The Real Ad-hoc Multi-hop Peer-to-peer (RAMP) Middleware: Content sharing and Social Networking

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Agenda

Scenario

- Smart devices and spontaneous networking
- Online social networks, social relationships, and content sharing

RAMP middleware

- Solution for spontaneous networking and content sharing
- Resource access filtering based on social relationship tightness
- Preliminary experimental results

Scenario: Smart Devices

Widespread availability of **smart devices** (smartphones, tablets, notebooks, smart TVs, etc.)

- **heterogeneous wireless connectivity**
- **powerful computing capabilities**
- exploited to **access services** and **generate/share** content

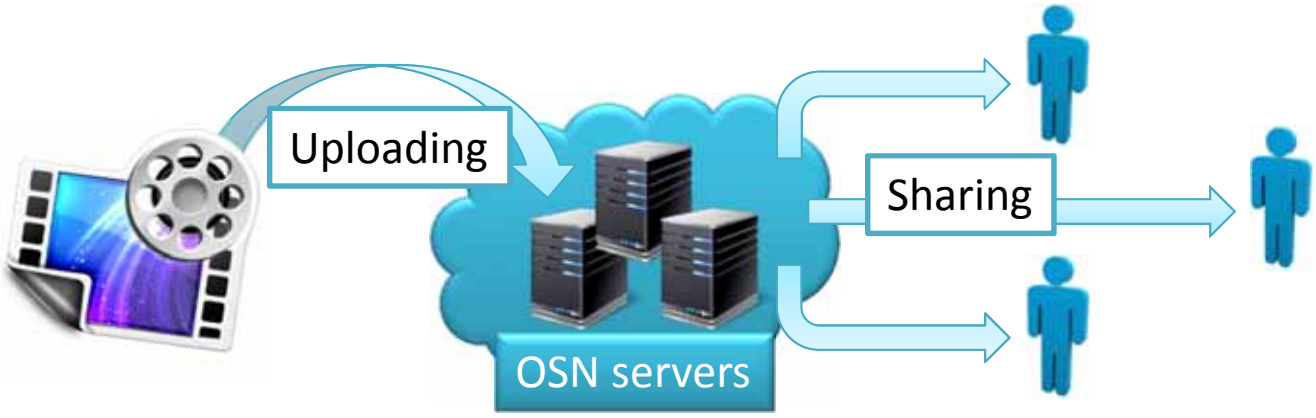


Scenario: Social Networks

Widespread use of **Online Social Networks** (**OSNs**)

- Creating relationships between users
- Interaction between users
  - Message exchanging, photo tagging, etc.
- **User-generated content sharing**

Sensitive issue: users **lose** control on resources when uploaded on OSNs



Challenges

Resource sharing

- **Middleware** solution allowing to **share content and services** in a **peer-to-peer** way while **fully preserving content ownership**
- Content sharing based on legacy protocols such as HTTP and UPnP

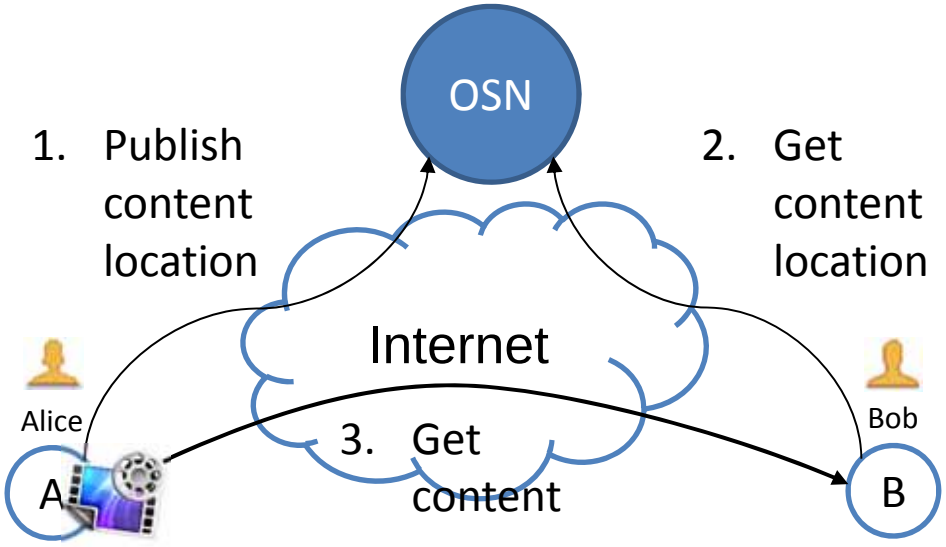
Visibility Filtering

- Resource filtering system based on relationships
- **Issue**: OSN relationship does not allow to discriminate among friends
- **Social Relationship Tightness evaluation** to tune/differentiate **access** to shared **resources**

Resource Sharing

Resource sharing **without centralized servers**

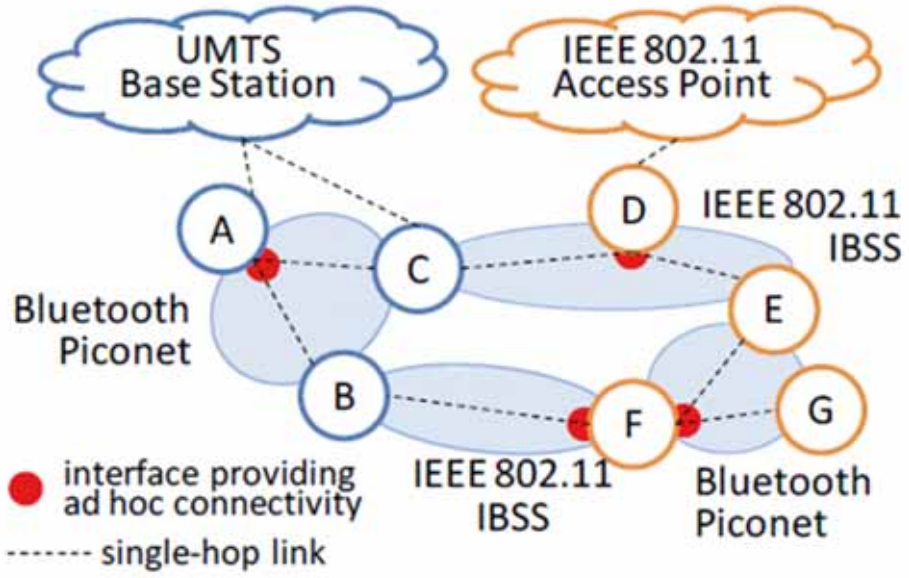
- OSN only to advertise the new content
- Resources sent from storing device to requesting one
- **Resource ownership maintained by resource owner**



Real Ad-Hoc Multi-hop Peer-to-peer (RAMP) middleware

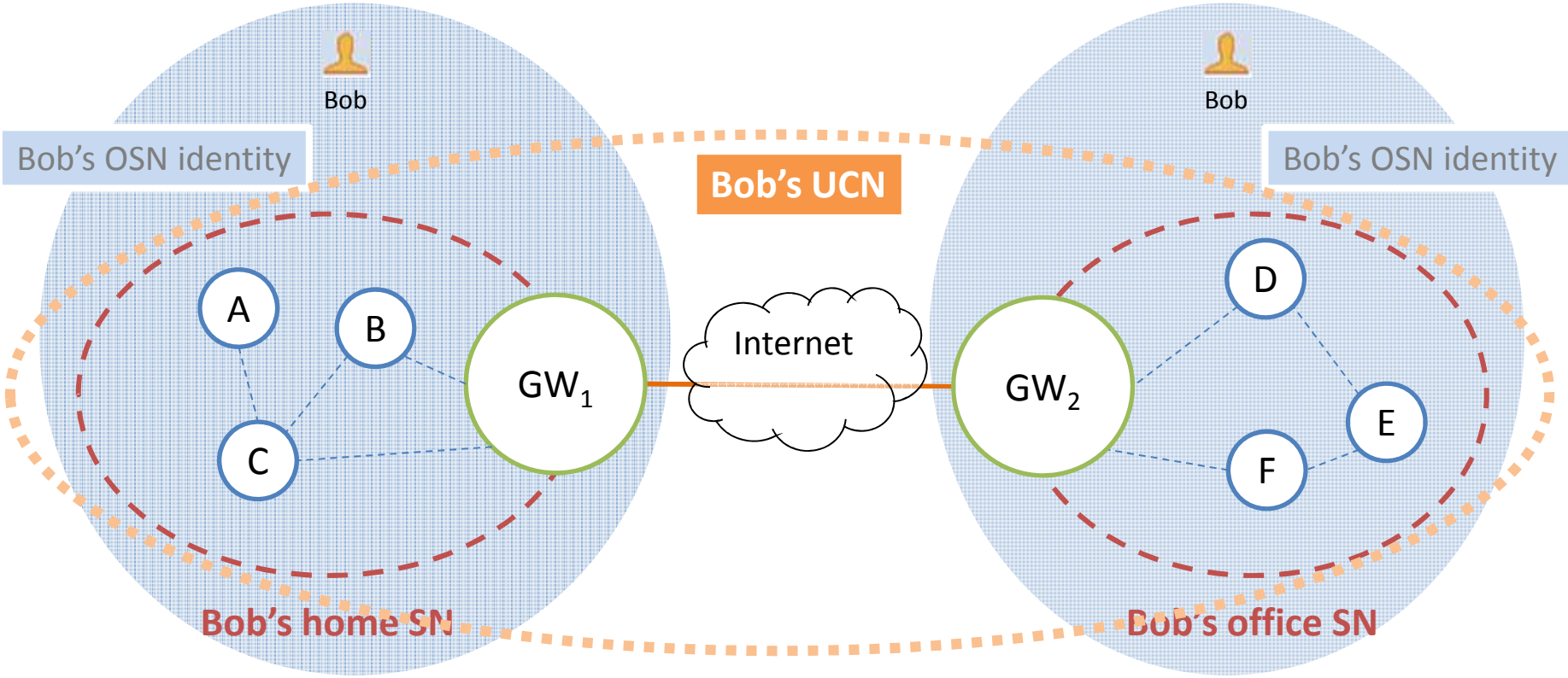
Automatic creation of **Spontaneous Networks (SNs)**

- **Impromptu** interconnection of mobile and fixed nodes
- **Node cooperation** (single/multi-hop connectivity, P2P services)
- Example: node A interacts with node E via intermediate nodes C and D



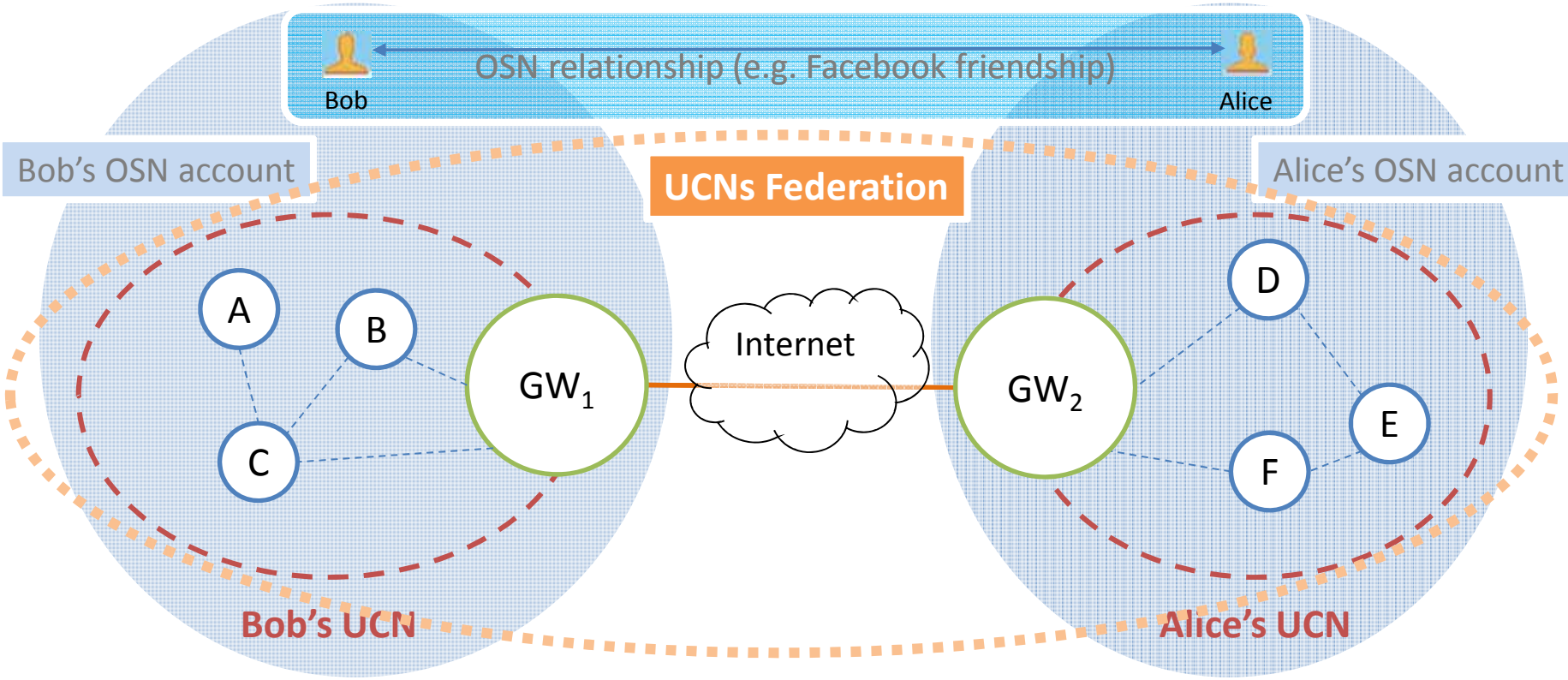
RAMP: User Centered Network (UCN)

Automatic creation of **User Centered Networks (UCNs)** based on **OSN identities**



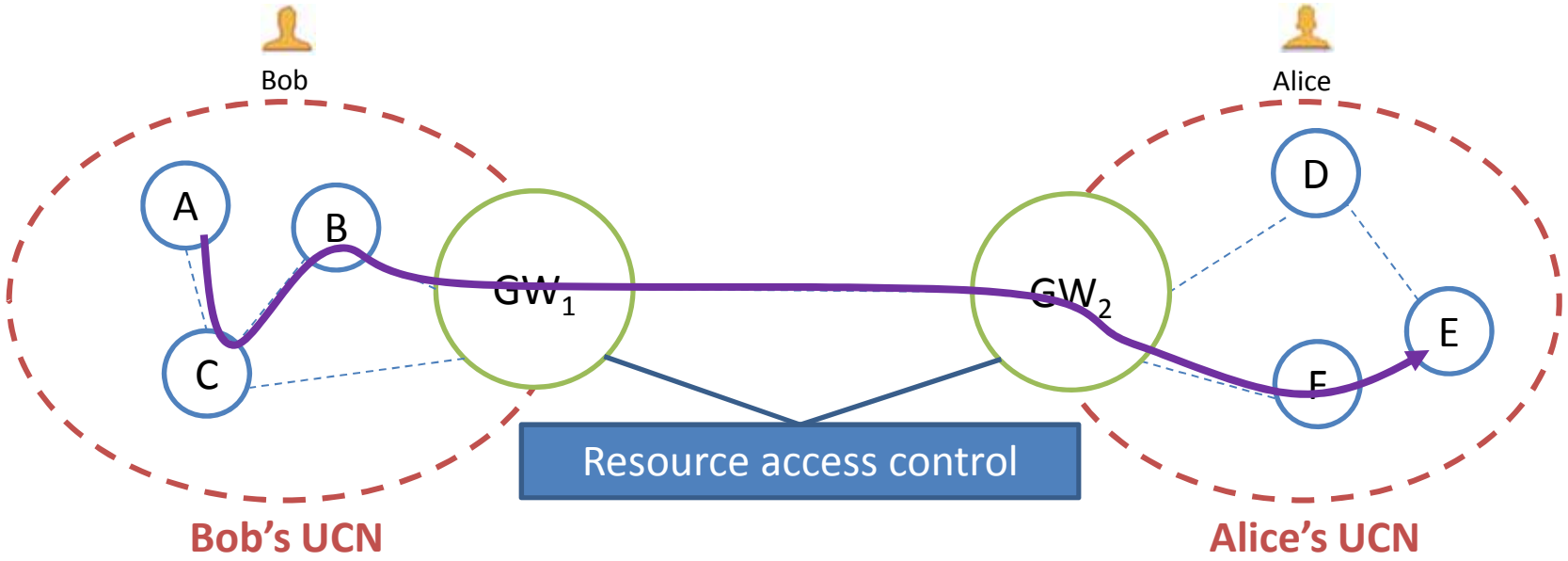
RAMP: Federation of UCNs

- **Home to home** resource sharing
- **Dynamic federation** of **UCNs** based on social relationships



Filtering System

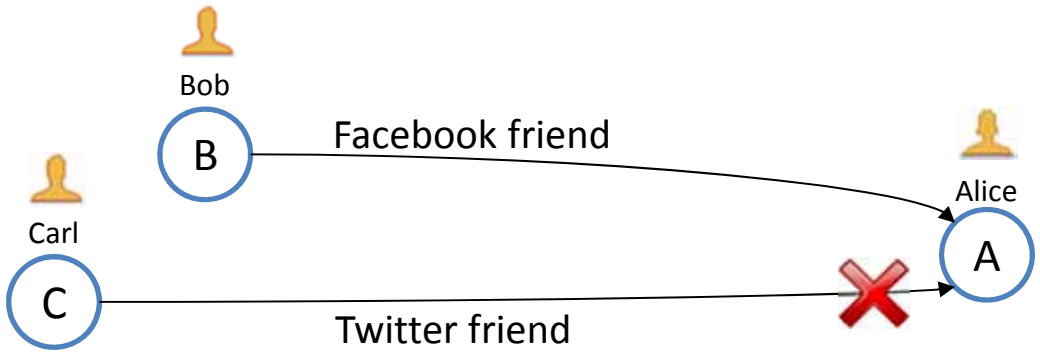
- Filtering system to **control access** to resources
- E.g. Bob and Alice are friends on Facebook; node A of Bob requests a resource to node E of Alice: requests will be accepted or denied



Current Filtering System: limitations

Very **coarse grained** filtering

- Checking **only the relationship type** (e.g. Facebook relationship, Twitter relationship)
- E.g. Alice specifies a rule for Facebook relationships: that rule will be applied to all requests coming from her Facebook friends

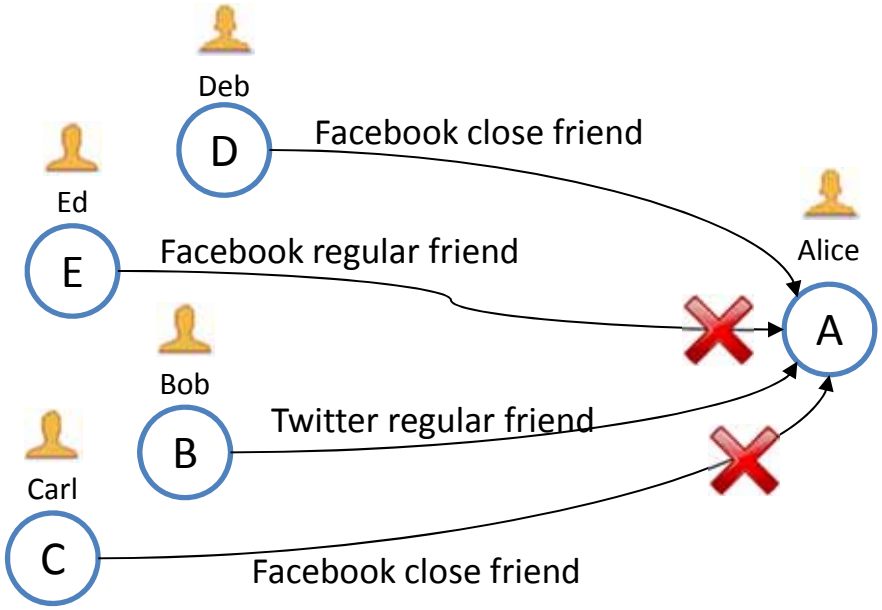


Rules

- **Facebook** friends: allowed
- **Twitter** friends: denied

New Filtering System: insights

- **Idea**: if two users are close friends, it is likely they are willing to share services and resources one another
- Close friends should be able to access more resources
- Filtering rules based on **relationship tightness** or specific **friend ID**

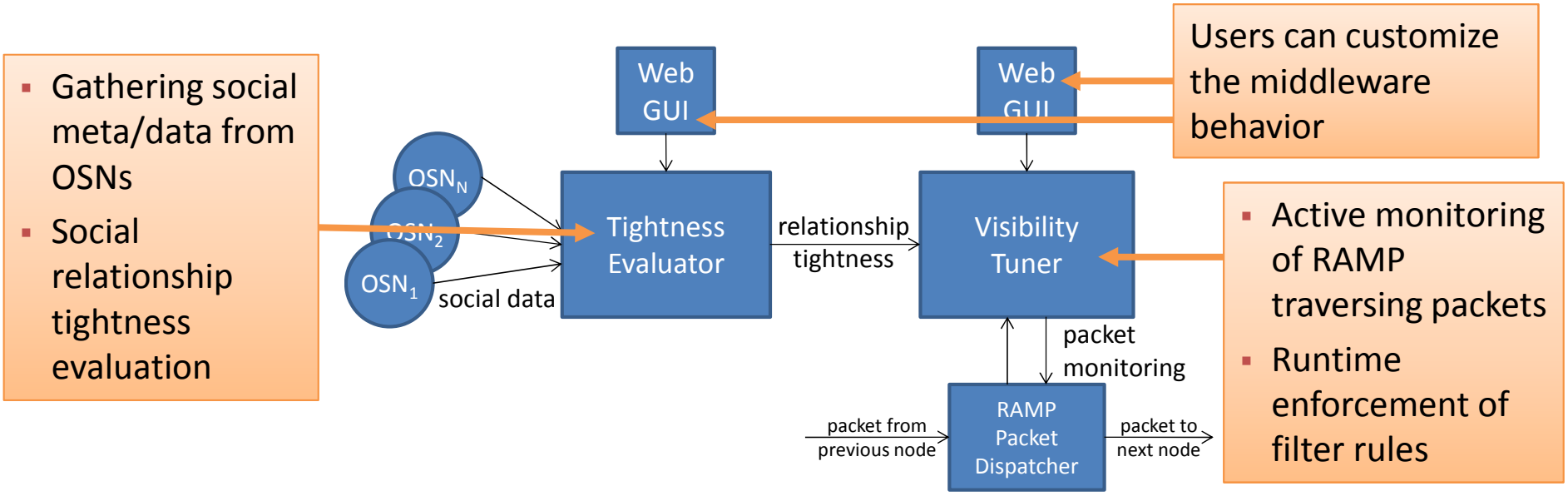


Rules

- **Twitter** friends: allowed
- **Facebook close** friends: allowed
- **Facebook regular** friends: denied
- **Carl**: denied

RAMP: new Filtering System

- Dynamically evaluated **relationship tightness**
- Well-defined grammar to specify **high-level filtering rules**
- Runtime **visibility** tuning of shared resources



Tightness Evaluator

- **Idea**: if two users interact very frequently on a OSN, it is likely that their relationship is tight
- Three tightness categories: "**tight**", "**regular**", "**loose**"

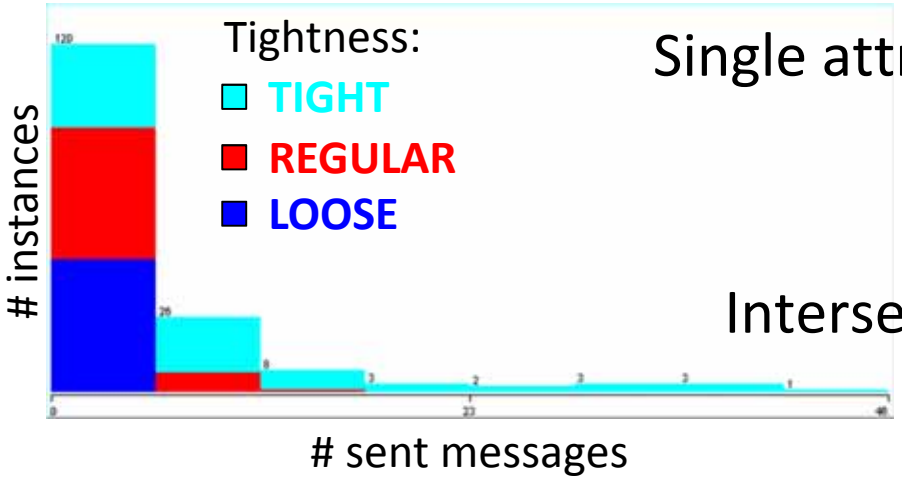
E.g. Alice and Bob have exchanged

- more than 50 messages => tight
- between 5 and 50 messages => regular
- less than 5 messages => loose

Tightness Evaluator

- Users typically exploit **OSN interaction tools** in different ways (private/public message exchanging, quotes in texts, photos, videos, etc.)
  - E.g. Alice exploits only private messages to interact with her tight friends, while Bob is used to exploit public posts
- **Survey** (20 Facebook users, 10 Twitter users) to identify useful data and build to **decision model**
- **Weka** to analyze gathered data

Tightness Evaluator



Single attribute is not enough to classify relationships

Intersection of different attributes

Five most significant Facebook attributes

1. # of messages friend has sent to the user
2. # of messages user has sent to the friend
3. # of user's photos friend is tagged in
4. # of user's posts friend is tagged in
5. # of posts friend has sent to the system user

Tightness Evaluator

- **Default Decision Tree Model** useful for the first evaluation
- Users can **improve** the Decision Tree Model specifying the tightness of (part of) their relationships

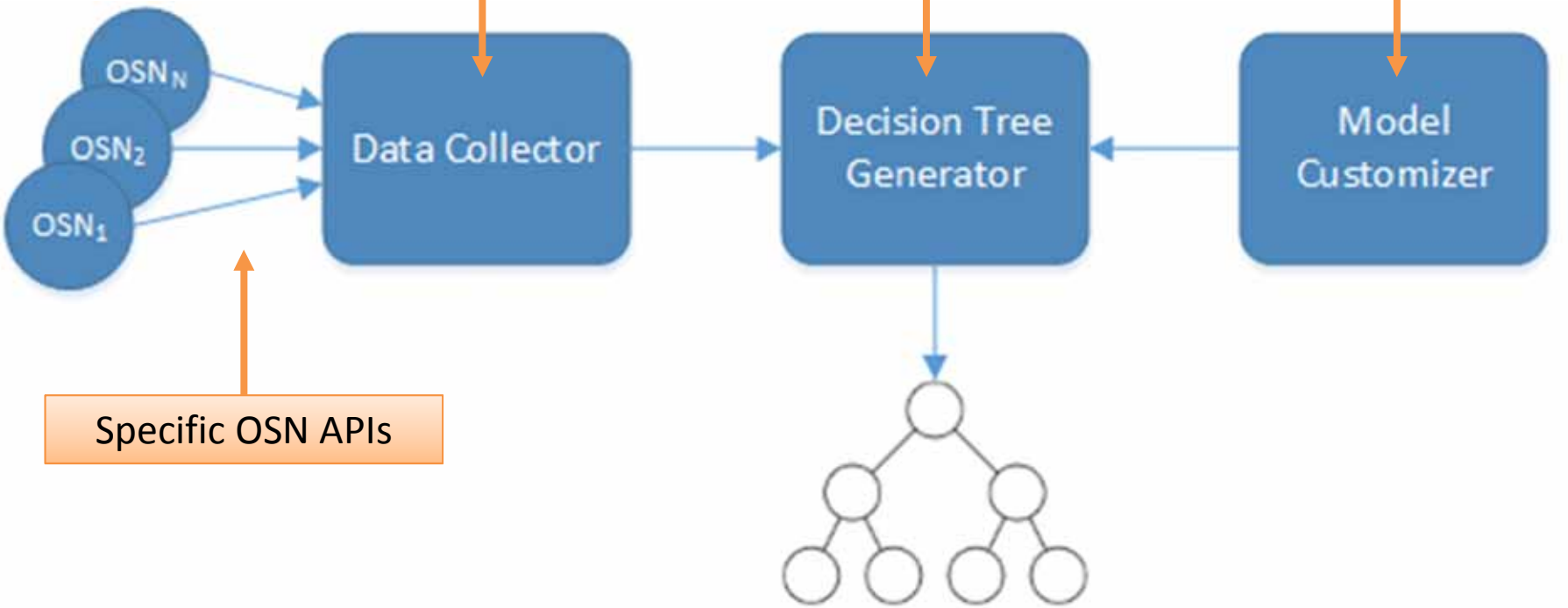
```
sentMessagesRate <= 0.045
|   sentTweetsOnReceivedRate <= 0.007
|   |   sentTweetsOnTotalSentRate <= 0.047
|   |   |   commonFollowingRate <= 0.144
|   |   |   |   mentionTweetsRate <= 0.083
|   |   |   |   |   commonFollowersRate <= 0.098: LOOSE
|   |   |   |   |   commonFollowersRate > 0.098: REGULAR
|   |   |   |   mentionTweetsRate > 0.083: REGULAR
|   |   |   commonFollowingRate > 0.144: REGULAR
|   |   sentTweetsOnTotalSentRate > 0.047: REGULAR
|   sentTweetsOnReceivedRate > 0.007: REGULAR
sentMessagesRate > 0.045
|   receivedMessagesRate <= 0: REGULAR
|   receivedMessagesRate > 0: TIGHT
```

Tightness Evaluator: implementation insights

- Social meta/data gathered from OSNs
- Producing suitable information to support Decision Tree Generator
- Periodic data updating

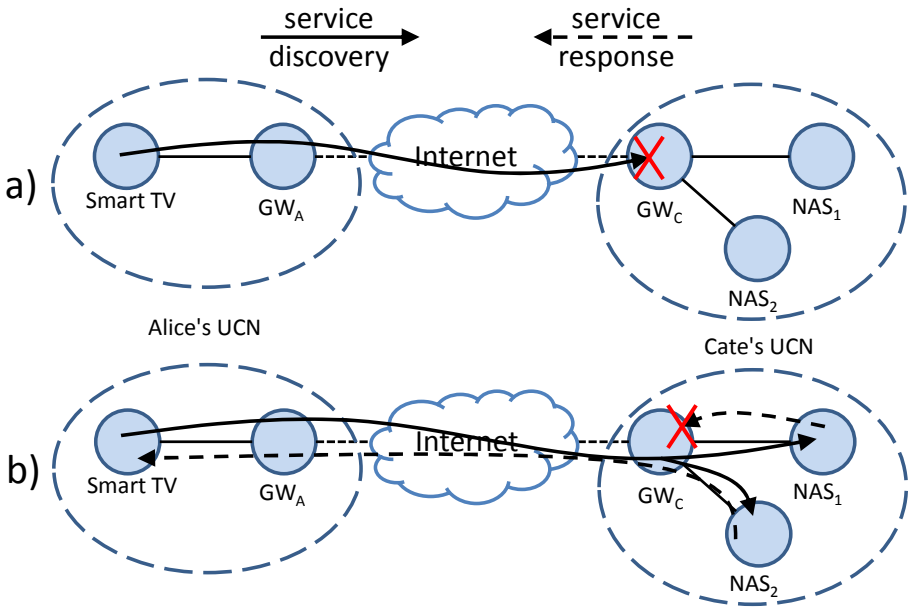
- Decision tree based on gathered information
- J48 (C4.5) algorithm
- Weka APIs to perform classification

- Usage pattern computation to customize the decision tree
- User's direct customization



Visibility Tuner: Packet Filters

- Packet monitoring and runtime enforcement of visibility rules
- **Discovery Filter**: to hide/expose nodes and services
- **Browse Filter**: to tune the visibility of shared contents
- **Action Filter**: to tune the access to supported features and resources



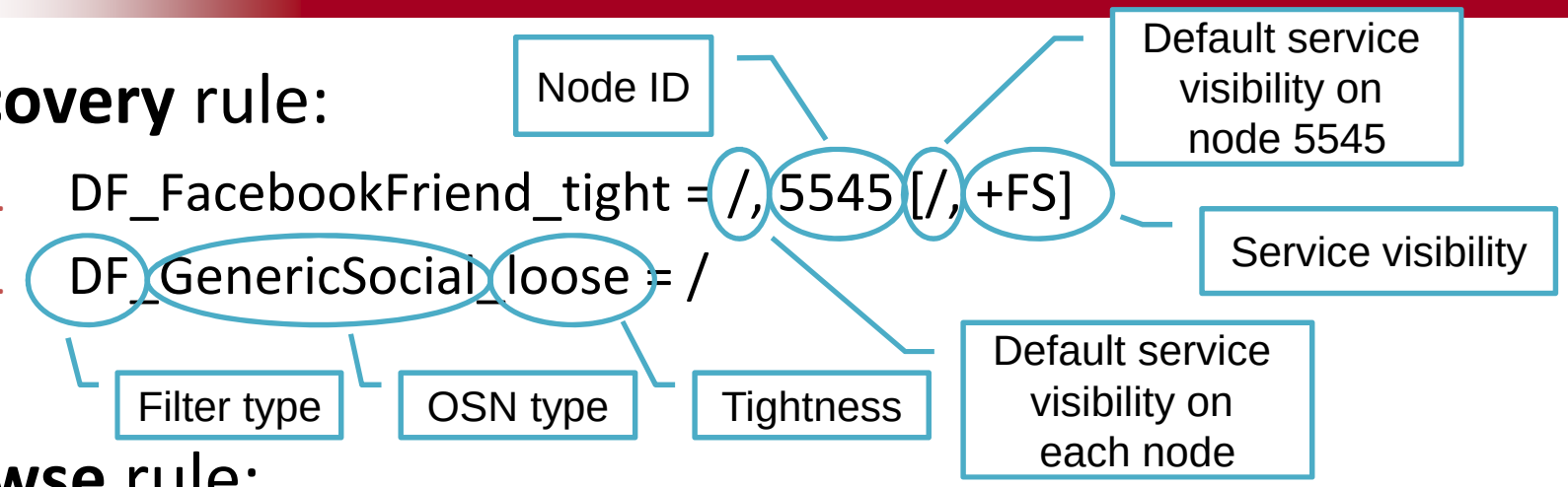
Ingress packet filtering (dropping a request)

Egress packet filtering (selective forwarding of only replies coming from given devices)

Visibility Tuner: Rules grammar

Discovery rule:

1. DF_FacebookFriend_tight = /, 5545 [/, +FS]
2. DF_GenericSocial_loose = /



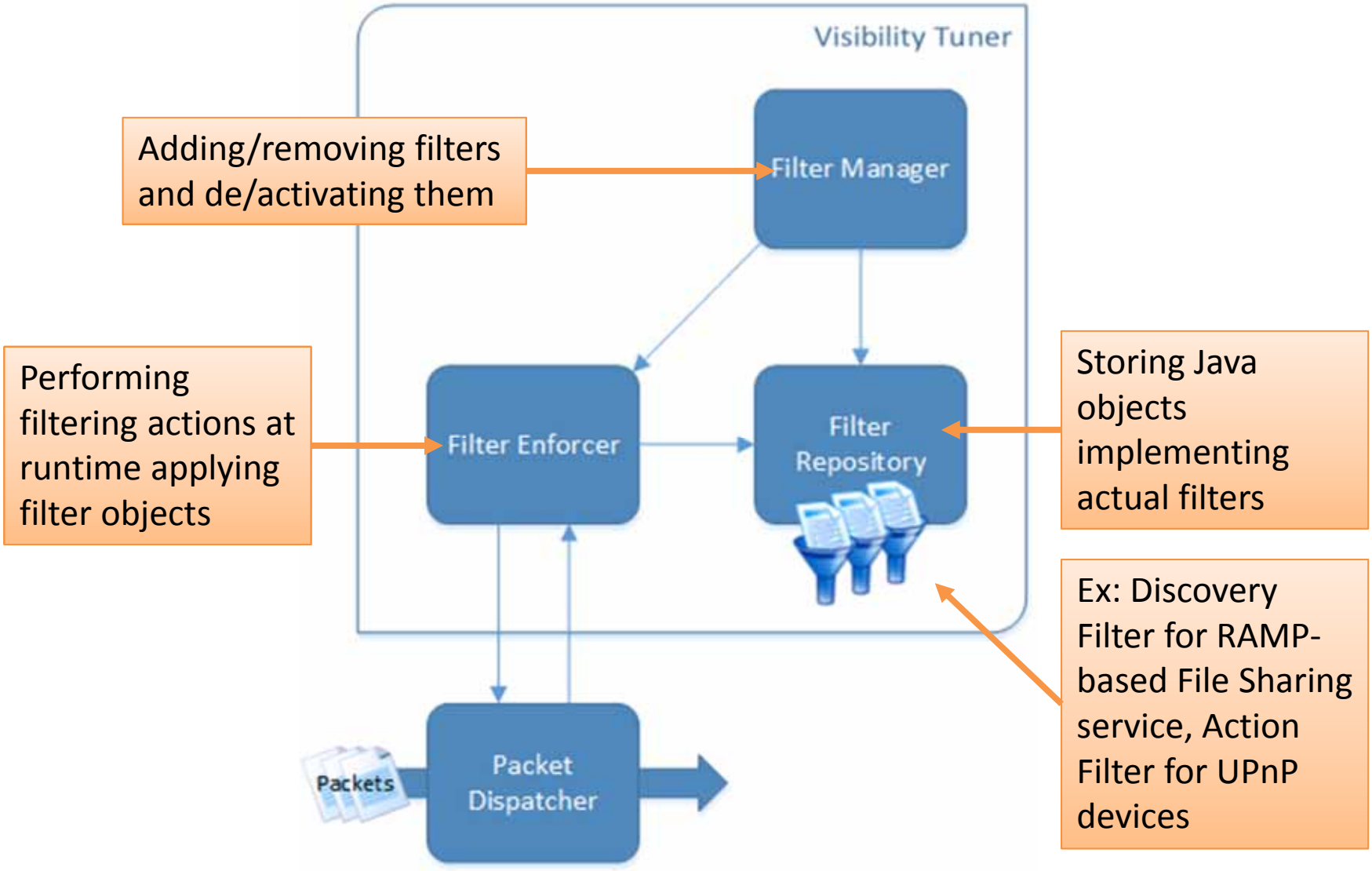
Browse rule:

3. BF_TwitterFriend_tight = *
4. BF_TwitterFriend_57349 = /, 5545 [/, FS ".*?\.(mp3|divx)$"]

Action rule:

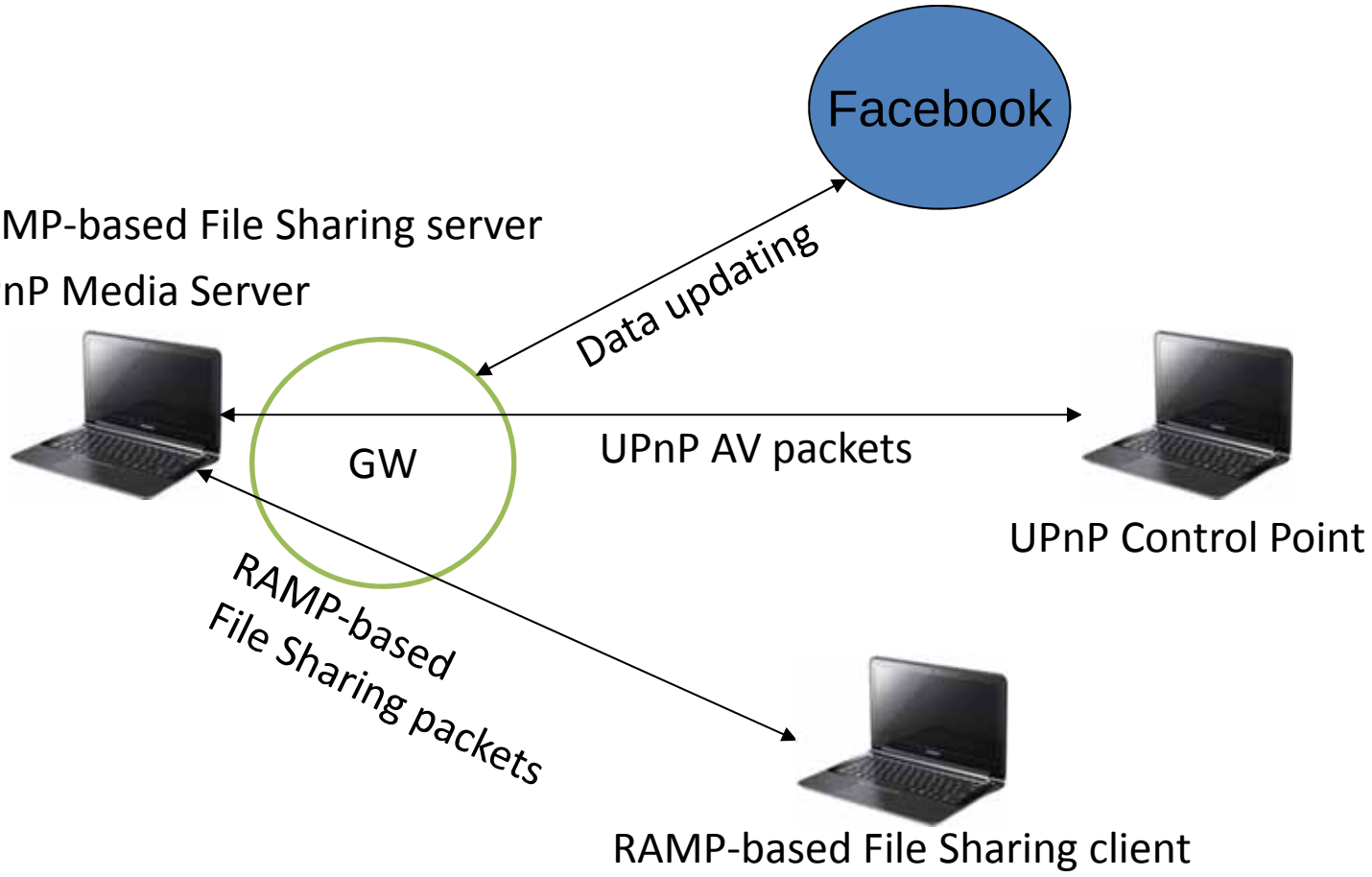
5. AF_FacebookFriend_regular = /, 5545 [/, FS [/, +get]]
6. AF_Generic = *, 124878 [/, Light [/, +SwitchPower]]

Visibility Tuner: implementation insights

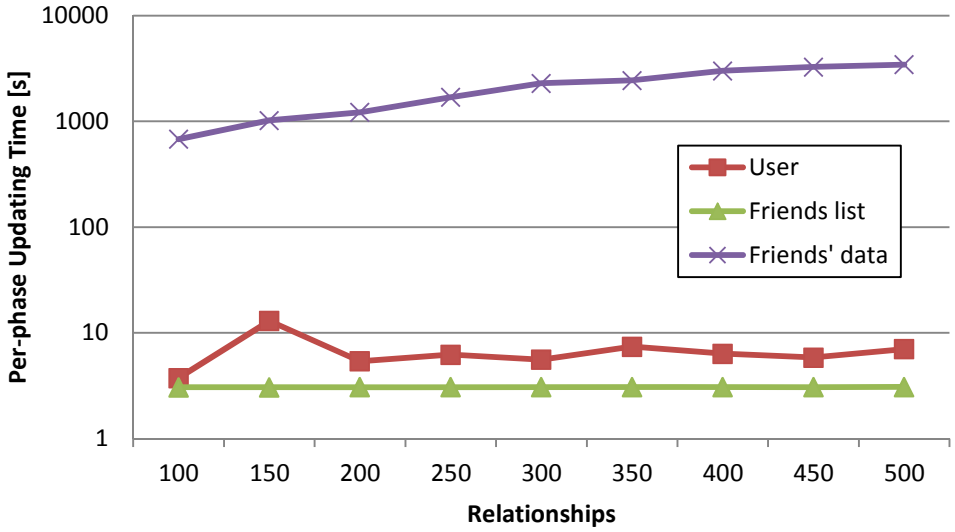


Experimental results: testbed

- Required times to evaluate tightness
- Required times to filter packets

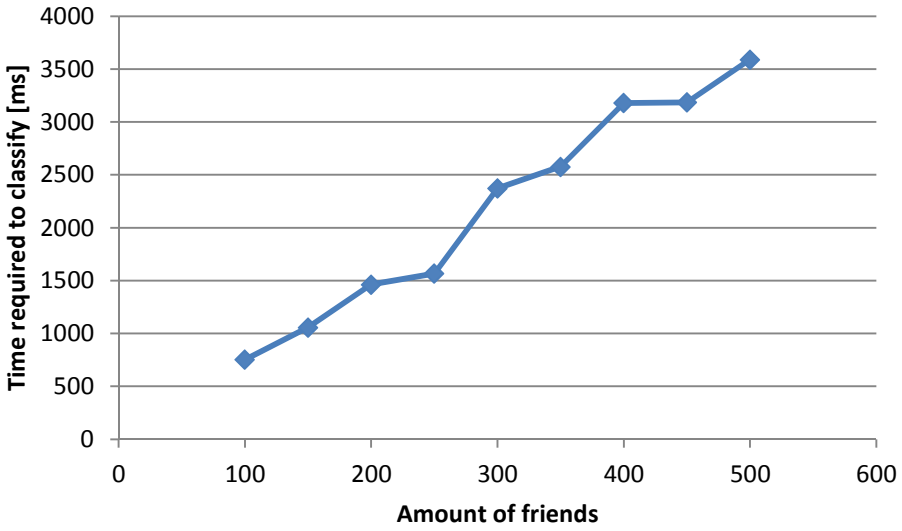


Experimental results: Tightness Evaluator

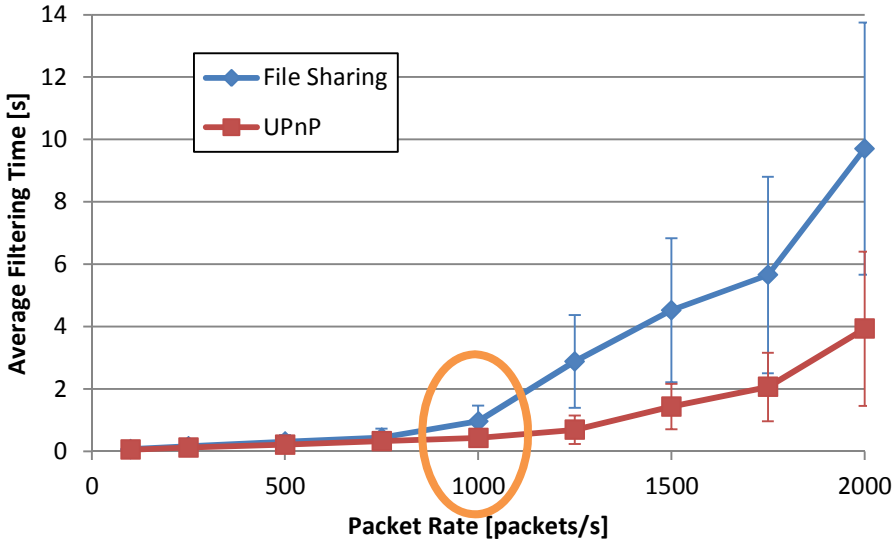


- Required time to process **User**, **Friend List** and **Friend Data**
- **Friend Data sub-phase** greatly influences the total time

Required time to **classify relationships** linearly grows with the amount of friends

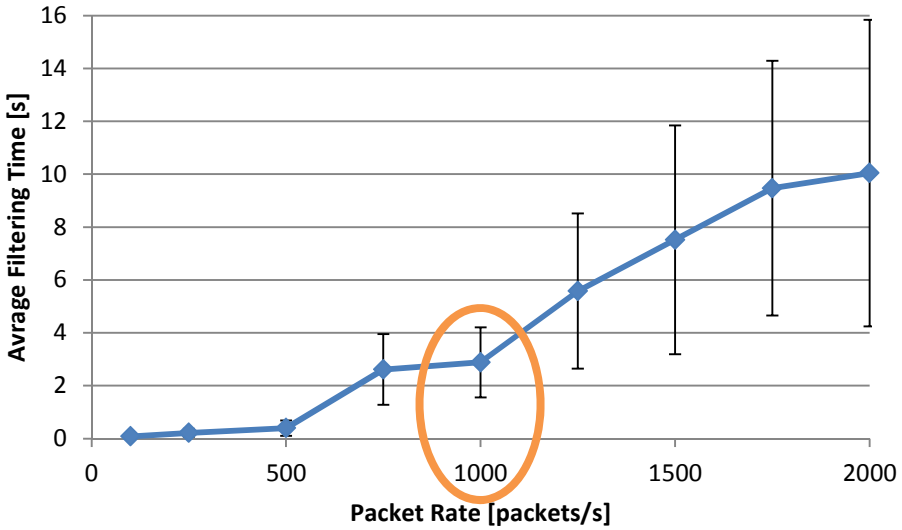


Experimental results: Visibility Tuner



Filtering of **ingress** "**browse**" request packets (File Sharing 53 bytes; UPnP 52 bytes)

- Filtering of **egress** "**browse**" packets (responses to "browse" requests; 60 bytes) for the **File Sharing** service
- Parsing and modification of responses ➡ Almost linear growing with the packet rate



Conclusions and ongoing work

- **Automatic creation** of **SNs** and **UCNs**
- **Federation of UCNs** based on **Social Relationships**
- **Automatic** Social Relationship **tightness evaluation**
- **Feature and resource visibility tuning** based on Social Relationship Tightness (⇨ Packet Filters)

Ongoing work

- GUI to facilitate rules definition
- Support to NAT-T environment
- Hybrid cloud-based deployment to improve availability

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THANKS FOR YOUR ATTENTION

Questions time…

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Stefano Poli

see also

P. Bellavista, C. Giannelli , L. Iannario, L. Goix, C. Venezia:
"Peer-to-peer Content Sharing Based on Social Identities and Relationships",
IEEE Internet Computing (accepted for publication)

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