# Security Models

## Computer Security Lecture 15

Mike Just[1]

School of Informatics
University of Edinburgh

8th March 2010

[1] Based on original lecture notes by David Aspinall

# Outline

Access and information flow

Access control mechanisms

Security levels

The BLP security model

# Outline

- Access and information flow
- Access control mechanisms
- Security levels
- The BLP security model

# Controlling access or information flow

A **security policy** describes requirements for a system.
A **security model** is a way of formalizing a policy.

# Controlling access or information flow

A **security policy** describes requirements for a system.

A **security model** is a way of formalizing a policy.

There are two basic paradigms:

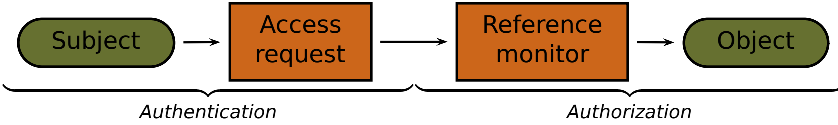
# Controlling access or information flow

A **security policy** describes requirements for a system.

A **security model** is a way of formalizing a policy.

There are two basic paradigms:

- **access control**: a guard controls whether a principal (the **subject**) is allowed access to a resource (the **object**).



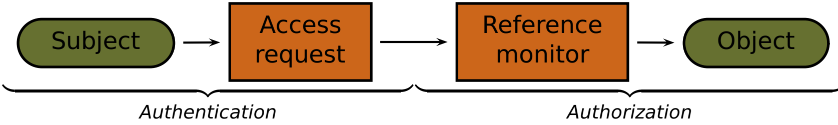
# Controlling access or information flow

A **security policy** describes requirements for a system.

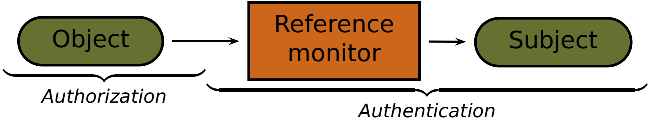
A **security model** is a way of formalizing a policy.

There are two basic paradigms:

- **access control**: a guard controls whether a principal (the **subject**) is allowed access to a resource (the **object**).




- **information flow control**: dual notion sometimes used when confidentiality is the primary concern. A guard controls whether information may flow from a resource to a principal.



# Access operations

- We can consider some fundamental **access modes**. Typically:

| | |
|---|---|
| observe | examine contents of an object |
| alter | change contents of an object |

# Access operations

- We can consider some fundamental **access modes**. Typically:

| | |
|---|---|
| observe | examine contents of an object |
| alter | change contents of an object |

- Next we define **access rights** and their profiles:

| | exec | read | append | write |
|---|---|---|---|---|
| observe | | ✓ | | ✓ |
| alter | | | ✓ | ✓ |

These are the access rights of the influential **Bell-LaPadula** (BLP) model. Access rights are the model's level of granularity for defining security policy. Each real operation requires particular access rights.

# Access operations

- We can consider some fundamental **access modes**. Typically:

| | |
|---|---|
| observe | examine contents of an object |
| alter | change contents of an object |

- Next we define **access rights** and their profiles:

| | exec | read | append | write |
|---|---|---|---|---|
| observe | | ✓ | | ✓ |
| alter | | | ✓ | ✓ |

  These are the access rights of the influential **Bell-LaPadula** (BLP) model. Access rights are the model's level of granularity for defining security policy. Each real operation requires particular access rights.
- Profiles and names of rights differ between systems, or even for different subject kinds. E.g., sometimes have a delete. In Unix, exec for directories indicates ability to read the directory.

# Ownership and identity

- Who may set the security policy? A resource may have a **owner** who controls access on a case-by-case basis, or the resource may be controlled by a uniform system-wide policy.

# Ownership and identity

- Who may set the security policy? A resource may have a **owner** who controls access on a case-by-case basis, or the resource may be controlled by a uniform system-wide policy.
  - **discretionary access control** (DAC): owners decide who may access their objects
  - **mandatory access control** (MAC): policy set system-wide

  A mixture of both may apply.

# Ownership and identity

- Who may set the security policy? A resource may have a **owner** who controls access on a case-by-case basis, or the resource may be controlled by a uniform system-wide policy.
  - **discretionary access control** (DAC): owners decide who may access their objects
  - **mandatory access control** (MAC): policy set system-wide

  A mixture of both may apply.
- Owners of resources may be principals in the system: *subjects* themselves under access control. BLP does not (directly) consider operations to modify access controls (e.g., chown in Windows), nor explain when such operations are safe.

# Ownership and identity

- Who may set the security policy? A resource may have a **owner** who controls access on a case-by-case basis, or the resource may be controlled by a uniform system-wide policy.
  - **discretionary access control** (DAC): owners decide who may access their objects
  - **mandatory access control** (MAC): policy set system-wide

  A mixture of both may apply.
- Owners of resources may be principals in the system: *subjects* themselves under access control. BLP does not (directly) consider operations to modify access controls (e.g., chown in Windows), nor explain when such operations are safe.
- The **identity** of subjects is also flexible: e.g., *identity changes* during operations (SUID programs in Unix). Again, this doesn't fit BLP.

# Outline

Access and information flow

Access control mechanisms

Security levels

The BLP security model

# Access control structures

- How are access control rights defined? Many schemes, but ultimately modelled by:

# Access control structures

- How are access control rights defined? Many schemes, but ultimately modelled by:
  - A set $S$ of subjects, a set $O$ of objects

# Access control structures

- How are access control rights defined? Many schemes, but ultimately modelled by:
  - A set $S$ of subjects, a set $O$ of objects
  - A set $A$ of operations (modelled by access rights), we'll consider $A = \{\mathsf{exec}, \mathsf{read}, \mathsf{append}, \mathsf{write}\}$.

# Access control structures

- How are access control rights defined? Many schemes, but ultimately modelled by:
  - A set $S$ of subjects, a set $O$ of objects
  - A set $A$ of operations (modelled by access rights), we'll consider $A = \{\mathsf{exec}, \mathsf{read}, \mathsf{append}, \mathsf{write}\}$.
  - An **access control matrix**

$$M = (M_{so})_{s \in S, o \in O}$$

    where each entry $M_{so} \subseteq A$ defines rights for $s$ to access $o$.

# Access control structures

- How are access control rights defined? Many schemes, but ultimately modelled by:
  - A set $S$ of subjects, a set $O$ of objects
  - A set $A$ of operations (modelled by access rights), we'll consider $A = \{\text{exec}, \text{read}, \text{append}, \text{write}\}$.
  - An **access control matrix**

$$M = (M_{so})_{s \in S, o \in O}$$

  where each entry $M_{so} \subseteq A$ defines rights for $s$ to access $o$.
- Example matrix for $S = \{\text{Alice}, \text{Bob}\}$ and three objects:

| | `bob.doc` | `edit.exe` | `fun.com` |
|---|---|---|---|
| Alice | $\{\}$ | $\{\text{exec}\}$ | $\{\text{exec}, \text{read}\}$ |
| Bob | $\{\text{read}, \text{write}\}$ | $\{\text{exec}\}$ | $\{\text{exec}, \text{read}, \text{write}\}$ |

# Representing the access control matrix

- Implementing $M$ directly is impractical, so different schemes are used. Complementary possibilities: either use **capabilities** (store $M$ by rows) or use **access control lists** (store $M$ by columns)

# Representing the access control matrix

- Implementing $M$ directly is impractical, so different schemes are used. Complementary possibilities: either use **capabilities** (store $M$ by rows) or use **access control lists** (store $M$ by columns)
- A **capability** is an unforgeable token that specifies a subject's access rights. Pros: can pass around capabilities; good fit with discr. AC. Cons: difficult to revoke, or find out who has, access to a particular resource (must examine all capabilities). Interest reinstated recently with distributed and mobile computation.

# Representing the access control matrix

- Implementing *M* directly is impractical, so different schemes are used. Complementary possibilities: either use **capabilities** (store *M* by rows) or use **access control lists** (store *M* by columns)
- A **capability** is an unforgeable token that specifies a subject's access rights. Pros: can pass around capabilities; good fit with discr. AC. Cons: difficult to revoke, or find out who has, access to a particular resource (must examine all capabilities). Interest reinstated recently with distributed and mobile computation.
- An **access control list** (ACL) stores the access rights to an object with the object itself. Pros: good fit with object-biased OSes. Cons: difficult to revoke, or find out, permissions of a particular subject (must search all ACLs).

# Outline

- Access and information flow
- Access control mechanisms
- Security levels
- The BLP security model

# Security levels

- **Multi Level Security** (MLS) systems originated in the military. A **security level** is a label for subjects and objects, to describe a policy.

# Security levels

- **Multi Level Security** (MLS) systems originated in the military. A **security level** is a label for subjects and objects, to describe a policy.
- Security levels are ordered:

$$\text{unclassified} \leq \text{confidential} \leq \text{secret} \leq \text{topsecret}.$$

# Security levels

- **Multi Level Security** (MLS) systems originated in the military. A **security level** is a label for subjects and objects, to describe a policy.
- Security levels are ordered:

$$\text{unclassified} \leq \text{confidential} \leq \text{secret} \leq \text{topsecret}.$$

- Ordering can express policies like "no write-down" which means that a high-level subject cannot write down to a low-level object. (A user with confidential clearance cannot write an unclassified file: it might contain confidential information read earlier.)

# Security levels

- **Multi Level Security** (MLS) systems originated in the military. A **security level** is a label for subjects and objects, to describe a policy.
- Security levels are ordered:

$$\text{unclassified} \leq \text{confidential} \leq \text{secret} \leq \text{topsecret}.$$

- Ordering can express policies like “no write-down” which means that a high-level subject cannot write down to a low-level object. (A user with confidential clearance cannot write an unclassified file: it might contain confidential information read earlier.)
- In practice, we need more flexibility. We may want *categorizations* as well, for example, describing departments or divisions in an organization. Then individual levels may not be comparable. . .

# Security lattices

- A *lattice* is a set $L$ equipped with a partial ordering $\leq$ such every two elements $a, b \in L$ has a *least upper bound* $a \vee b$ and a *greatest lower bound* $a \wedge b$. A finite lattice must have top and bottom elements.

# Security lattices

- A *lattice* is a set $L$ equipped with a partial ordering $\leq$ such every two elements $a, b \in L$ has a *least upper bound* $a \vee b$ and a *greatest lower bound* $a \wedge b$. A finite lattice must have top and bottom elements.
- In security, if $a \leq b$, we say that $b$ **dominates** $a$.
  - system low is the bottom level dominated by all others.
  - system high is the top level which dominates all others.

# Security lattices

- A *lattice* is a set $L$ equipped with a partial ordering $\leq$ such every two elements $a, b \in L$ has a *least upper bound* $a \vee b$ and a *greatest lower bound* $a \wedge b$. A finite lattice must have top and bottom elements.
- In security, if $a \leq b$, we say that $b$ **dominates** $a$.
  - system low is the bottom level dominated by all others.
  - system high is the top level which dominates all others.
- Lattices are useful for MLS policies because:

# Security lattices

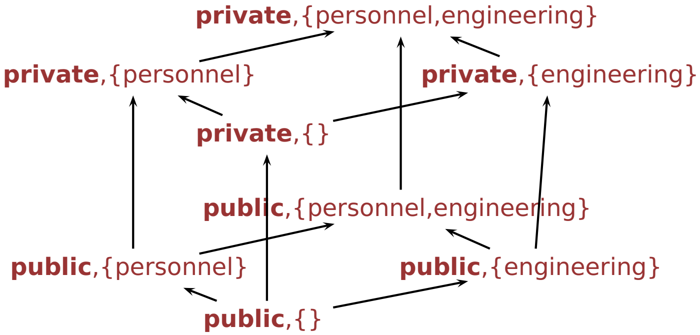
- A *lattice* is a set $L$ equipped with a partial ordering $\leq$ such every two elements $a, b \in L$ has a *least upper bound* $a \vee b$ and a *greatest lower bound* $a \wedge b$. A finite lattice must have top and bottom elements.
- In security, if $a \leq b$, we say that $b$ **dominates** $a$.
  - system low is the bottom level dominated by all others.
  - system high is the top level which dominates all others.
- Lattices are useful for MLS policies because:
  - for two *objects* at levels $a$ and $b$, there is a minimal security level $a \vee b$ for a *subject* to access both;

# Security lattices

- A *lattice* is a set $L$ equipped with a partial ordering $\leq$ such every two elements $a, b \in L$ has a *least upper bound* $a \vee b$ and a *greatest lower bound* $a \wedge b$. A finite lattice must have top and bottom elements.
- In security, if $a \leq b$, we say that $b$ **dominates** $a$.
  - system low is the bottom level dominated by all others.
  - system high is the top level which dominates all others.
- Lattices are useful for MLS policies because:
  - for two *objects* at levels $a$ and $b$, there is a minimal security level $a \vee b$ for a *subject* to access both;
  - for two *subjects* at levels $a$ and $b$, there is a maximal security level $a \wedge b$ for an *object* which must be readable by both.

# A Lattice Construction [Gollmann]

- take a set of *classifications* $H$ and linear ordering $\leq_H$
- take a set $C$ of categories; *compartments* are subsets of $C$
- *security levels* are pairs $(h, c)$ with $h \in H$ and $c \subseteq C$
- ordering $(h_1, c_1) \leq (h_2, c_2) \iff h_1 \leq h_2, c_1 \subseteq c_2$ gives a lattice.



# Outline

- Access and information flow
- Access control mechanisms
- Security levels
- The BLP security model

# Bell-LaPadula Model (BLP)

- BLP (1973) is state machine model for confidentiality.

# Bell-LaPadula Model (BLP)

- BLP (1973) is state machine model for confidentiality.
- Permissions use an AC matrix and **security levels**. The **security policy** prevents information flowing from a high level to a lower level.

# Bell-LaPadula Model (BLP)

- BLP (1973) is state machine model for confidentiality.
- Permissions use an AC matrix and **security levels**. The **security policy** prevents information flowing from a high level to a lower level.
- Assume subjects $S$, objects $O$, accesses $A$ as before.

# Bell-LaPadula Model (BLP)

- BLP (1973) is state machine model for confidentiality.
- Permissions use an AC matrix and **security levels**. The **security policy** prevents information flowing from a high level to a lower level.
- Assume subjects $S$, objects $O$, accesses $A$ as before.
- A set $L$ of security levels, with a partial ordering $\leq$.

# Bell-LaPadula Model (BLP)

- BLP (1973) is state machine model for confidentiality.
- Permissions use an AC matrix and **security levels**. The **security policy** prevents information flowing from a high level to a lower level.
- Assume subjects $S$, objects $O$, accesses $A$ as before.
- A set $L$ of security levels, with a partial ordering $\leq$.
- The state set $\mathcal{B} \times \mathcal{M} \times \mathcal{F}$ captures the current permissions and subjects accessing objects. It has three parts:

# Bell-LaPadula Model (BLP)

- BLP (1973) is state machine model for confidentiality.
- Permissions use an AC matrix and **security levels**. The **security policy** prevents information flowing from a high level to a lower level.
- Assume subjects $S$, objects $O$, accesses $A$ as before.
- A set $L$ of security levels, with a partial ordering $\leq$.
- The state set $\mathcal{B} \times \mathcal{M} \times \mathcal{F}$ captures the current permissions and subjects accessing objects. It has three parts:
  - $\mathcal{B}$ possible current accesses

# Bell-LaPadula Model (BLP)

- BLP (1973) is state machine model for confidentiality.
- Permissions use an AC matrix and **security levels**. The **security policy** prevents information flowing from a high level to a lower level.
- Assume subjects $S$, objects $O$, accesses $A$ as before.
- A set $L$ of security levels, with a partial ordering $\leq$.
- The state set $\mathcal{B} \times \mathcal{M} \times \mathcal{F}$ captures the current permissions and subjects accessing objects. It has three parts:
  - $\mathcal{B}$ possible current accesses
  - $\mathcal{M}$ permissions matrices

# Bell-LaPadula Model (BLP)

- BLP (1973) is state machine model for confidentiality.
- Permissions use an AC matrix and **security levels**. The **security policy** prevents information flowing from a high level to a lower level.
- Assume subjects $S$, objects $O$, accesses $A$ as before.
- A set $L$ of security levels, with a partial ordering $\leq$.
- The state set $\mathcal{B} \times \mathcal{M} \times \mathcal{F}$ captures the current permissions and subjects accessing objects. It has three parts:
  - $\mathcal{B}$ possible current accesses
  - $\mathcal{M}$ permissions matrices
  - $\mathcal{F}$ security level assignments

# Bell-LaPadula Model (BLP)

- BLP (1973) is state machine model for confidentiality.
- Permissions use an AC matrix and **security levels**. The **security policy** prevents information flowing from a high level to a lower level.
- Assume subjects $S$, objects $O$, accesses $A$ as before.
- A set $L$ of security levels, with a partial ordering $\leq$.
- The state set $\mathcal{B} \times \mathcal{M} \times \mathcal{F}$ captures the current permissions and subjects accessing objects. It has three parts:
  - $\mathcal{B}$ possible current accesses
  - $\mathcal{M}$ permissions matrices
  - $\mathcal{F}$ security level assignments
- A BLP state is a triple $(b, M, f)$.

# BLP state set

- $\mathcal{B} = \mathcal{P}(S \times O \times A)$ is the set of all possible current accesses.
  An element $b \in B$ is a set of tuples $(s, o, a)$ meaning $s$ is performing operation $a$ on an object $o$.

# BLP state set

- $\mathcal{B} = \mathcal{P}(S \times O \times A)$ is the set of all possible current accesses.
  An element $b \in B$ is a set of tuples $(s, o, a)$ meaning $s$ is performing operation $a$ on an object $o$.
- $\mathcal{M}$ is the set of permission matrices $M = (M_{so})_{s \in S, o \in O}$.

# BLP state set

- $\mathcal{B} = \mathcal{P}(S \times O \times A)$ is the set of all possible current accesses.
  An element $b \in B$ is a set of tuples $(s, o, a)$ meaning $s$ is performing operation $a$ on an object $o$.
- $\mathcal{M}$ is the set of permission matrices $M = (M_{so})_{s \in S, o \in O}$.
- $\mathcal{F} \subset L^S \times L^S \times L^O$ is the set of security level assignments.
  An element $f \in \mathcal{F}$ is a triple $(f_S, f_C, f_O)$ where

# BLP state set

- $\mathcal{B} = \mathcal{P}(S \times O \times A)$ is the set of all possible current accesses.
  An element $b \in B$ is a set of tuples $(s, o, a)$ meaning $s$ is performing operation $a$ on an object $o$.
- $\mathcal{M}$ is the set of permission matrices $M = (M_{so})_{s \in S, o \in O}$.
- $\mathcal{F} \subset L^S \times L^S \times L^O$ is the set of security level assignments.
  An element $f \in \mathcal{F}$ is a triple $(f_S, f_C, f_O)$ where
  - $f_S : S \to L$ gives the **maximal security level** each subject can have;

# BLP state set

- $\mathcal{B} = \mathcal{P}(S \times O \times A)$ is the set of all possible current accesses.
  An element $b \in B$ is a set of tuples $(s, o, a)$ meaning $s$ is performing operation $a$ on an object $o$.
- $\mathcal{M}$ is the set of permission matrices $M = (M_{so})_{s \in S, o \in O}$.
- $\mathcal{F} \subset L^S \times L^S \times L^O$ is the set of security level assignments.
  An element $f \in \mathcal{F}$ is a triple $(f_S, f_C, f_O)$ where
  - $f_S : S \to L$ gives the **maximal security level** each subject can have;
  - $f_C : S \to L$ gives the **current security level** of each subject (st $f_C \le f_S$), and

# BLP state set

- $\mathcal{B} = \mathcal{P}(S \times O \times A)$ is the set of all possible current accesses.
  An element $b \in B$ is a set of tuples $(s, o, a)$ meaning $s$ is performing operation $a$ on an object $o$.
- $\mathcal{M}$ is the set of permission matrices $M = (M_{so})_{s \in S, o \in O}$.
- $\mathcal{F} \subset L^S \times L^S \times L^O$ is the set of security level assignments.
  An element $f \in \mathcal{F}$ is a triple $(f_S, f_C, f_O)$ where
  - $f_S : S \to L$ gives the **maximal security level** each subject can have;
  - $f_C : S \to L$ gives the **current security level** of each subject (st $f_C \leq f_S$), and
  - $f_O : O \to L$ gives the **classification** of all objects.

# BLP Mandatory Access Control Policy

Consider a state $(b, M, f)$, where $b$ is the set of current accesses.

# BLP Mandatory Access Control Policy

Consider a state $(b, M, f)$, where $b$ is the set of current accesses.

**Simple security property**

The **ss-property** states for each access $(s, o, a) \in b$ where $a \in \{\text{read}, \text{write}\}$, then $f_O(o) \leq f_S(s)$ (*no read-up*).

**Star property**

The $*$**-property** states for each access $(s, o, a) \in b$ where $a \in \{\text{append}, \text{write}\}$, then $f_C(s) \leq f_O(o)$ (*no write-down*) and moreover, we must have $f_O(o') \leq f_O(o)$ for all $o'$ with $(s, o', a') \in b$ and $a' \in \{\text{read}, \text{write}\}$ (*o must dominate any other object s can read*).

# BLP Mandatory Access Control Policy

Consider a state $(b, M, f)$, where $b$ is the set of current accesses.

**Simple security property**

The **ss-property** states for each access $(s, o, a) \in b$ where $a \in \{\text{read}, \text{write}\}$, then $f_O(o) \le f_S(s)$ (*no read-up*).

**Star property**

The $*$**-property** states for each access $(s, o, a) \in b$ where $a \in \{\text{append}, \text{write}\}$, then $f_C(s) \le f_O(o)$ (*no write-down*) and moreover, we must have $f_O(o') \le f_O(o)$ for all $o'$ with $(s, o', a') \in b$ and $a' \in \{\text{read}, \text{write}\}$ (*o must dominate any other object s can read*).

Together these form the *mandatory access control* policy for BLP.

# BLP Discretionary Control and Security

The access control matrix $M$ allows DAC as well.

**Discretionary security property**

The **ds-property**: for each access $(s, o, a) \in b$, we have that $a \in M_{so}$ (*discretionary access controls are obeyed*).

# BLP Discretionary Control and Security

The access control matrix $M$ allows DAC as well.

**Discretionary security property**

The **ds-property**: for each access $(s, o, a) \in b$, we have that $a \in M_{so}$ (*discretionary access controls are obeyed*).

- **Definition of Security:** The state $(b, M, f)$ is **secure** if the three properties above are satisfied.

Notice that BLP's notion of security is entirely captured in the current state.

# Current clearance level

- Unfortunately, the $*$-property means a high-level subject cannot send messages to a low-level subject. This is unrealistic!

# Current clearance level

- Unfortunately, the $*$-property means a high-level subject cannot send messages to a low-level subject. This is unrealistic!
- There are two ways out:

# Current clearance level

- Unfortunately, the $*$-property means a high-level subject cannot send messages to a low-level subject. This is unrealistic!
- There are two ways out:
  1. temporarily downgrade a high-level subject, which is why the model includes the current **clearance level** setting $f_C$, or

# Current clearance level

- Unfortunately, the $*$-property means a high-level subject cannot send messages to a low-level subject. This is unrealistic!
- There are two ways out:
  1. temporarily downgrade a high-level subject, which is why the model includes the current **clearance level** setting $f_C$, or
  2. identify a set of **trusted subjects** allowed to violate the $*$-property.

# Current clearance level

- Unfortunately, the $*$-property means a high-level subject cannot send messages to a low-level subject. This is unrealistic!
- There are two ways out:
  1. temporarily downgrade a high-level subject, which is why the model includes the current **clearance level** setting $f_C$, or
  2. identify a set of **trusted subjects** allowed to violate the $*$-property.
- Approach 1 works because the current state describes exactly what each subject knows. So if a subject (e.g. a process) is downgraded, it cannot access higher-level material, so may safely write at any lower level than its maximum.

# Current clearance level

- Unfortunately, the $*$-property means a high-level subject cannot send messages to a low-level subject. This is unrealistic!
- There are two ways out:
  1. temporarily downgrade a high-level subject, which is why the model includes the current **clearance level** setting $f_C$, or
  2. identify a set of **trusted subjects** allowed to violate the $*$-property.
- Approach 1 works because the current state describes exactly what each subject knows. So if a subject (e.g. a process) is downgraded, it cannot access higher-level material, so may safely write at any lower level than its maximum.
- When subjects are people with high-level clearances, approach 2 works: we trust someone to violate the property in the model, e.g., by publishing part of a secret document.

# Basic security theorem

- A transition from state $v_1$ to $v_2$ is **secure** simply if both states $v_1$ and $v_2$ are secure.

# Basic security theorem

- A transition from state $v_1$ to $v_2$ is **secure** simply if both states $v_1$ and $v_2$ are secure.
- This leads to a rather simple and general theorem:

# Basic security theorem

- A transition from state $v_1$ to $v_2$ is **secure** simply if both states $v_1$ and $v_2$ are secure.
- This leads to a rather simple and general theorem:

**Basic security theorem**

If all state transitions in a system are secure and the initial state of the system is secure, then every subsequent state is also secure.

# Basic security theorem

- A transition from state $v_1$ to $v_2$ is **secure** simply if both states $v_1$ and $v_2$ are secure.
- This leads to a rather simple and general theorem:

**Basic security theorem**

If all state transitions in a system are secure and the initial state of the system is secure, then every subsequent state is also secure.

# Basic security theorem

- A transition from state $v_1$ to $v_2$ is **secure** simply if both states $v_1$ and $v_2$ are secure.
- This leads to a rather simple and general theorem:

**Basic security theorem**

If all state transitions in a system are secure and the initial state of the system is secure, then every subsequent state is also secure.

(NB: this follows immediately by induction, it has nothing to do with the properties of BLP!)

- The point: we can reduce checking the system for all possible inputs to checking that each kind of possible state transition preserves security. Of course, to do this we need a concrete instance of the model which describes possible transitions.

# References

See Ch 3–5 of Gollmann, Ch 7–9 of Anderson and Parts 2–3 of Bishop.


- Ross Anderson. *Security Engineering: A Comprehensive Guide to Building Dependable Distributed Systems*.
  Wiley & Sons, 2001.
- Matt Bishop. *Computer Security: Art and Science*.
  Addison-Wesley, 2003.
- Dieter Gollmann. *Computer Security*.
  John Wiley & Sons, second edition, 2006.


**Recommended Reading**

Sections 4.1, 4.2, 7.1-7.3 of Anderson (1st edition).