CS 556 – Computer Security
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Lippner’s Integrity Matrix Model

Integrity Matrix Model

The Combined Model

Lippner’s Integrity Matrix Model

Model Goals

- Relevant in the commercial sector
- Tries to control the production program
  - Integrity of the object is of prime importance

Requirements in Production Program

- Users will not write their own programs, but will use existing production programs and databases.
- Programmers will develop and test programs on a non-production system.
  - If they need access to actual data, they will be given production data via a special process, but will use it on their development system.

Requirements (cont'd)

- A special process must be followed to install a program from the development system onto the production system.
- The special process must be controlled and audited.
- The managers and auditors must have access to both the system state and the system logs that are generated.

Model Contributions

- Separation of duty.
- Separation of function.
- Auditing.

Separation of Duty

- If two or more steps are required to perform a critical function, at least two separate persons should perform the steps.
  - ✦ Moving a program from the development stage to the production system is an example.
  - ✦ A separate "installer" is more likely to catch a problem than the original developer.
  - ✦ If developer wants to subvert production data with a corrupt program, a separate certifier will be able to catch it.

Separation of Function

- The same person should not perform two or more different functions in the system.
  - Developers do not develop new programs on production systems because of the potential threat to production data.
  - Developers do not process production data on the development system.

Auditing

- Auditing is the process of analyzing systems to determine what actions took place and who performed them.
  - This is needed for recovery and accountability.

Integrity Matrix Model

Model Overview

- Combined BLP with Biba to address the concerns of the commercial sector.
- Defined two security levels
  - Audit Manager (AM): system audit and management functions are at this level.
  - System Low (SL): any process can read information at this level.
- Defined five compartments

Lipner's Compartments

- Development (D): production programs under development and testing but not yet in production state.
- Production Code (PC): production process and programs
- Production Data (PD): data covered by the integrity policy
- System Development (SD): system programs under development but not yet in production use
- Software Tools (T): programs provided on the production system not related to the sensitive or protected data.

User to Security Level Assignment

- Ordinary users will use production code to modify production data; their clearance is (SL, $\{$PC, PD$\}$).
- Application developers need tools for developing their programs and to a category for the programs that are being developed; their clearance is (SL, $\{$D, T$\}$).
- System programmers use tools to develop system programs; their clearance is (SL, $\{$SD, T$\}$).

User to Security Level Assignment

- System Managers and auditors need high system clearance as they must be able to access all logs; their clearance is (AM, $\{$D, PC, PD, SD, T$\}$).
- System controllers must have ability to downgrade code once it is certified for production so other entities cannot write to it; thus the clearance is (SL, $\{$D, PC, PD, SD, T$\}$) and downgrade privilege

Object to Security Level Assignment

- Objects are assigned to security level based on who should access them.
- Objects that may be altered have two compartments
    - That of the data itself.
    - That of the program that may alter it.

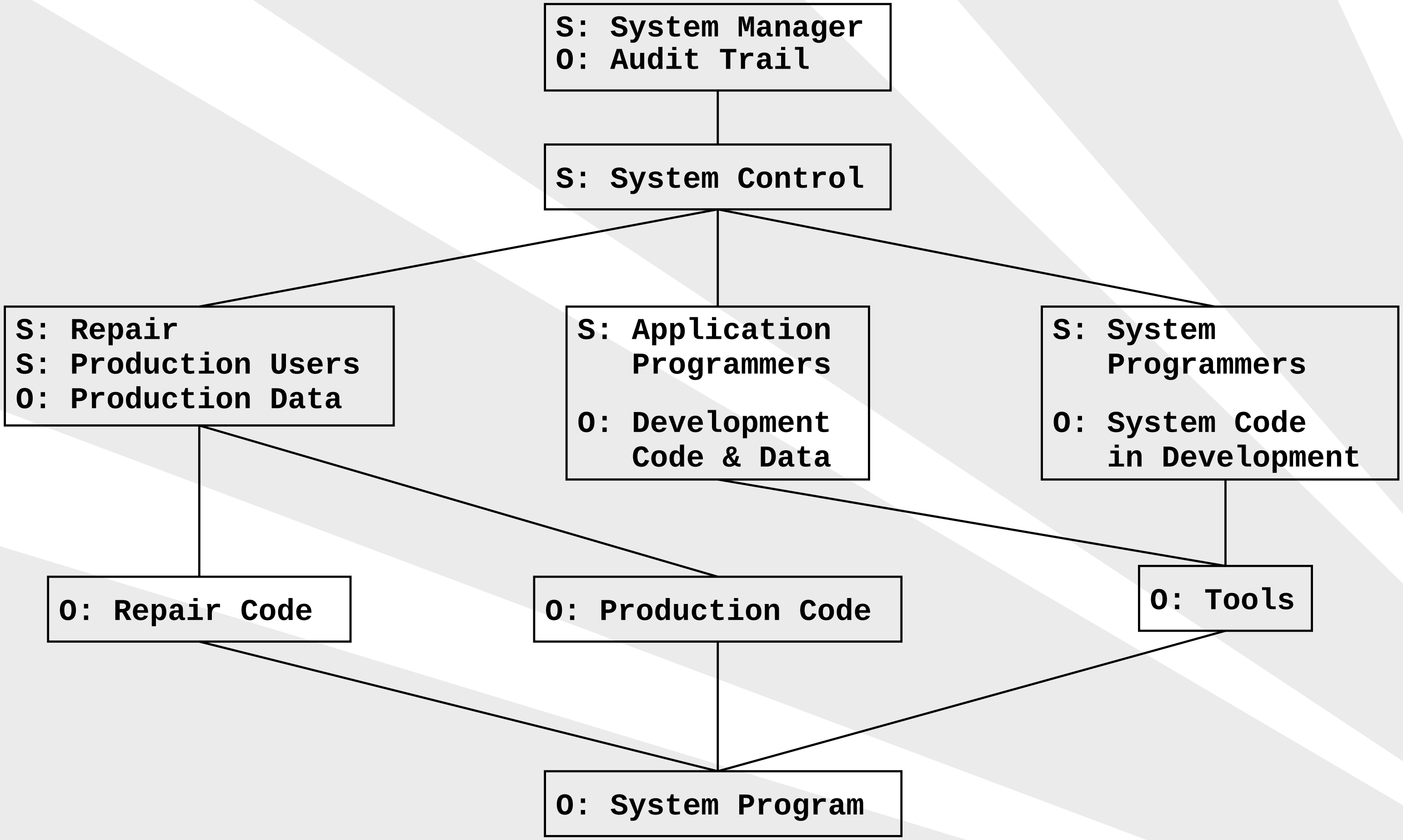
Object to Security Level Assignment

- Development code/test data – (SL, $\{D,T\}$)
- Production code – (SL, $\{PC\}$)
- Production data – (SL, $\{PC, PD\}$)
- Software tools – (SL, $\{T\}$)
- System programs – (SL, $\{\phi\}$)
- System programs in modification – (SL, $\{SD, T\}$)
- System and application logs – (AM, $\{$appropriate category$\}$)

Security Level for Logs

- All logs are append only. By the BLP *-property, their classes must dominate those of the subjects that write to them. Hence each log will have its own category.
  - Simplest way to prevent log compromise is to put all logs at the highest security level.

Lipner's Lattice



S: System Manager
O: Audit Trail

S: System Control

S: Repair
S: Production Users
O: Production Data

S: Application Programmers
O: Development Code & Data

S: System Programmers
O: System Code in Development

O: Repair Code

O: Production Code

O: Tools

O: System Program

Lipner's Lattice

- The position of the audit trail at lowest integrity demonstrates the limitation of an information flow approach to integrity
- System control subjects are exempted from the Star property and allowed to
  - Write up with respect to integrity or
  - Write down with respect to confidentiality

Lipner’s Use of BLP

- With the two security levels and five compartments, the model satifies the five commercial security requirements.
- However, it allows little flexibility in special purpose software
  - A program for repairing an inconsistent or erroneous production database cannot be an application-level software.
- To remedy this Lipner integrates his BLP model with the Biba model (Combined Model)

The Combined Model

LIPPNER'S INTEGRITY MATRIX MODEL
INTEGRITY MATRIX MODEL
THE COMBINED MODEL

Integrity Levels and Compartments

- Three integrity levels
  - ✦ System Program (ISP): the classification for system programs
  - ✦ Operational (IO): the classification for production programs and development software
  - ✦ System Low (ISL): the classification at which users log in
- Two integrity compartments:
  - ✦ Development (ID): development entities
  - ✦ Production (IP): production entities

New Security Compartments

- The previous security category T (tools) allowed application developers and system programmers to use the same programs without being able to alter these programs.
  - ✦ The Integrity compartments now distinguish between production and development so the compartment T can be eliminated.
- Production code and production data can be collapsed into the same compartment.
- This results in 3 security compartments in the combined model.

New Security Compartments

- Production (SP): production code and data
- Development (SD): same as previous security compartment Development (D)
- System Development (SSD): same as previous compartment System Development (SD)

Lippner's Model's Implication on LBAC

- In practice we will always need to violate the direction of information flow
- This is done by downgrading objects by passing them through a sanitizing process which is typically a trusted subject
    - For example – declassifying confidential objects