# *PRIVACY IN EVOLVING SOCIAL NETWORKS*

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twitter - @raparuldo

*NWPT 2015*

**DataBIN**
*Data-driven Secure Business Intelligence*

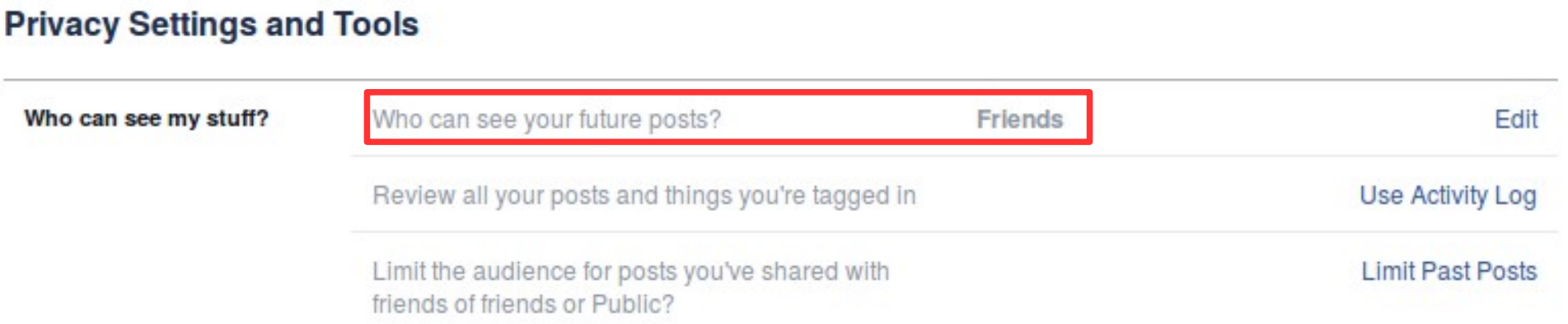

CHALMERS


UNIVERSITY OF GOTHENBURG

# FACEBOOK PRIVACY SETTINGS

*Imagine you only want your friends to know your location*

# FACEBOOK PRIVACY SETTINGS



# FACEBOOK PRIVACY SETTINGS

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- John's privacy settings

| | | |
|---|---|---|
| Who can see your future posts? | **Friends** | Edit |

- Raúl's privacy settings

| | | |
|---|---|---|
| Who can see your future posts? | **Friends and John's friends** | Edit |
| When you're tagged in a post, who do you want to add to the audience if they aren't already in it? | **Friends** | Edit |

# FACEBOOK PRIVACY SETTINGS


Event for Gothenburg Expats Hosted by [redacted] and 5 others

Join | Maybe | Decline | •••

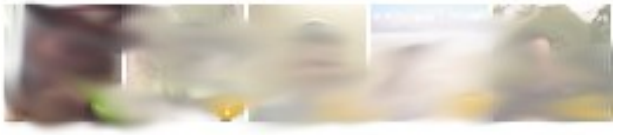
22 May at 18:30
about 2 weeks ago

Jerntorgets Brygghus
Järntorget 4, 41304 Gothenburg

Show Map

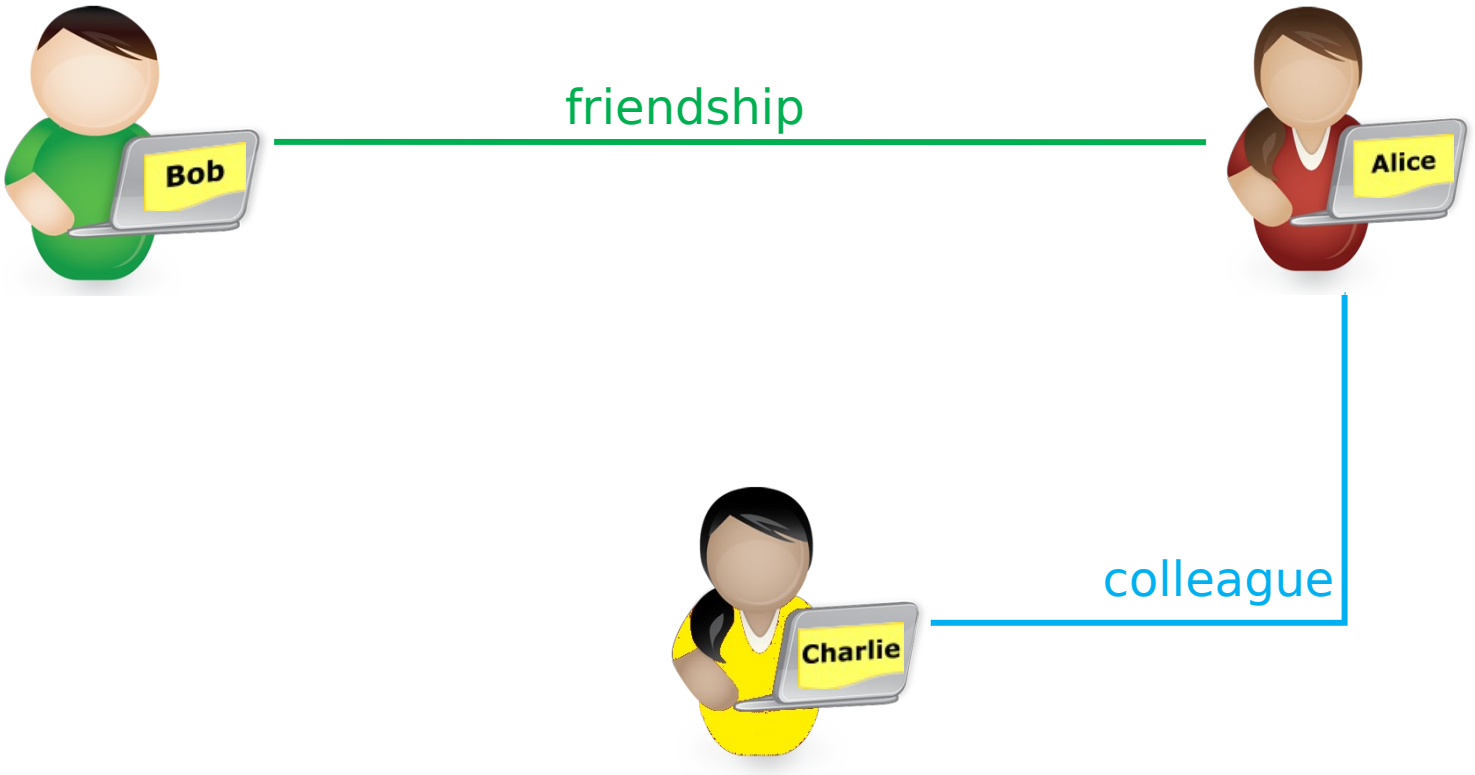
Invited by [redacted]

Join · Maybe · Decline

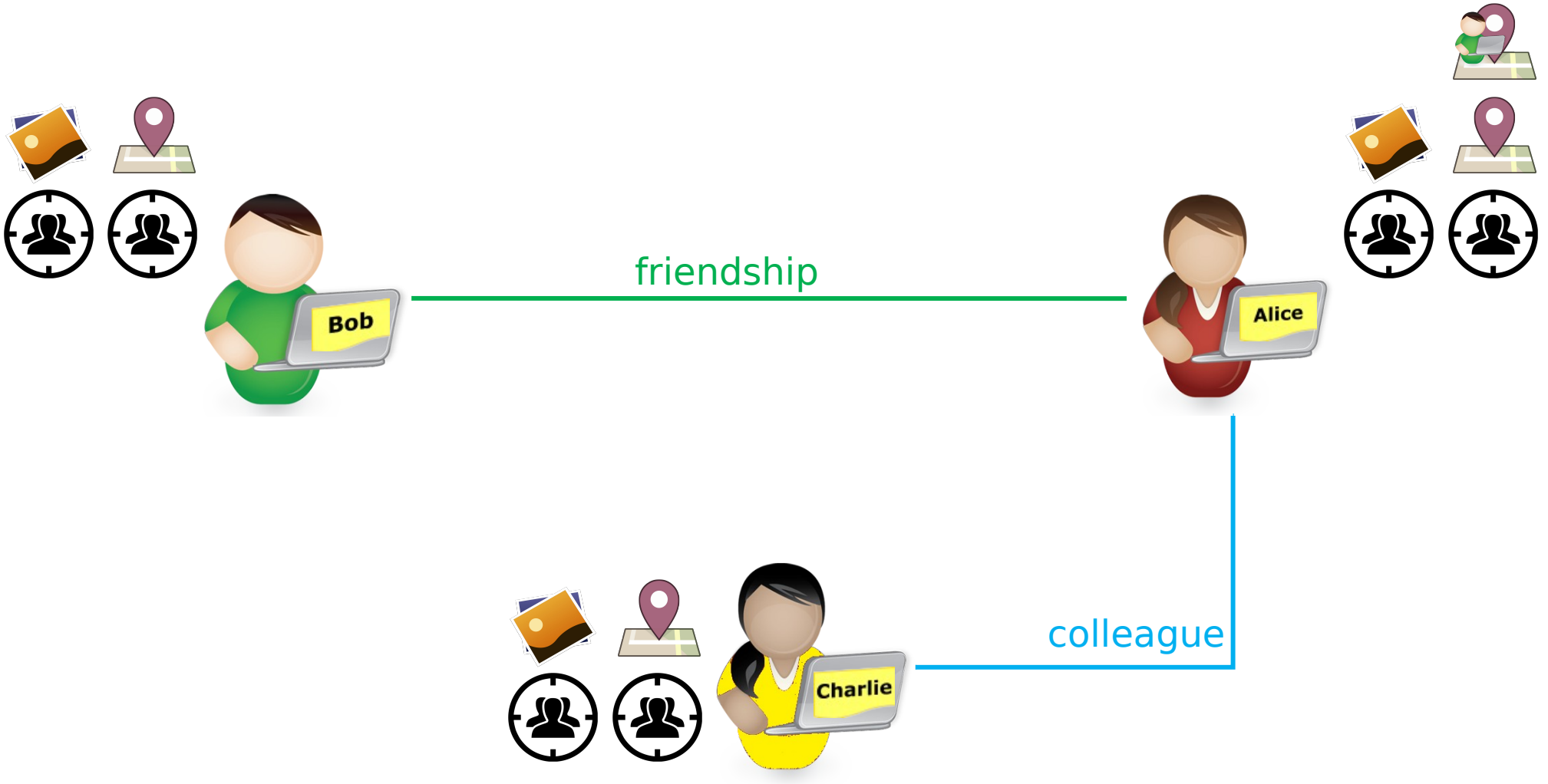


| 36 | 59 | 985 |
|---|---|---|
| went | maybe | invited |

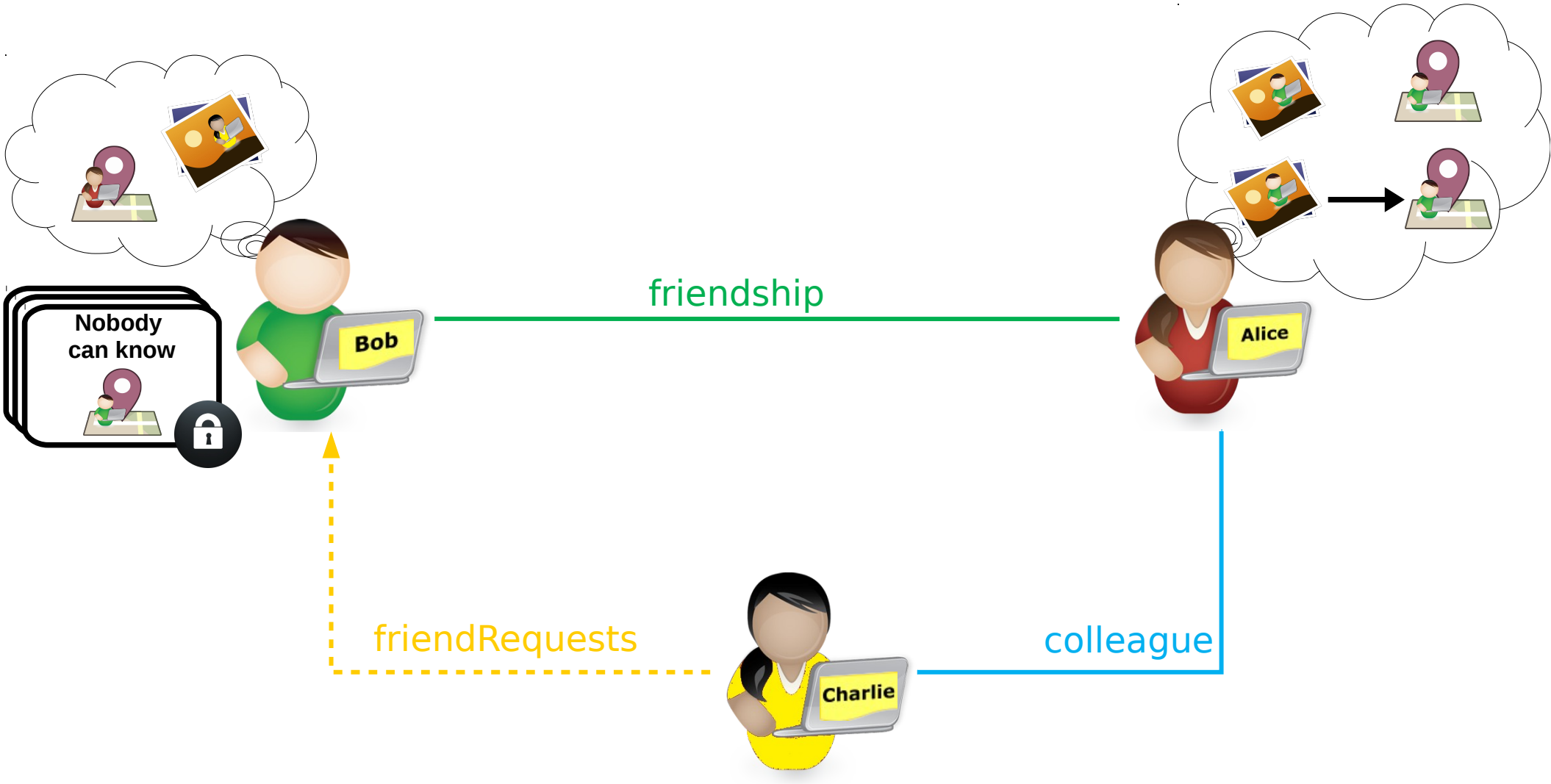
# SOCIAL NETWORK GRAPH



# RELATIONSHIP-BASED ACCESS CONTROL



# SOCIAL NETWORK MODEL



# FORMAL LANGUAGES

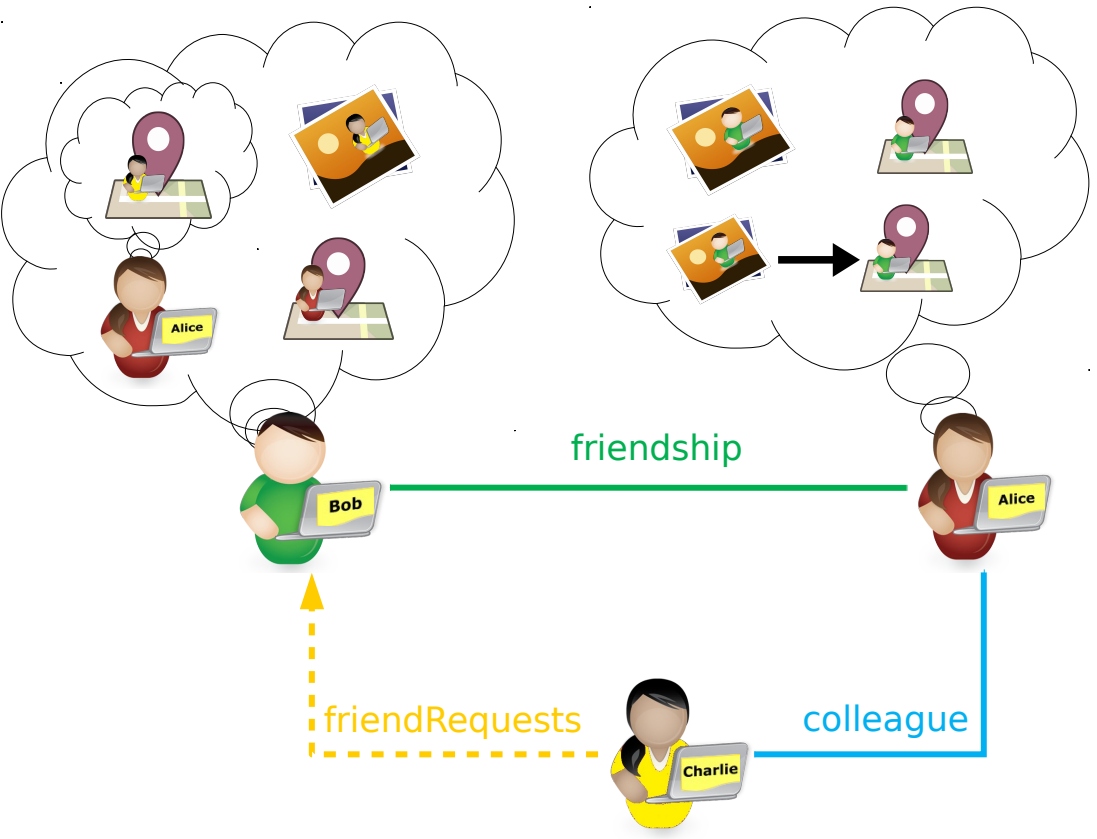
- Knowledge Based Logic - KBL

$$\varphi \ ::= \ p(\vec{t}) \mid c_m(i,j) \mid a_n(i,j) \mid \varphi \wedge \varphi \mid \neg\varphi \mid \forall x.\varphi \mid$$
$$K_i\varphi \mid E_G\varphi \mid S_G\varphi \mid D_G\varphi \mid C_G\varphi$$

- Privacy Policy Language - PPL

$$\delta \ ::= \ \delta \wedge \delta \mid [\![\varphi \Rightarrow \neg\alpha]\!]_i \mid [\![\neg\alpha]\!]_i$$

# SATISFIABILITY - KBL




- Bob knows Alice's location

$$\models K_{Bob}$$ 

- Bob knows that Alice knows Charlie's location

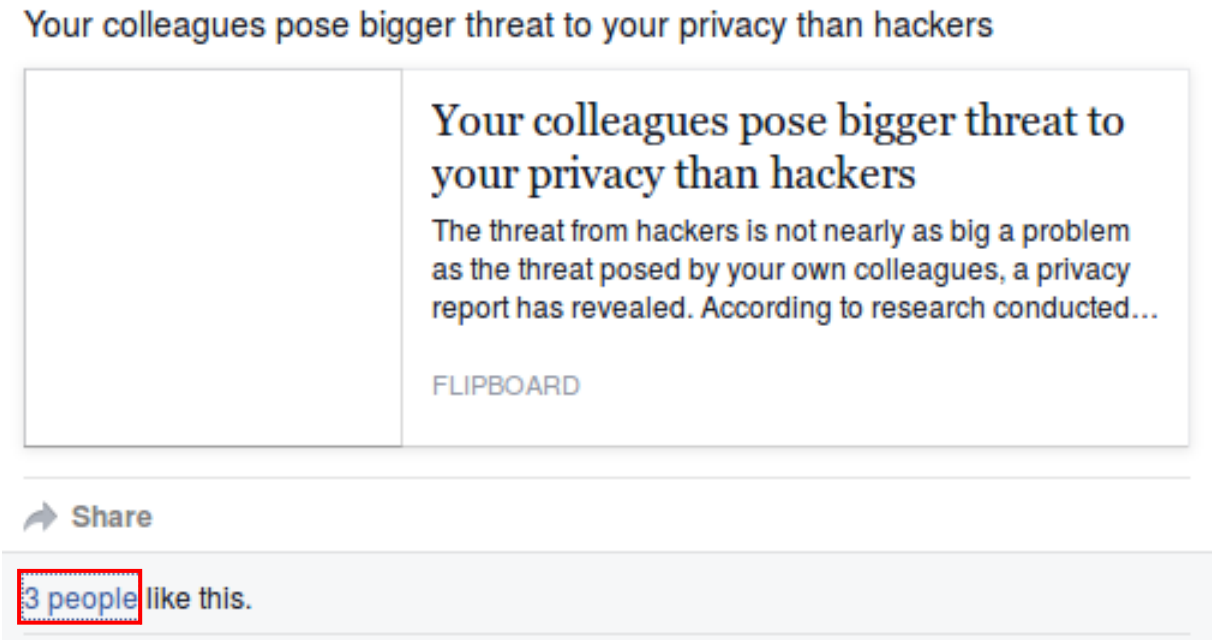
$$\models K_{Bob} K_{Alice}$$ 

- Alice and Bob know Bob's location

$$\models \neg E_{\{Alice, Bob\}}$$ 

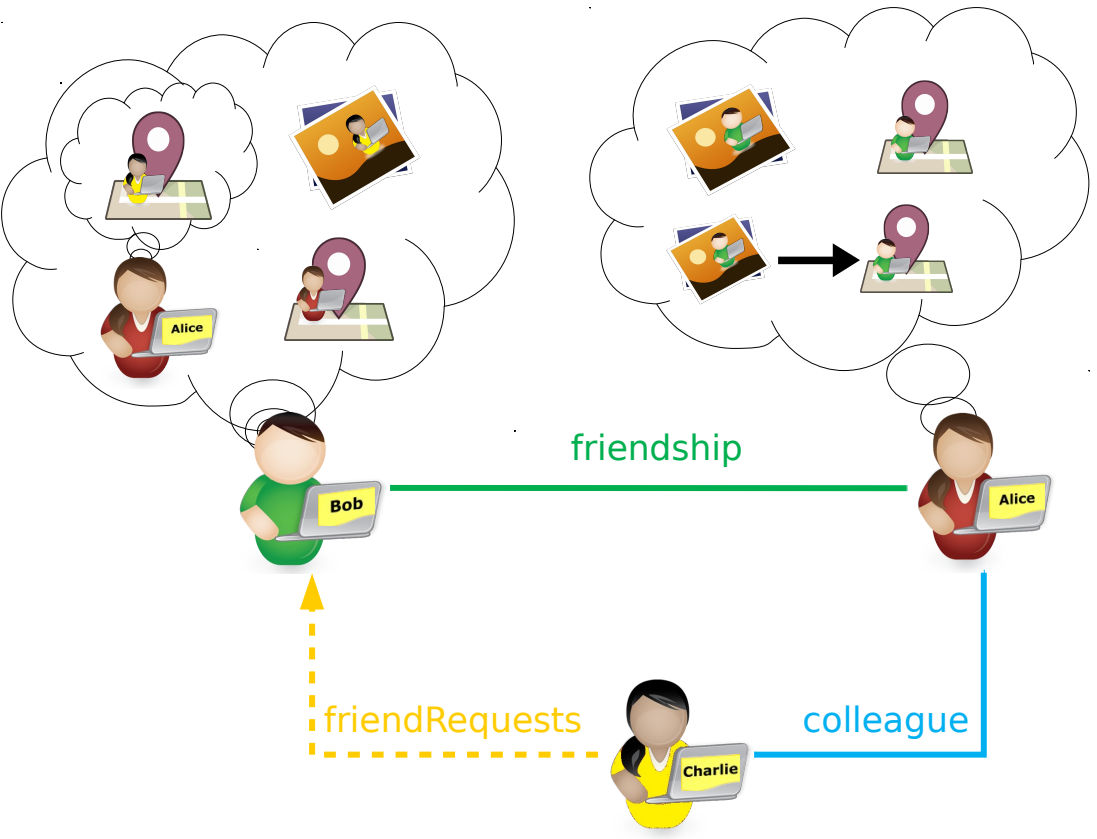
# EXAMPLES - KBL

- If I know a post, I know everyone who liked it




$$\forall x.\forall u.\forall i.\forall \eta\left(K_x\, post\left(\eta,u\right)\wedge K_i\, like\left(i,u,\eta\right)\Rightarrow K_x\, like\left(i,u,\eta\right)\right)$$

# CONFORMANCE - PPL




- Nobody can know Bob's location

$$\models_C [\![ \neg S_{Ag \setminus \{Bob\}} \; \text{  } \; ]\!]_{Bob}$$

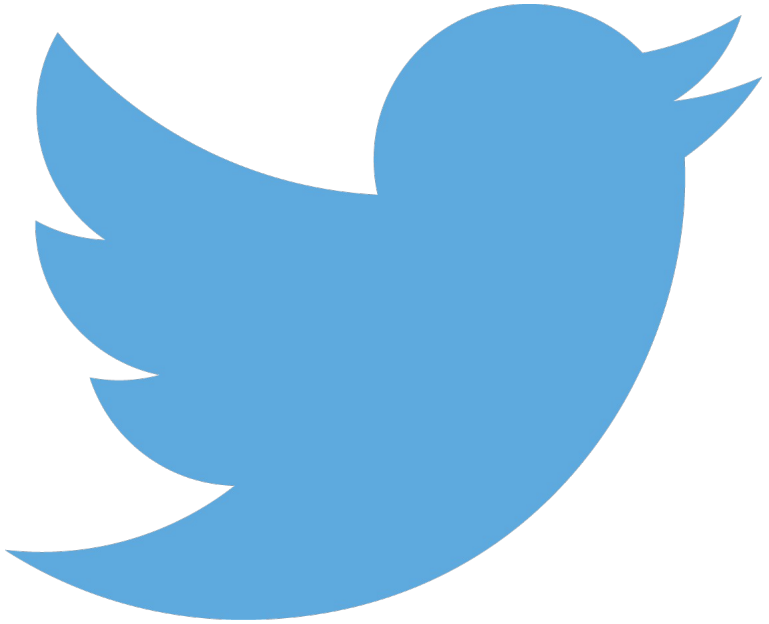
where *Ag = {Alice, Bob, Charlie}*

# EXAMPLES – PPL

- Only people who liked at least one of Bob's posts can join his event

$$\forall i . \forall \eta . [\![ \neg K_{Bob} like(i, Bob, \eta) \Rightarrow \neg P_i^{Bob} \, joinEvent ]\!]_{Bob}$$

# INSTANTIATIONS



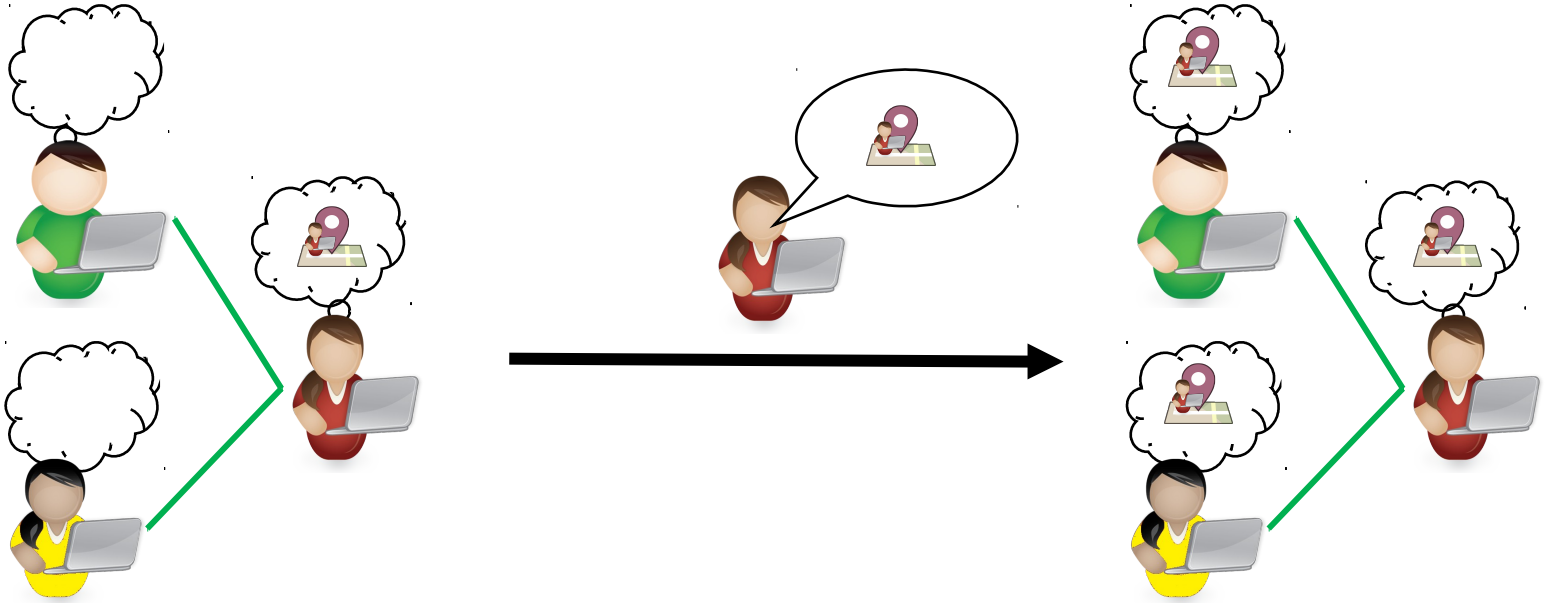
# EVENTS & RULES - FACEBOOK

$$EVT_{Facebook} = \{ post, share, like, sendFriendRequest, ... \}$$

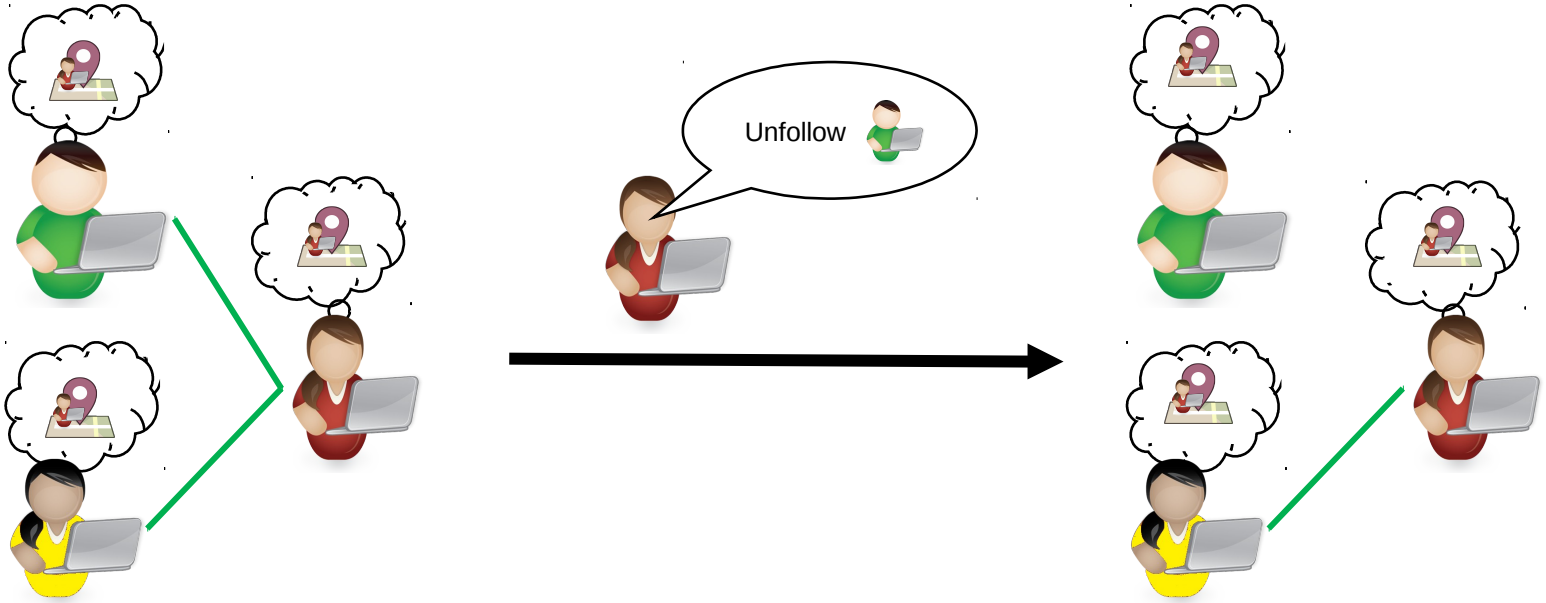
***share(Bob, post(Alice,η), Au)***

$$\frac{post(Alice,\eta) \in KB_{Bob} \quad (Alice, Bob) \in A_{sharePosts} \quad \forall\, j \in Au \quad KB'_j = KB_j \cup \{ C_{Au}\, share(Bob, Alice, \eta) \}}{\langle \_, \{\{A_i\}_{i\in\Sigma}, \_\}, KB, \_, \_ \rangle \xrightarrow{share(bob,\, post(Alice,\eta),\, Au)} \langle \_, \{\{A_i\}_{i\in\Sigma}, \_\}, KB', \_, \_ \rangle}$$

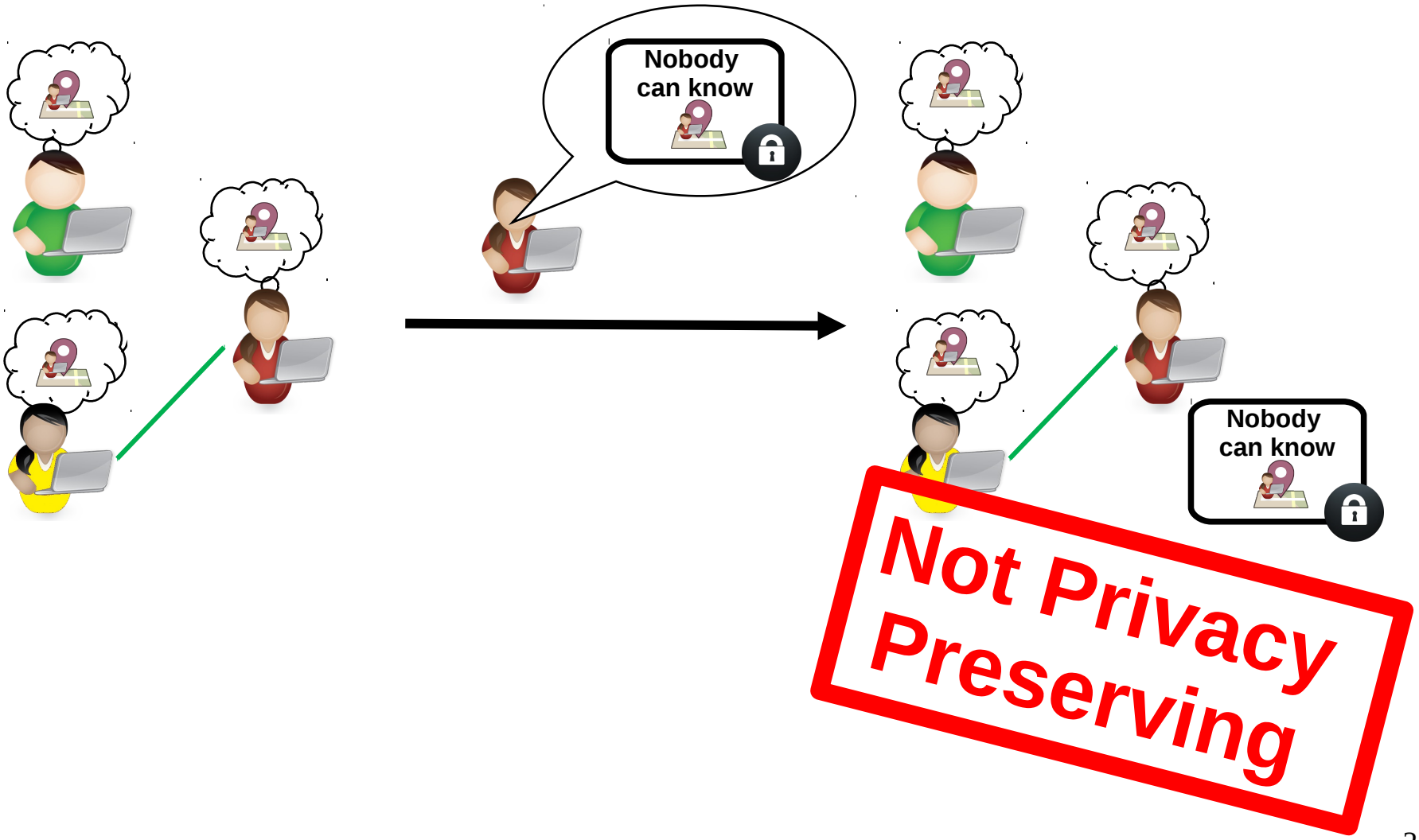
# DYNAMICS - EPISTEMIC



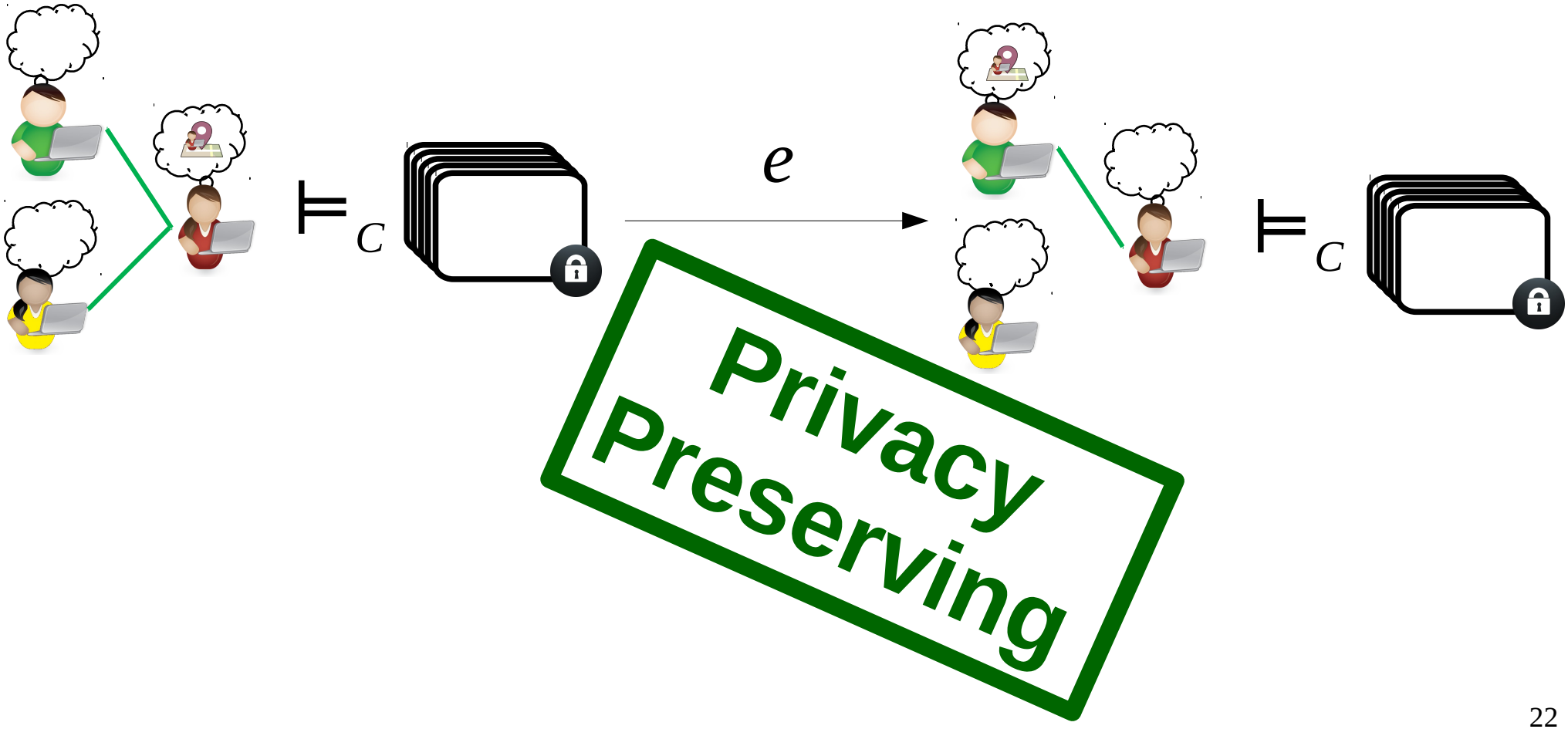
# DYNAMICS - TOPOLOGICAL



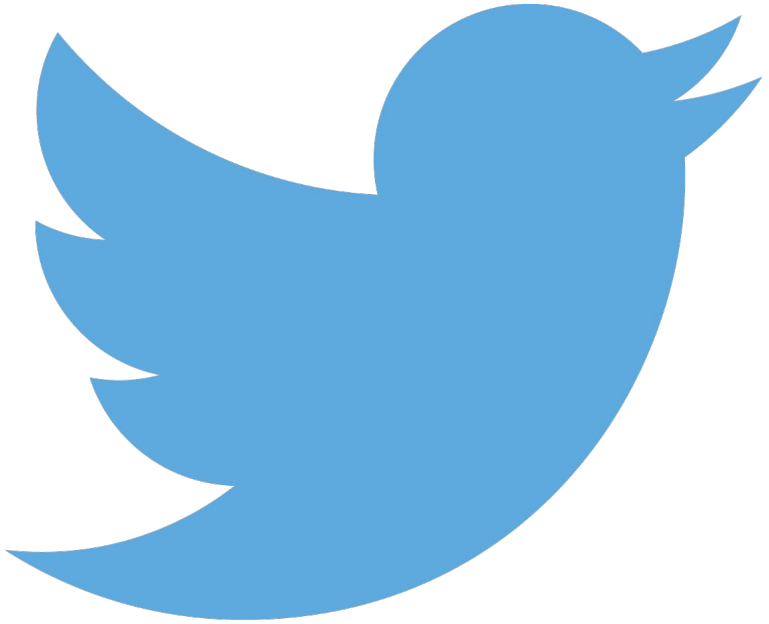
# DYNAMICS - POLICY



# DOES A SN PRESERVE PRIVACY?



# PRIVACY IN REAL SOCIAL NETWORKS




diaspora*

# REAL-TIME

- Time-stamp all the elements of the framework
- Specify intervals of time in privacy policies

$$[\![ \neg K_{boss(i)}\, location(i) ]\!]_i^{[18:00,03:00,Daily]}$$

# SUMMARY

- Formal Privacy Policy Framework (SEFM 2014)
  - Social Network Model - SN
  - Knowledge Based Logic – KBL
  - Privacy Policy Language – PPL
  - Instantiations
- Evolution of SNs (*submitted* to POST 2016)
  - Formal definition
  - Privacy preservation
  - Applied to Facebook and Twitter
- Current and Future work
  - Relation to Kripke models
  - Implementation in Diaspora*
  - Adding Real-time


תודה
Dankie
Gracias
Спасибо
شكراً
Merci
Takk
Köszönjük
Terima kasih
Grazie
Dziękujemy
Dėkojame
Ďakujeme
Vielen Dank
Paldies
Kiitos
Täname teid
谢谢
Thank You
Tak
感謝您
Obrigado
Teşekkür Ederiz
감사합니다
Σας ευχαριστούμε
ขอบคุณ
Bedankt
Děkujeme vám
ありがとうございます
Tack