Bootstrapping Privacy Compliance in Big Data Systems

Giulia Fanti
Based on slides by Anupam Datta
CMU

Fall 2019

Administrative

- HW2 will be released this week
  - Stay tuned
- How did Docker recitation go?

Quiz on Canvas

- Take the quiz on your laptops/tablets/devices
- Please do not look back at your notes
  - these quizzes do not affect your grade, so you should just try to do your best without gaming the grade
- 10 minutes

Today's Lecture

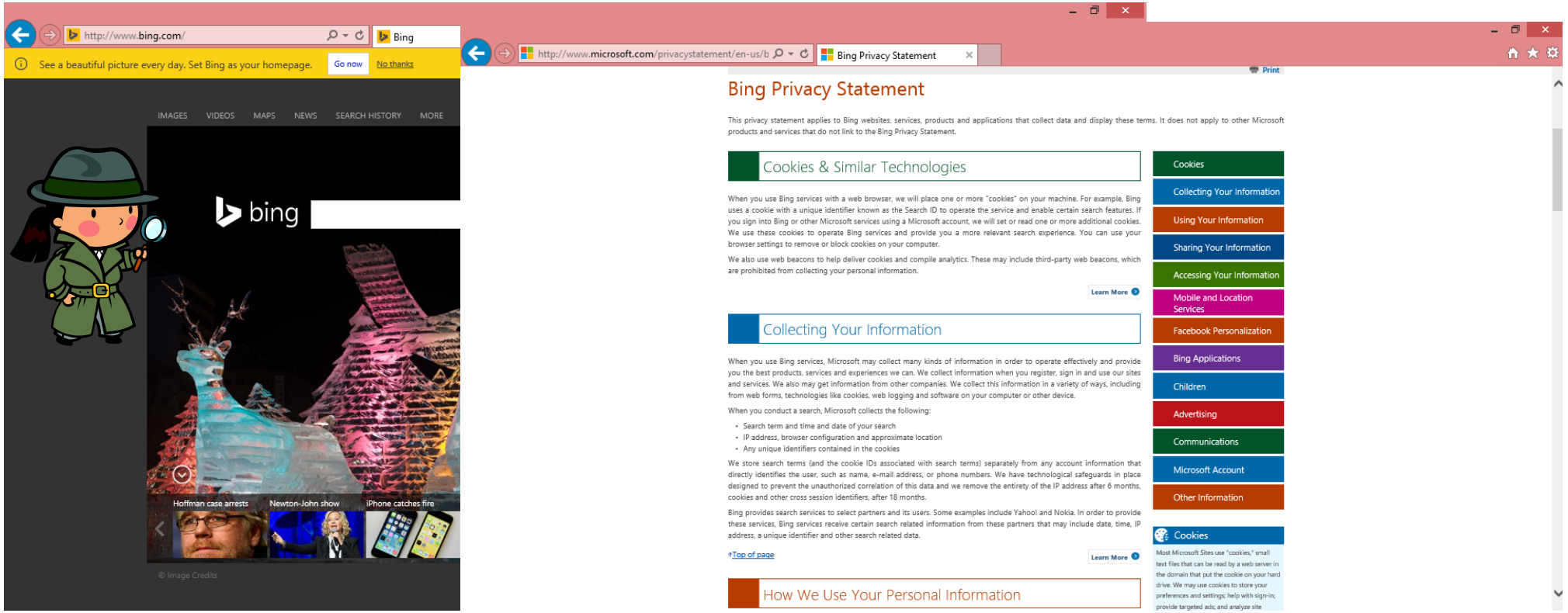
Bootstrapping Privacy Compliance in Big Data Systems

S. Sen, S. Guha, A. Datta, S. Rajamani, J. Tsai, J. M. Wing

Proceedings of 35th IEEE Symposium on Security and Privacy

May 2014.

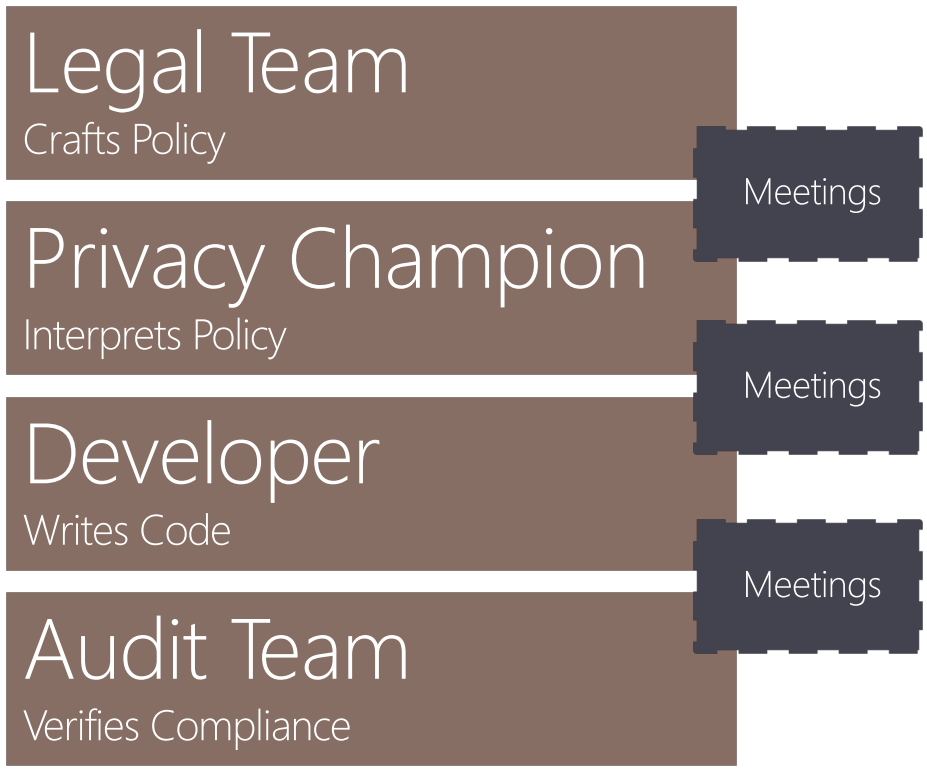
Privacy Compliance for Bing

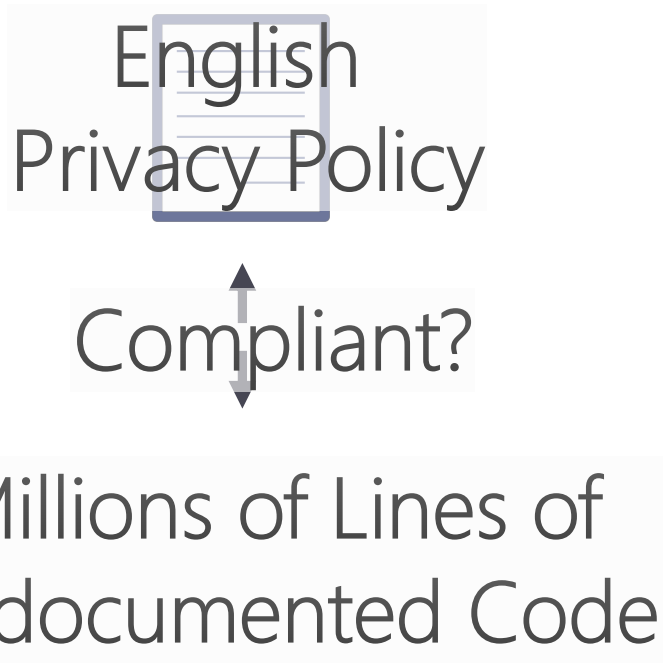


Setting:

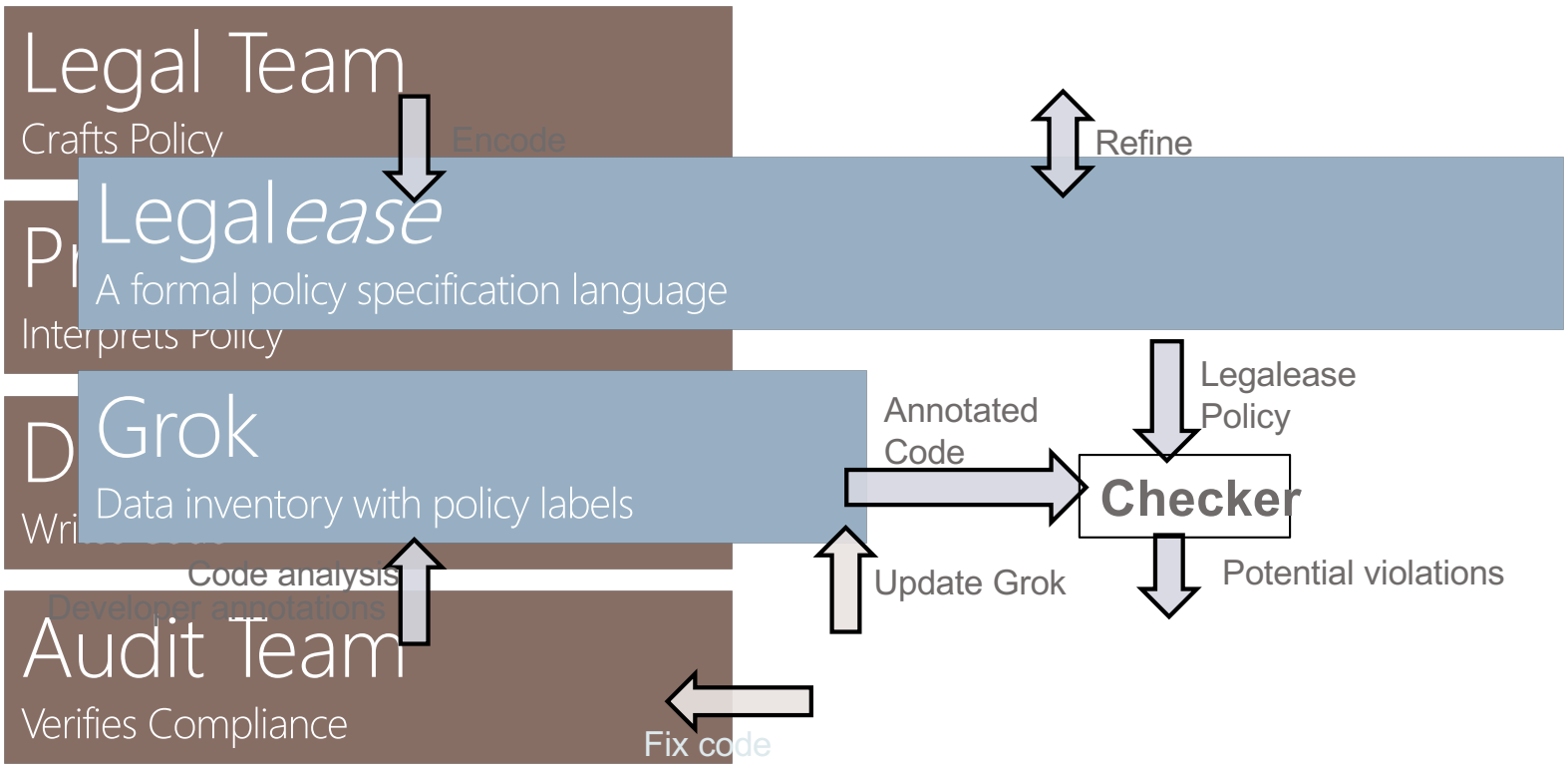
- Auditor has access to source code

The Privacy Compliance Challenge

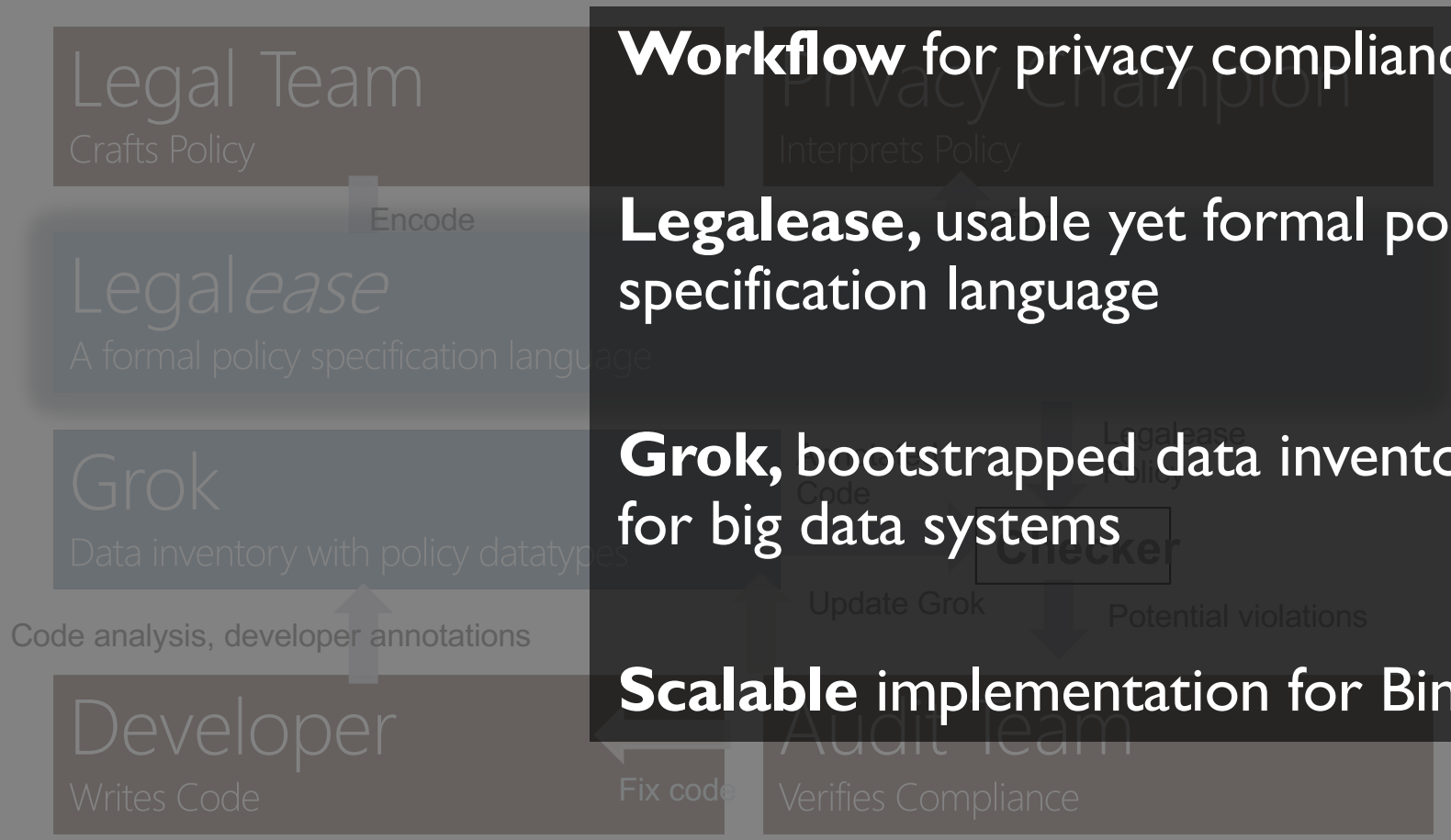




A Streamlined Audit Workflow



A Streamlined Audit Workflow



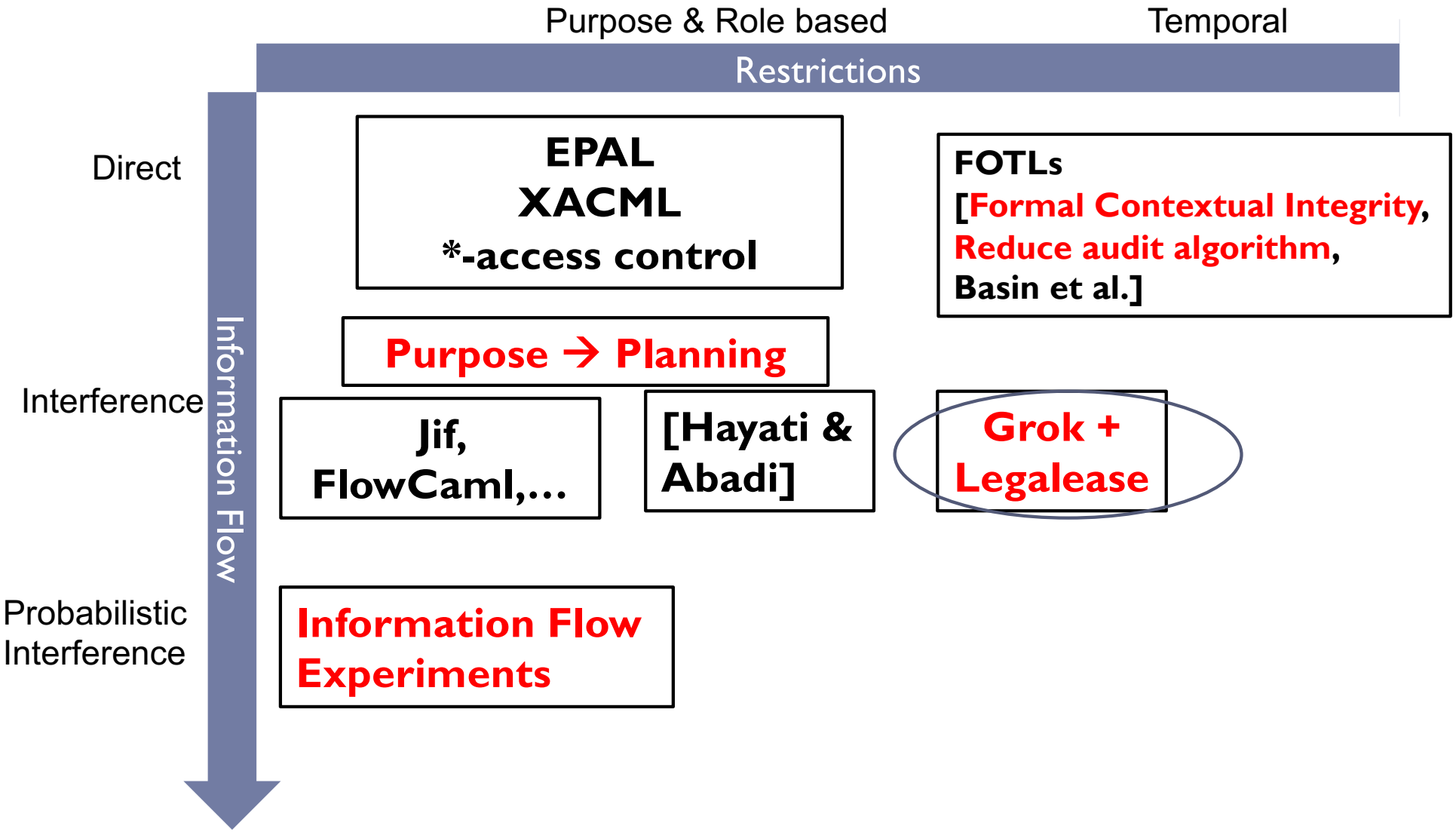
Workflow for privacy compliance

Legalease, usable yet formal policy specification language

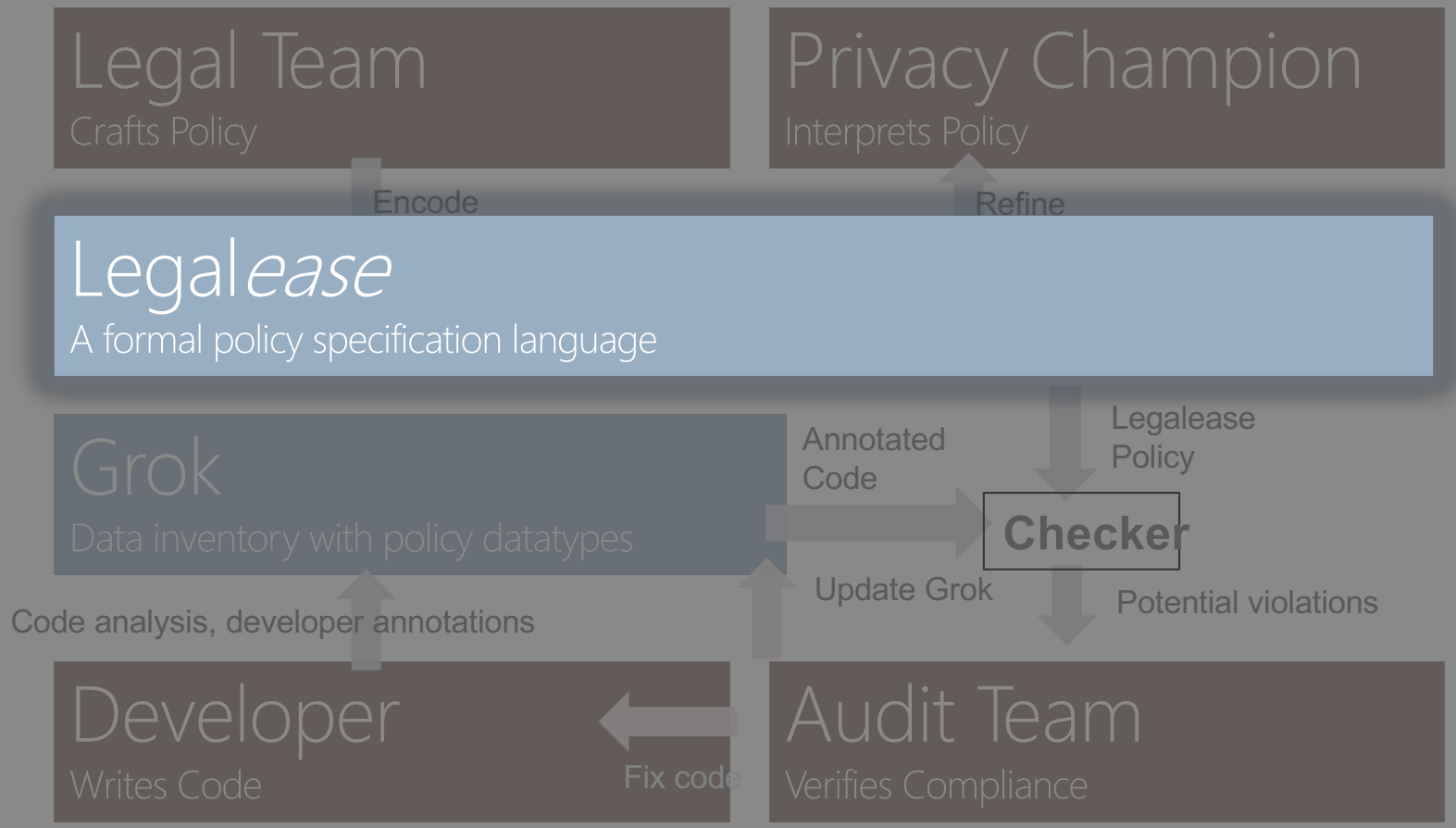
Grok, bootstrapped data inventory for big data systems

Scalable implementation for Bing

Privacy as Restrictions on Personal Information Flow



A Streamlined Audit Workflow



Specification: Legal*ease*

Usable. Expressive. Precise.	Usable by lawyers and privacy champs.	Expressive enough for real-world policies.	Precise semantics for local reasoning.

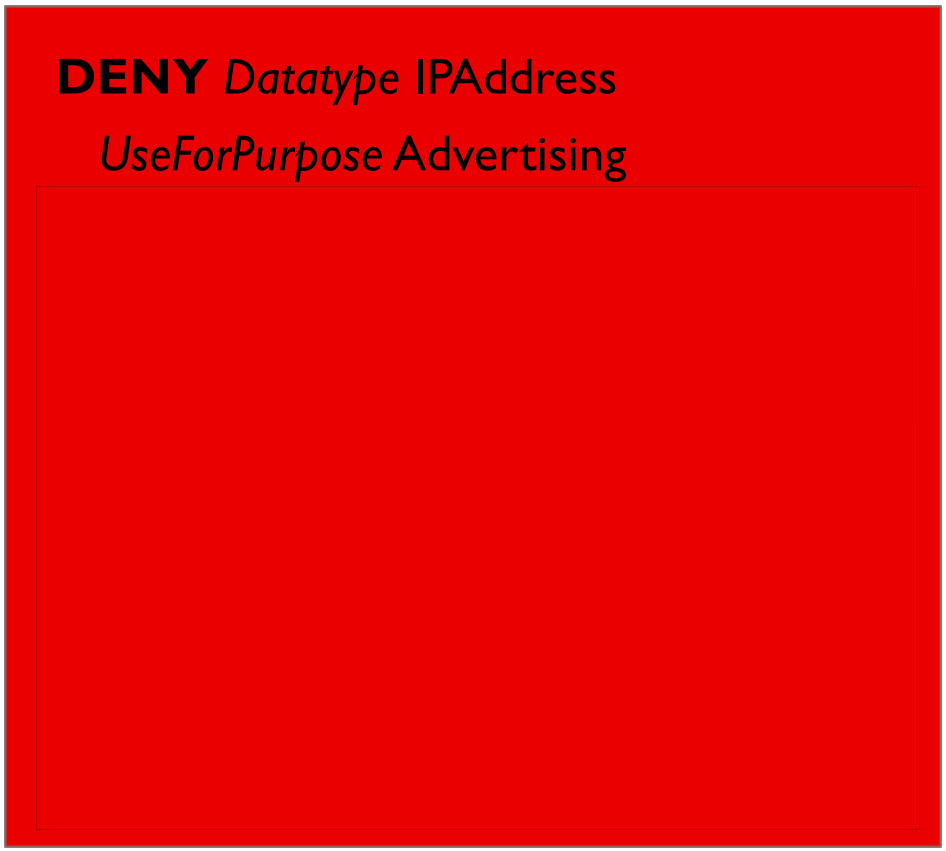
Legalease: Components

- Each statement is a clause reasoning about attributes
- Clauses
  - Allow
  - Deny
  - Except
- Attributes
  - InStore
  - UseForPurpose
  - AccessByRole
  - DataType

Legalease : Syntax

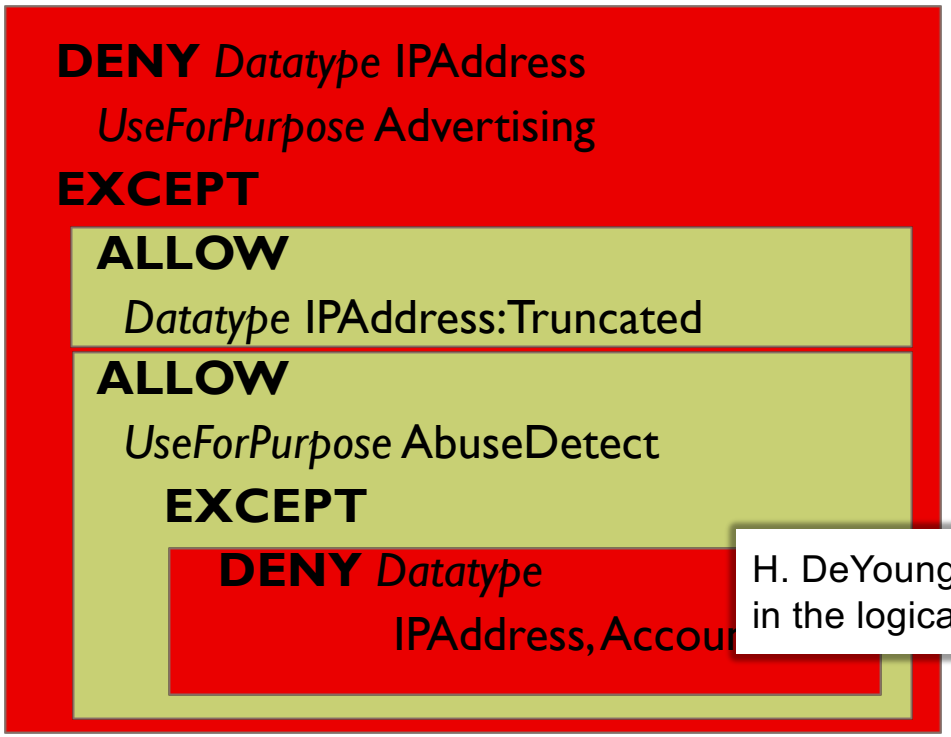
$$
\begin{array}{rcl}
\text{Policy Clause } C & ::= & D \mid A \\
\text{Deny Clause } D & ::= & \text{DENY } T_1 \cdots T_n \text{ EXCEPT } A_1 \cdots A_m \\
 & & \mid \text{DENY } T_1 \cdots T_n \\
\text{Allow Clause } A & ::= & \text{ALLOW } T_1 \cdots T_n \text{ EXCEPT } D_1 \cdots D_m \\
 & & \mid \text{ALLOW } T_1 \cdots T_n \\
\text{Attribute } T & ::= & \langle \text{attribute-name} \rangle \; v_1 \cdots v_l \\
\text{Value } v & ::= & \langle \text{attribute-value} \rangle
\end{array}
$$

Legalease



We will **not** use **full IP Address** for **Advertising**.

Designed for Usability



Exceptions

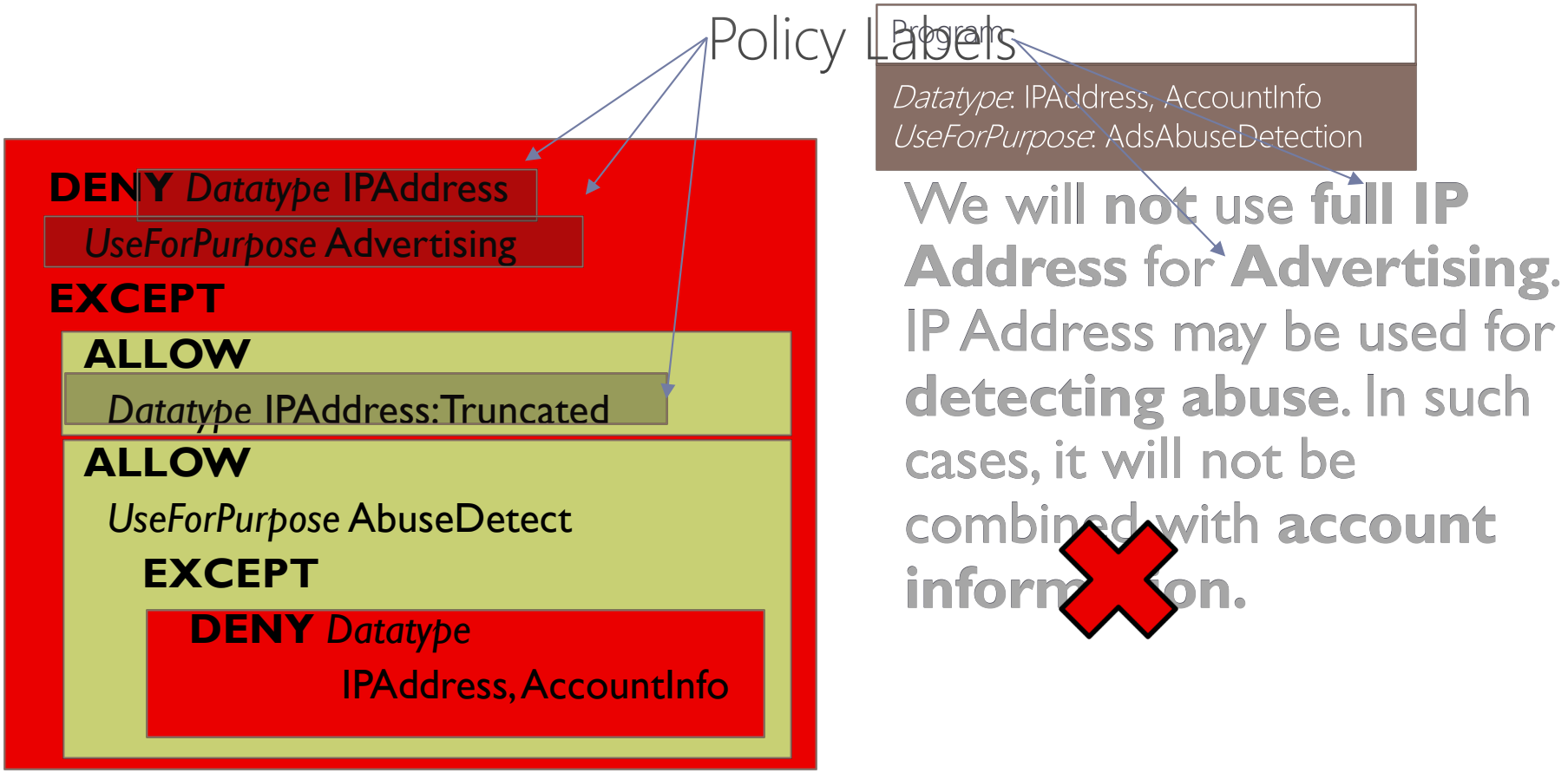
- How legal texts are structured
- One-to one correspondence

Local Reasoning

- Each exception refines its immediate parent
- Formally proven property

H. DeYoung, D. Garg, L. Jia, D. Kaynar, and A. Datta, "Experiences in the logical specification of the HIPAA and GLBA privacy laws"

Legalease : In Action

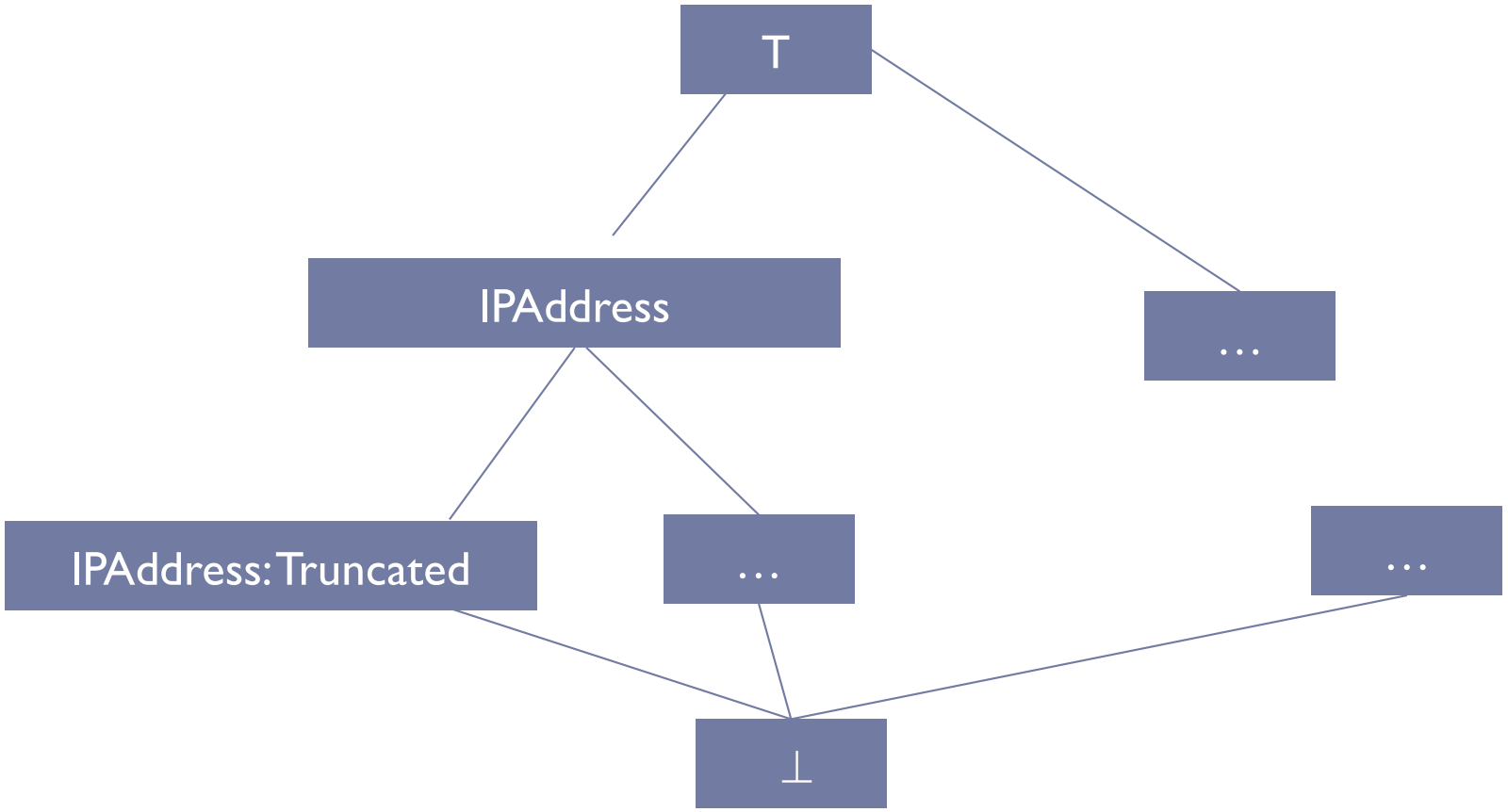


Primer on Lattices

- On document camera

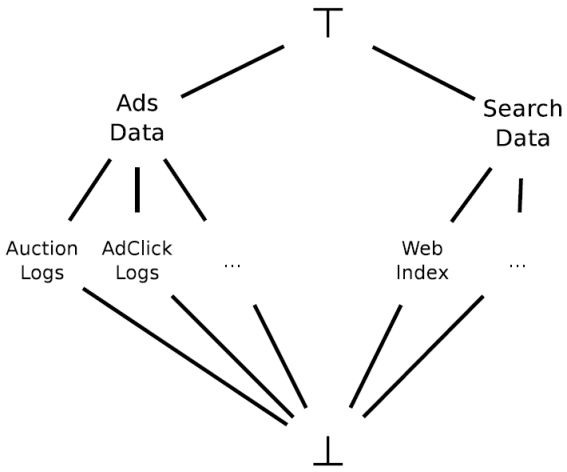
- Posets
- Lattices
- Rules for ALLOW and DENY
  - Examples

A Lattice of Policy Labels

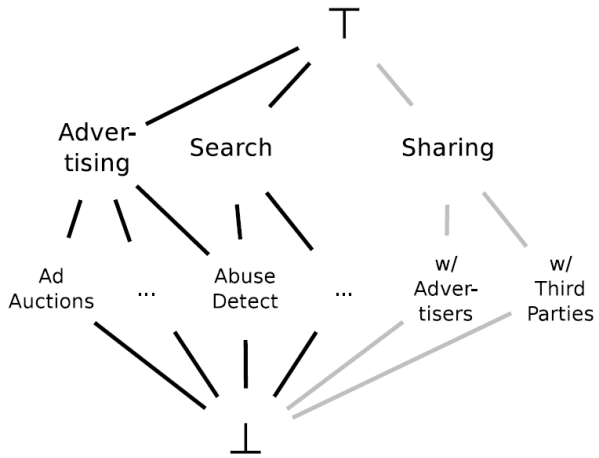


- If “IPAddress” use is allowed then so is everything below it
- If “IPAddress:Truncated” use is denied then so is everything above it

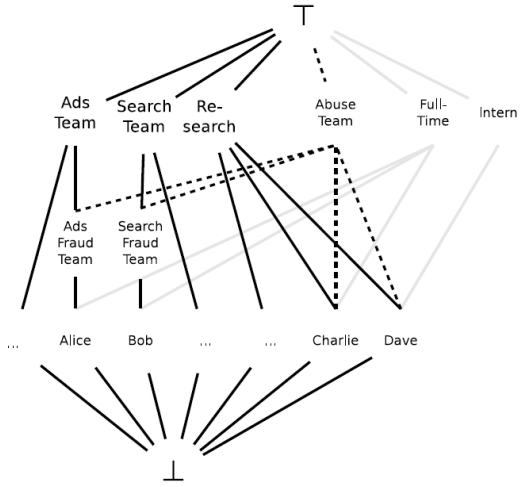
Policy Types : Concept Lattices



InStore Lattice

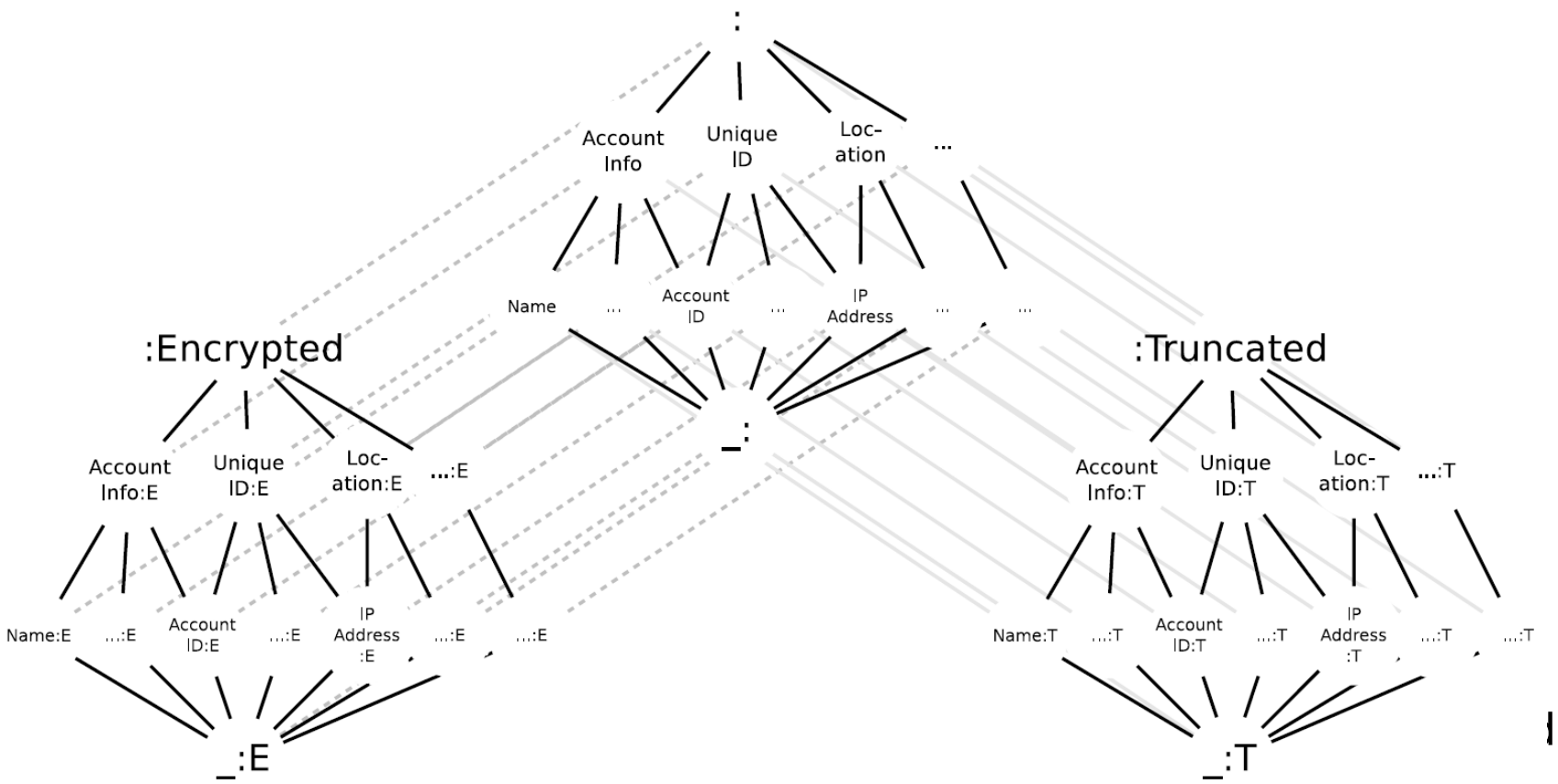


UseForPurpose Lattice



AccessByRole Lattice

Policy Labels : Datatypes



Formal Semantics

$$\frac{T^G \sqsubseteq T^C \quad \exists_i D_i \ \text{denies} \ T^G}{\text{ALLOW } T^C \text{ EXCEPT } D_1 \cdots D_m \ \text{denies} \ T^G} \ (\mathrm{A}_2)$$

Based on Lattice Orderings on Policy Types

Formal Semantics

$$\frac{T^G \sqsubseteq T^C \quad \boxed{\exists_i D_i \ \text{denies} \ T^G}}{\text{ALLOW } T^C \text{ EXCEPT } \boxed{D_1 \cdots D_m} \text{ denies } T^G} \ (\mathrm{A}_2)$$

Recursively check exceptions

- ALLOW clauses have DENY clauses as exceptions
- Top Level clause determines Blacklist/Whitelist