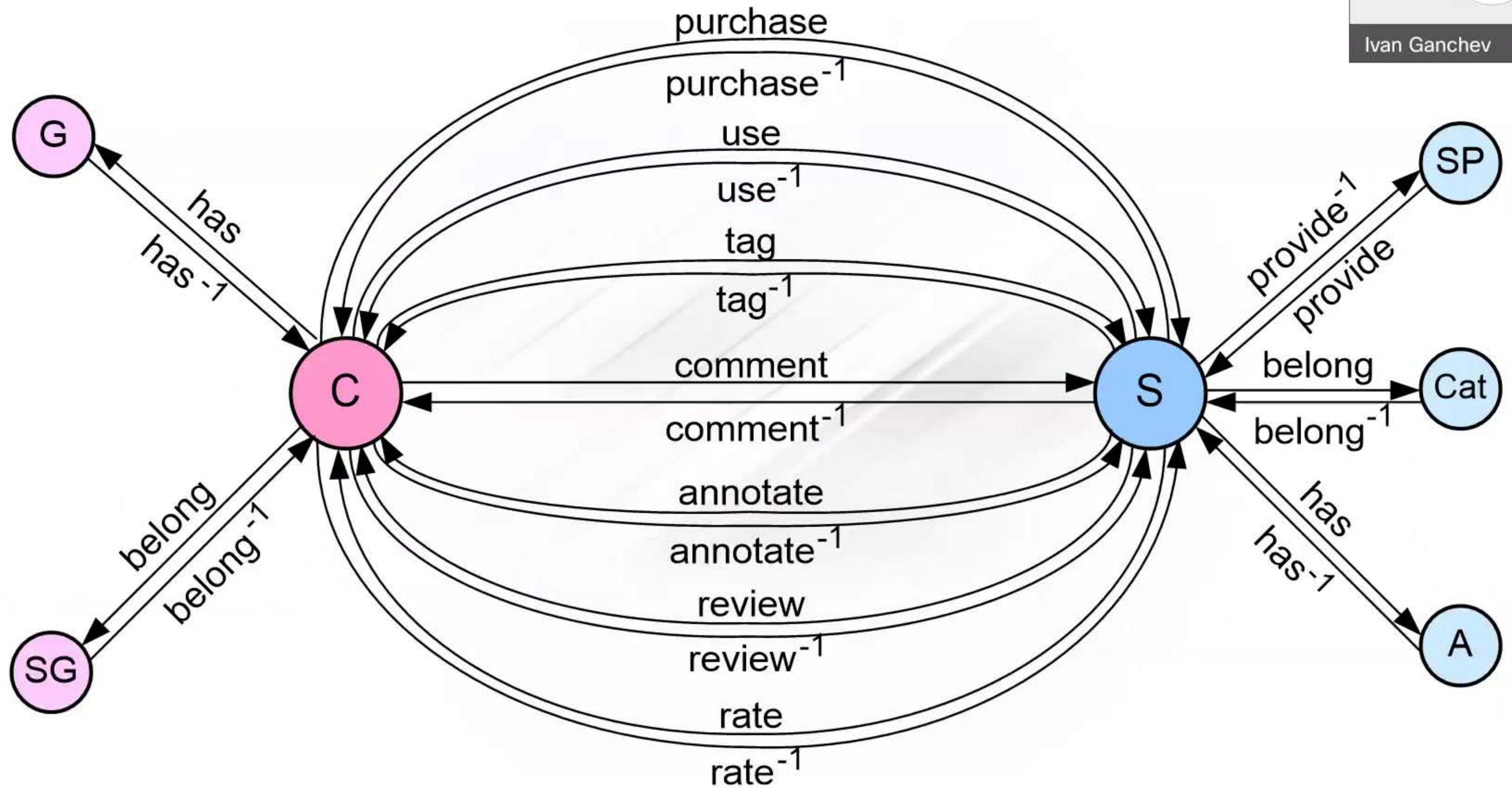
Heterogeneous Service Network: **Exempl**

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Network Schema



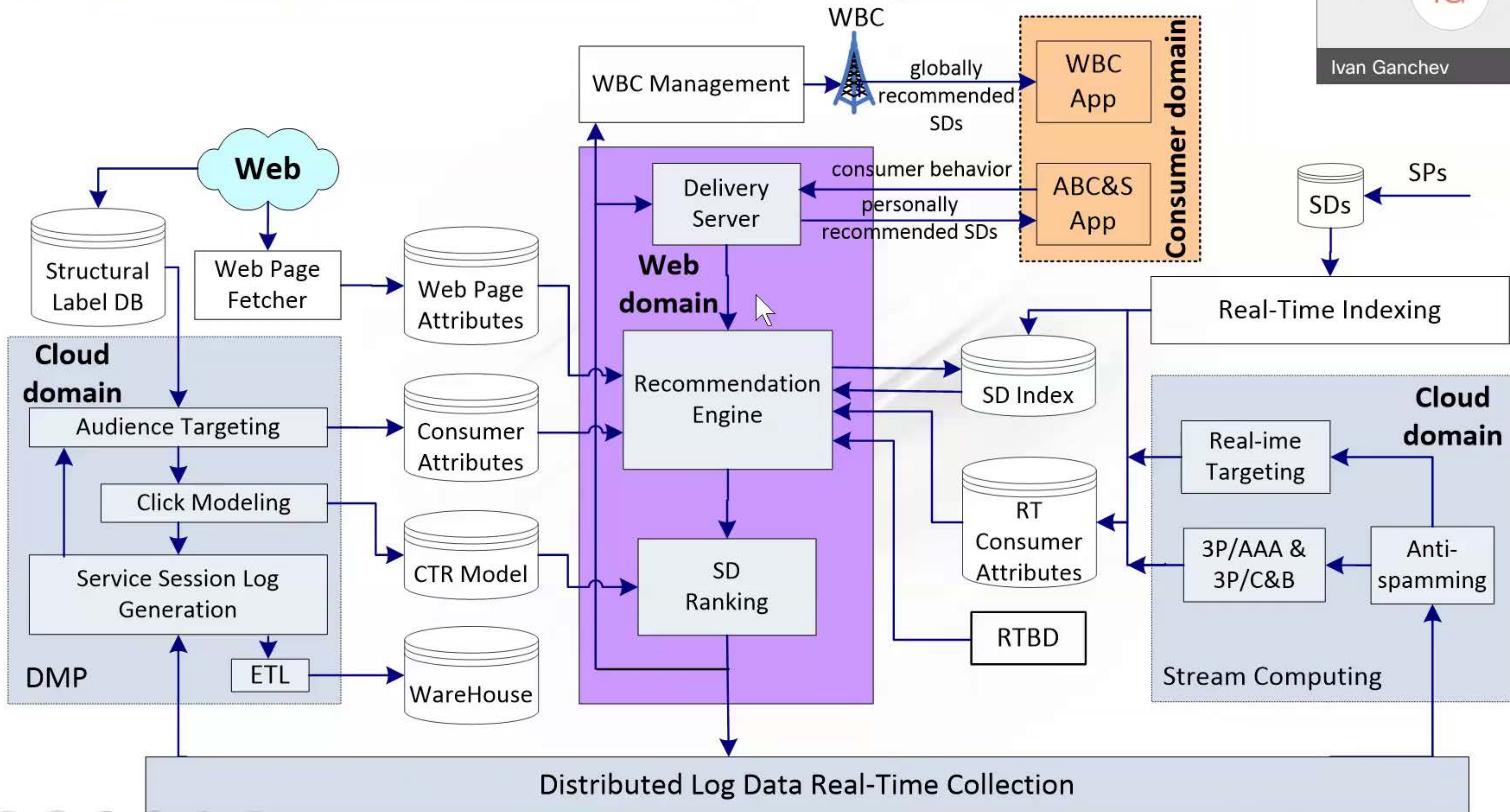
Meta-Path Approach

Path	Meta-paths
$C_i - S_n - C_j$	$C \xrightarrow{use} S \xrightarrow{use^{-1}} C; C \xrightarrow{tag} S \xrightarrow{tag^{-1}} C; C \xrightarrow{tag} S \xrightarrow{use^{-1}} C;$ $C \xrightarrow{use} S \xrightarrow{tag^{-1}} C; \text{etc.}$
$C_i - S_n - C_j - S_m - C_k$	$C \xrightarrow{use} S \xrightarrow{tag^{-1}} C \xrightarrow{use} S \xrightarrow{tag^{-1}} C; C \xrightarrow{tag} S \xrightarrow{use^{-1}} C \xrightarrow{tag} S \xrightarrow{use^{-1}} C;$ etc.
$Cat_r - S_n - C_j - G_s - C_k - S_m - Cat_t$	$Cat \xrightarrow{belong^{-1}} S \xrightarrow{use^{-1}} C \xrightarrow{has} G \xrightarrow{has^{-1}} C \xrightarrow{use} S \xrightarrow{belong} Cat$

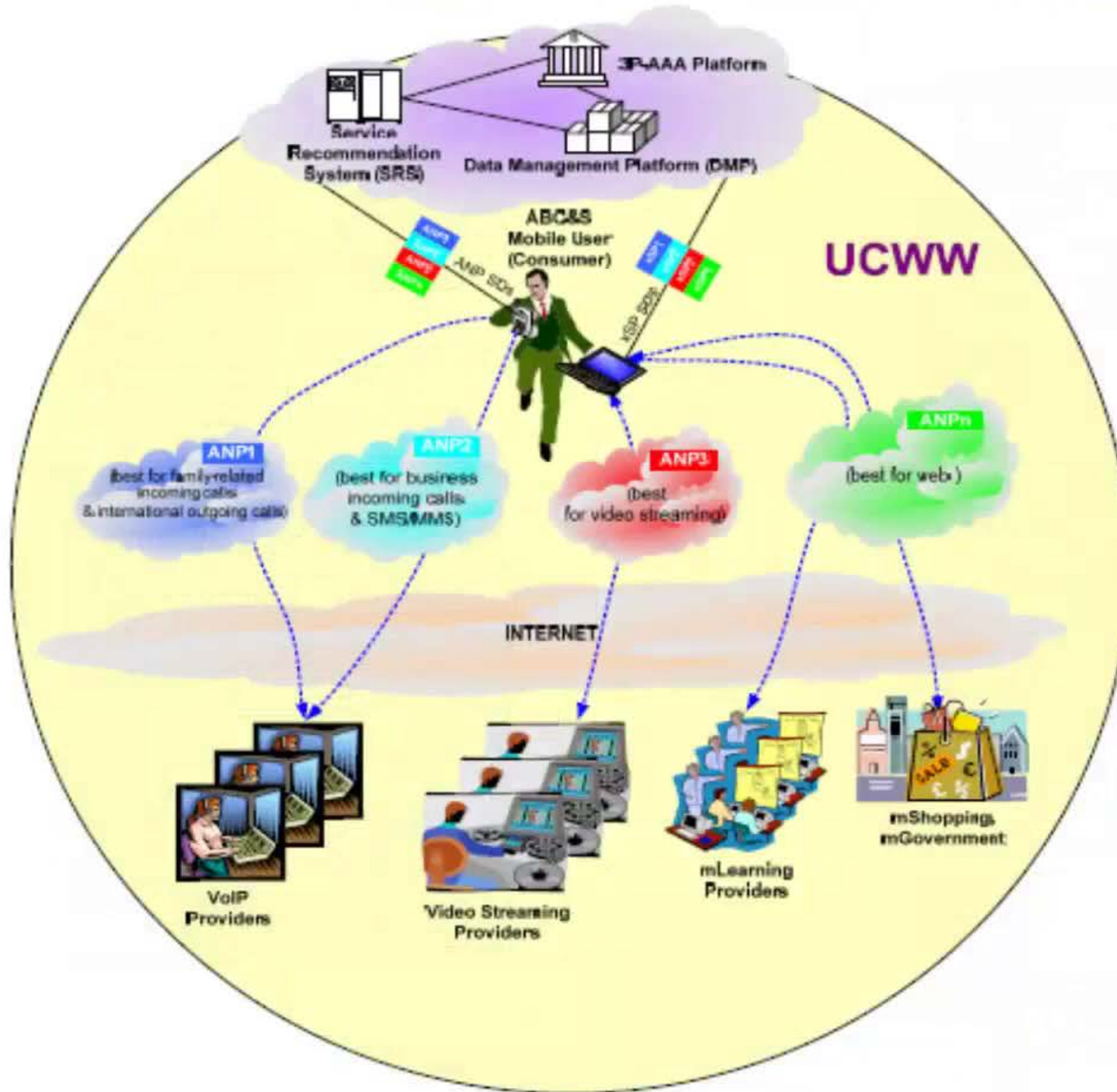
- Similarity/relevance measurement based on meta-paths
- *PathSim* and *HeteSim* are utilized

Smart Service Recommendation System: **Work in**


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Conclusion



- ❑ The elaborated intelligent recommendation framework can be used as a platform to assist service providers of any kind, not just telecom operators, to reach valuable targeted consumers (mobile users), by supplying to them an up-to-date list of ranked services (instances) to choose from, at any location and at any moment.
- ❑ Further on, if the services are used via the 'best' available access network, this would help realizing a truly consumer-driven always best connected and best served (**ABC&S**) paradigm.

Thank you for attention!

Questions & comments?

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