ECS 235B Module 38
Generalized Noninterference
Policies Changing Over Time

• Problem: previous analysis assumes static system
  • In real life, ACM changes as system commands issued
• Example: $w \in C^*$ leads to current state
  • $\textit{cando}(w, s, z)$ holds if $s$ can execute $z$ in current state
  • Condition noninterference on $\textit{cando}$
  • If $\neg \textit{cando}(w, \text{Lara, “write } f\text{”})$, Lara can’t interfere with any other user by writing file $f$
Generalize Noninterference

- $G \subseteq S$ set of subjects, $A \subseteq Z$ set of commands, $p$ predicate over elements of $C^*$
- $c_s = (c_1, ..., c_n) \in C^*$
- $\pi''(v) = v$
- $\pi''((c_1, ..., c_n)) = (c_1', ..., c_n')$, where
  - $c_i' = v$ if $p(c_1', ..., c_{i-1}')$ and $c_i = (s, z)$ with $s \in G$ and $z \in A$
  - $c_i' = c_i$ otherwise
Intuition

• $\pi''(c_s) = c_s$

• But if $p$ holds, and element of $c_s$ involves both command in $A$ and subject in $G$, replace corresponding element of $c_s$ with empty command $\nu$
  • Just like deleting entries from $c_s$ as $\pi_{A,G}$ does earlier
Noninterference

- $G, G' \subseteq S$ sets of subjects, $A \subseteq Z$ set of commands, $p$ predicate over $C^*$
- Users in $G$ executing commands in $A$ are *noninterfering with users in* $G'$ under condition $p$ iff, for all $c_s \in C^*$ and for all $s \in G'$, $\text{proj}(s, c_s, \sigma_i) = \text{proj}(s, \pi''(c_s), \sigma_i)$
  - Written $A, G :| G'$ if $p$
Example

• From earlier one, simple security policy based on noninterference:

\[ \forall (s \in S) \forall (z \in Z) [ \{z\}, \{s\} : | S \text{ if } \neg \text{cando}(w, s, z) ] \]

• If subject can’t execute command (the \(\neg \text{cando}\) part) in any state, subject can’t use that command to interfere with another subject
Another Example

- Consider system in which rights can be passed
  - $\text{pass}(s, z)$ gives $s$ right to execute $z$
  - $w_n = v_1, \ldots, v_n$ sequence of $v_i \in C^*$
  - $\text{prev}(w_n) = w_{n-1}$; $\text{last}(w_n) = v_n$
Policy

• No subject $s$ can use $z$ to interfere if, in previous state, $s$ did not have right to $z$, and no subject gave it to $s$

\[
\{ z \}, \{ s \} : | S
\]

\[
\text{if } [ \neg \text{cando}(\text{prev}(w), s, z) \land [ \text{cando}(\text{prev}(w), s', \text{pass}(s, z)) \Rightarrow \\
\neg \text{last}(w) = (s', \text{pass}(s, z)) ] ]
\]
Effect

• Suppose $s_1 \in S$ can execute $\text{pass}(s_2, z)$
• For all $w \in C^*$, $\text{cando}(w, s_1, \text{pass}(s_2, z))$ holds
• Initially, $\text{cando}(v, s_2, z)$ false
• Let $z' \in Z$ be such that $(s_3, z')$ noninterfering with $(s_2, z)$
  • So for each $w_n$ with $v_n = (s_3, z')$, $\text{cando}(w_n, s_2, z) = \text{cando}(w_{n-1}, s_2, z)$
Effect

• Then policy says for all $s \in S$
  
  \[
  \text{proj}(s, ((s_2, z), (s_1, \text{pass}(s_2, z)), (s_3, z'), (s_2, z)), \sigma_i) = 
  \text{proj}(s, ((s_1, \text{pass}(s_2, z)), (s_3, z'), (s_2, z)), \sigma_i)
  \]

• So $s_2$’s first execution of $z$ does not affect any subject’s observation of system