STAC: Software Tuning Panels for Autonomic Control

Automatically Identifying Software Tuning Parameters

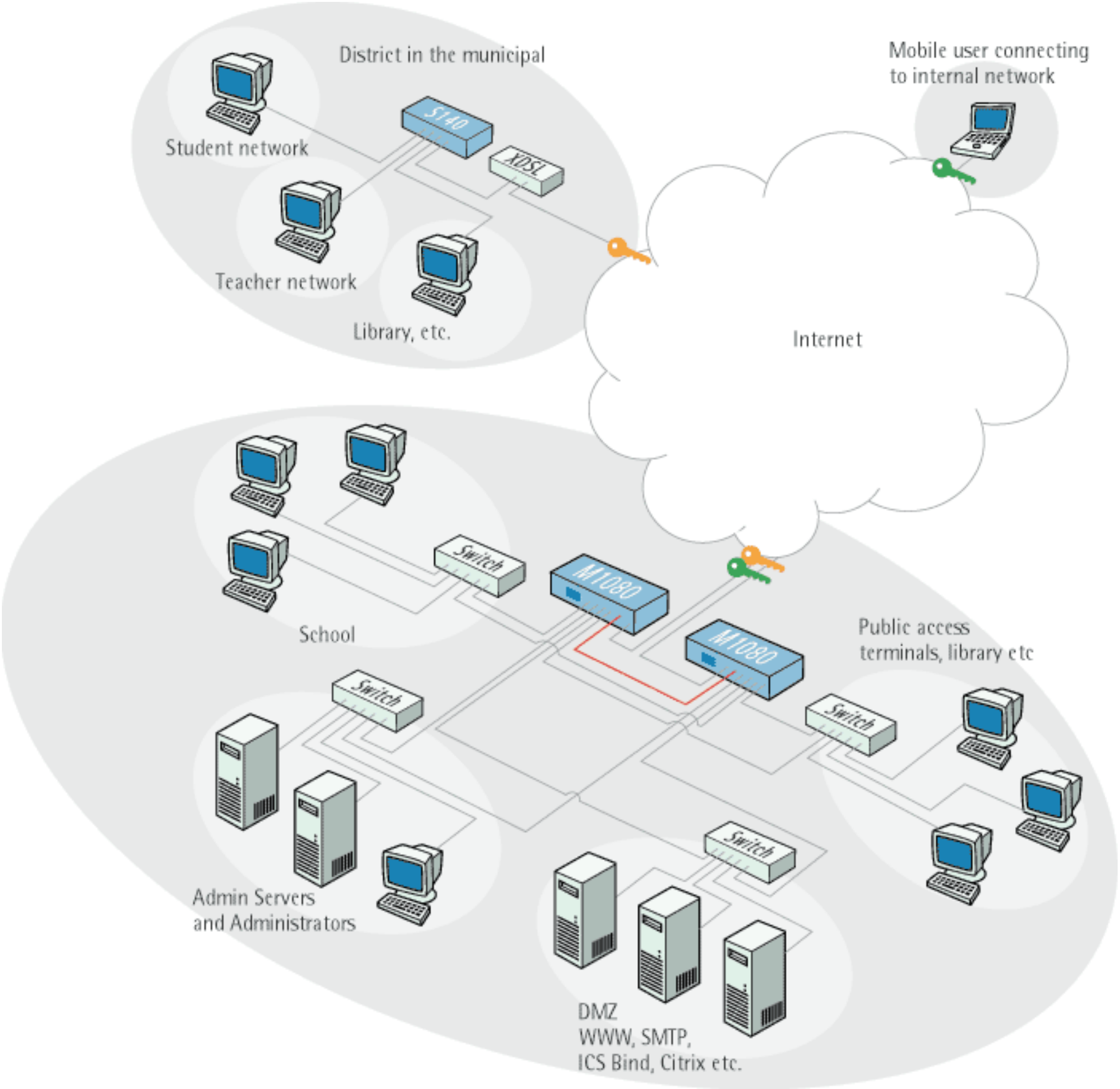
Project Participants

- Nevon Brake, Queen’s University
- Jim Cordy, Queen’s University
- Elizabeth Dancy, IBM
- Marin Litoiu, IBM
- Valentina Popescu, IBM

“Computing systems’ complexity appears to be approaching the limits of human capability...”

The Vision of Autonomic Computing, 2003

Pervasive Computing


District in the municipal
Student network
S140
XDSL
Teacher network
Library, etc.
Mobile user connecting to internal network
Internet
School
Switch
M1080
M1080
Public access terminals, library etc
Switch
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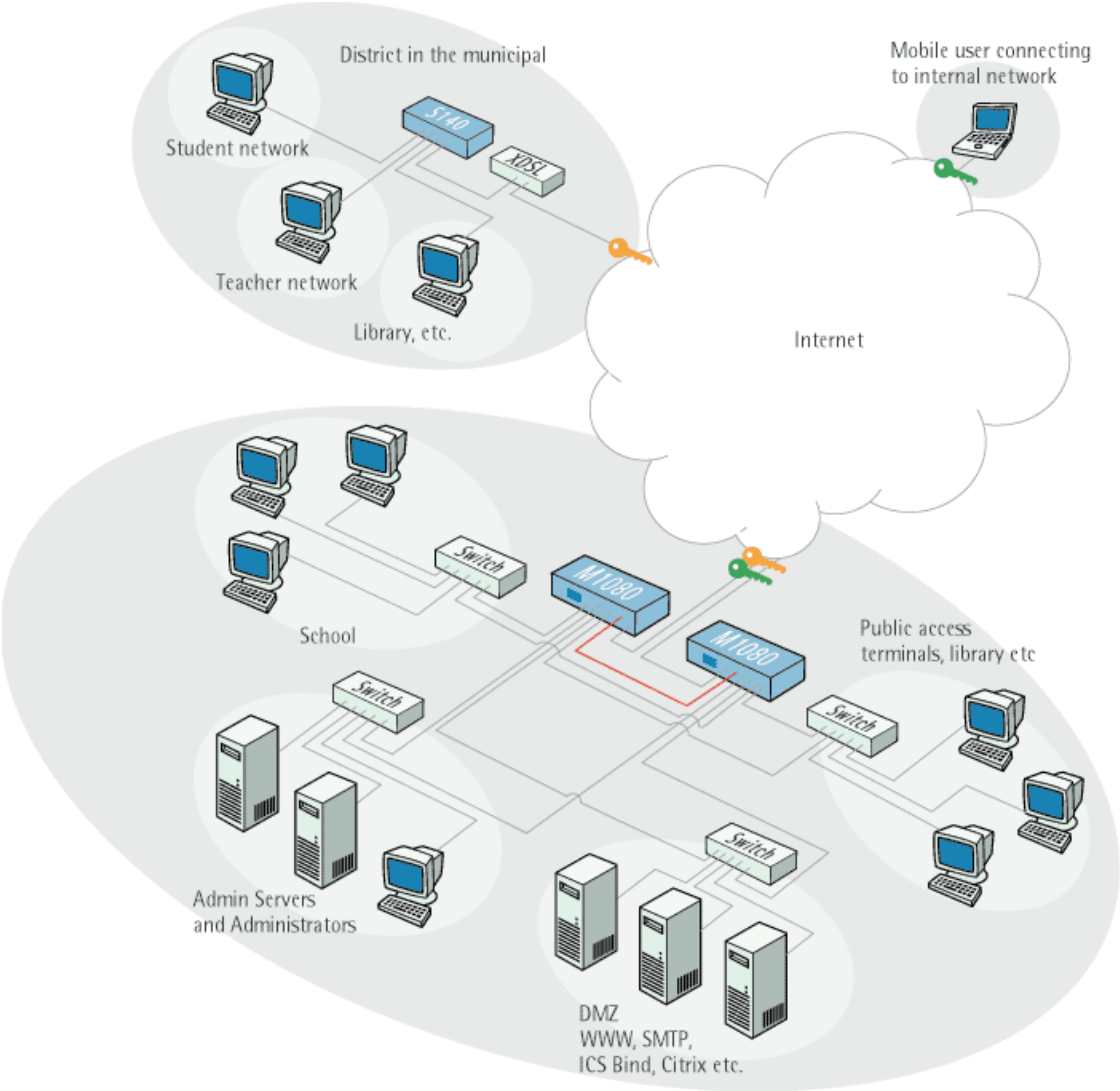
Admin Servers and Administrators
Switch
DMZ WWW, SMTP, ICS Bind, Citrix etc.

Pervasive Computing

- Interconnected (i.e., complex dependencies)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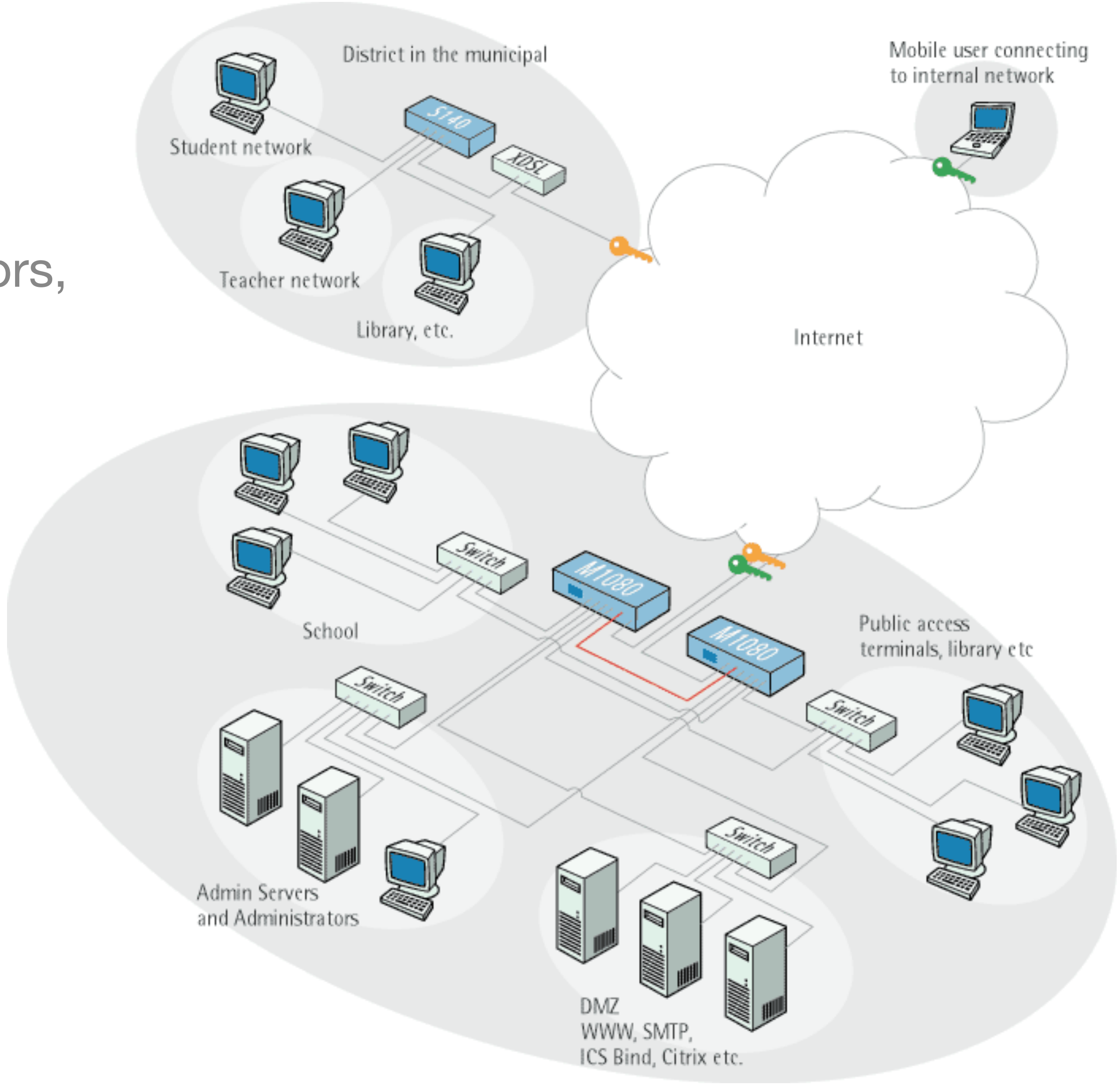
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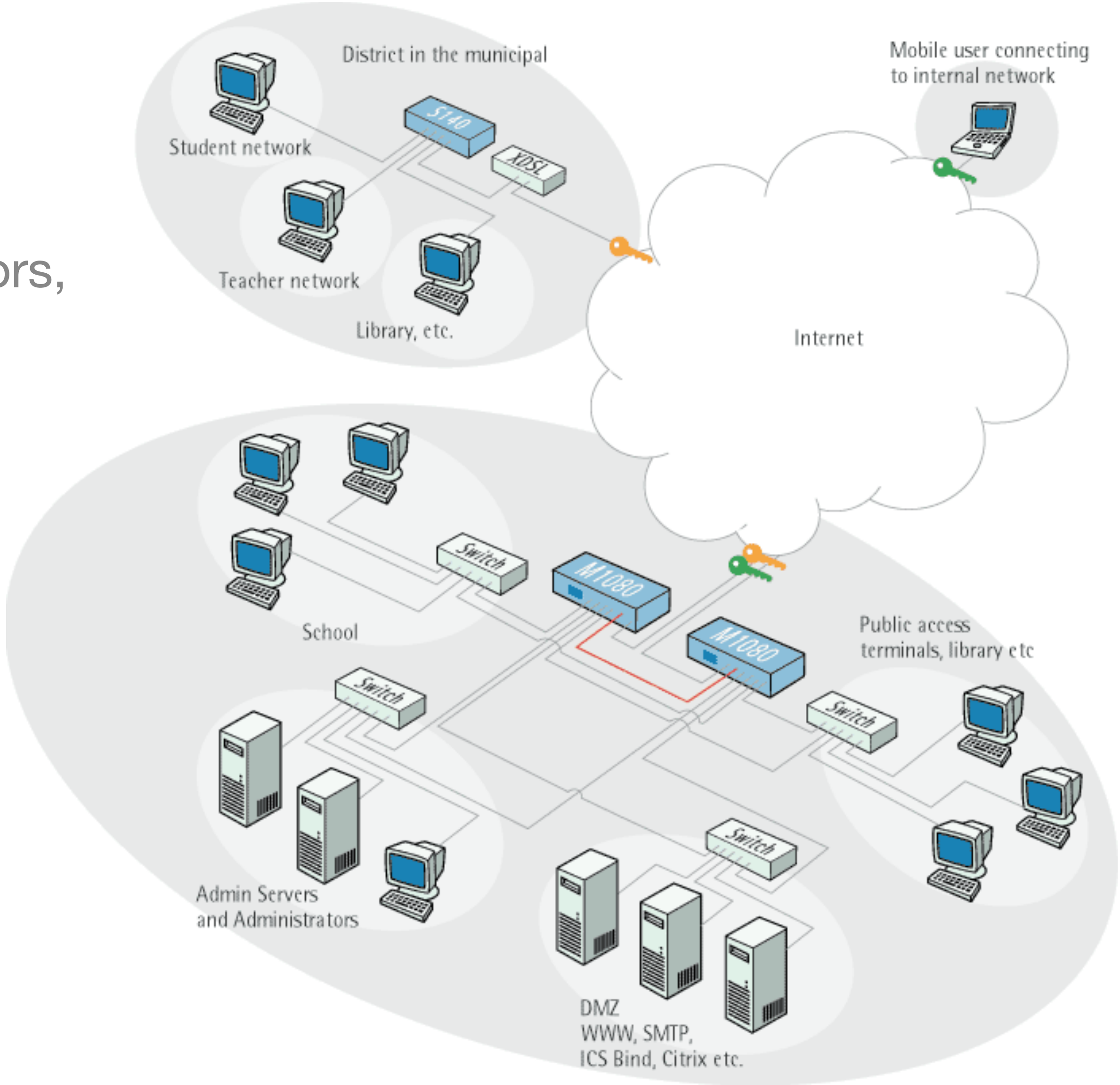
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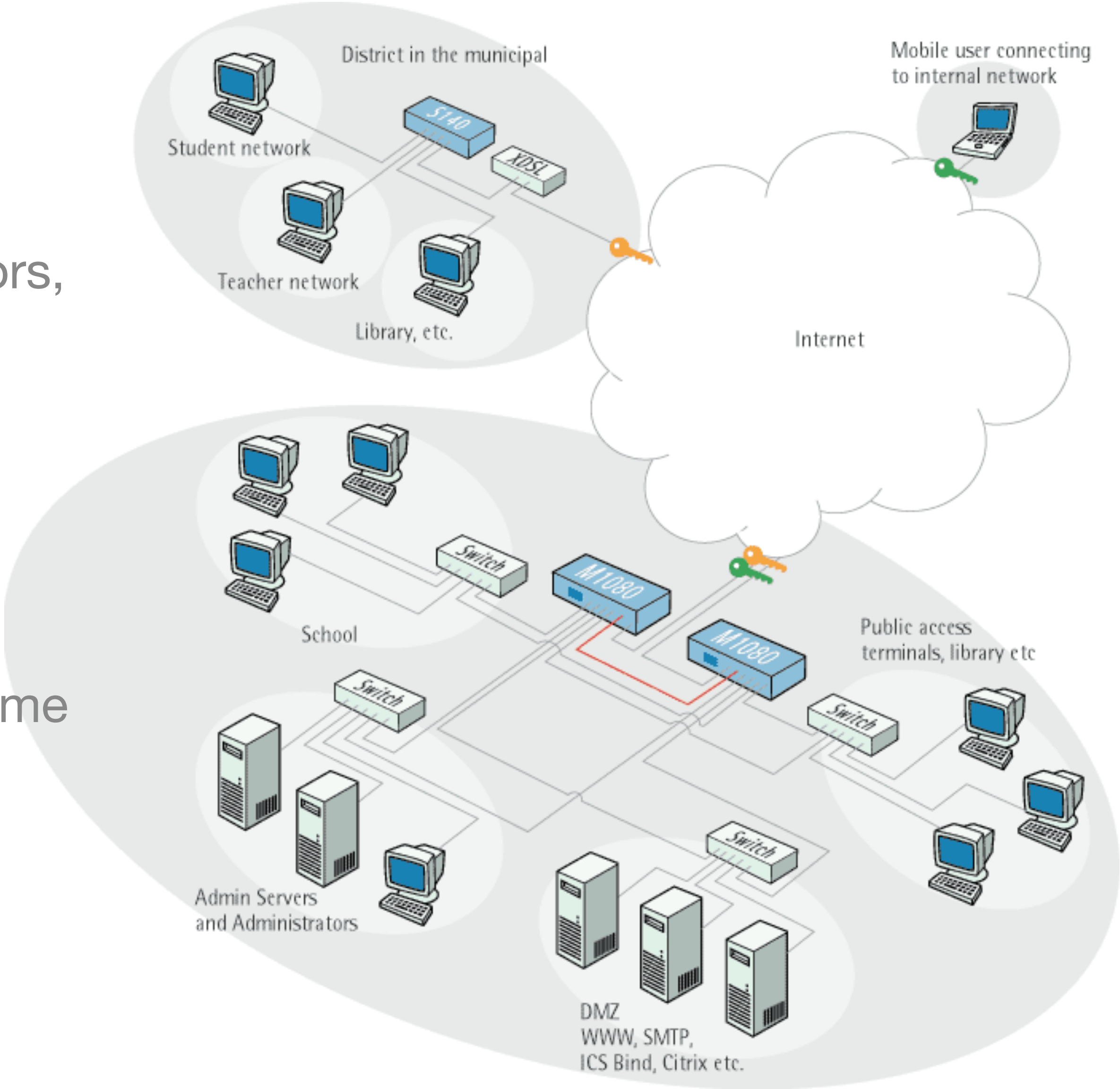
Pervasive Computing

- Interconnected (i.e., complex dependencies)
- Diverse (e.g., hardware vendors, software versions)
- Unanticipated interactions
- Runtime monitoring and diagnosis (e.g., 99.999% uptime requirements)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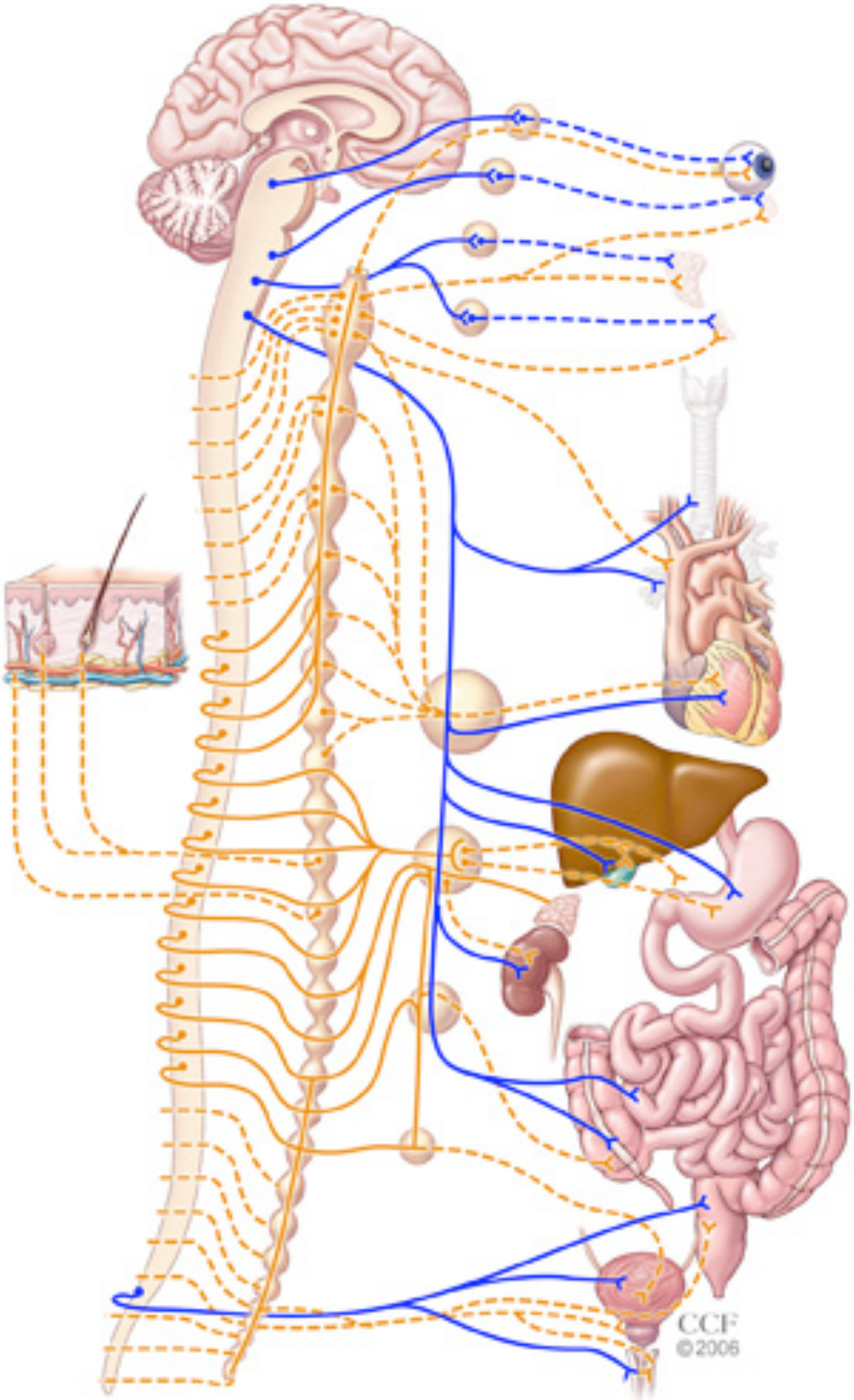
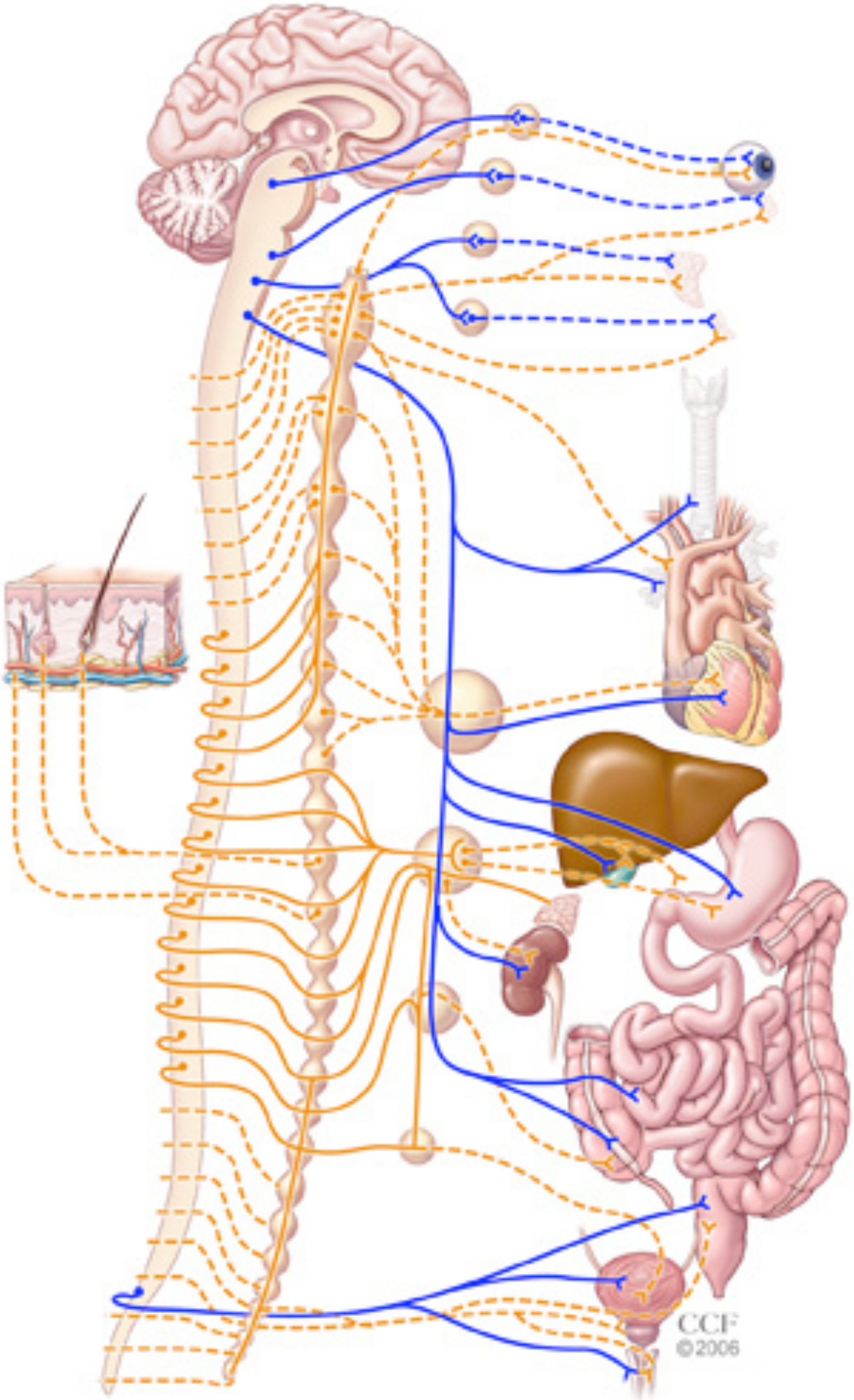
The Autonomic Vision



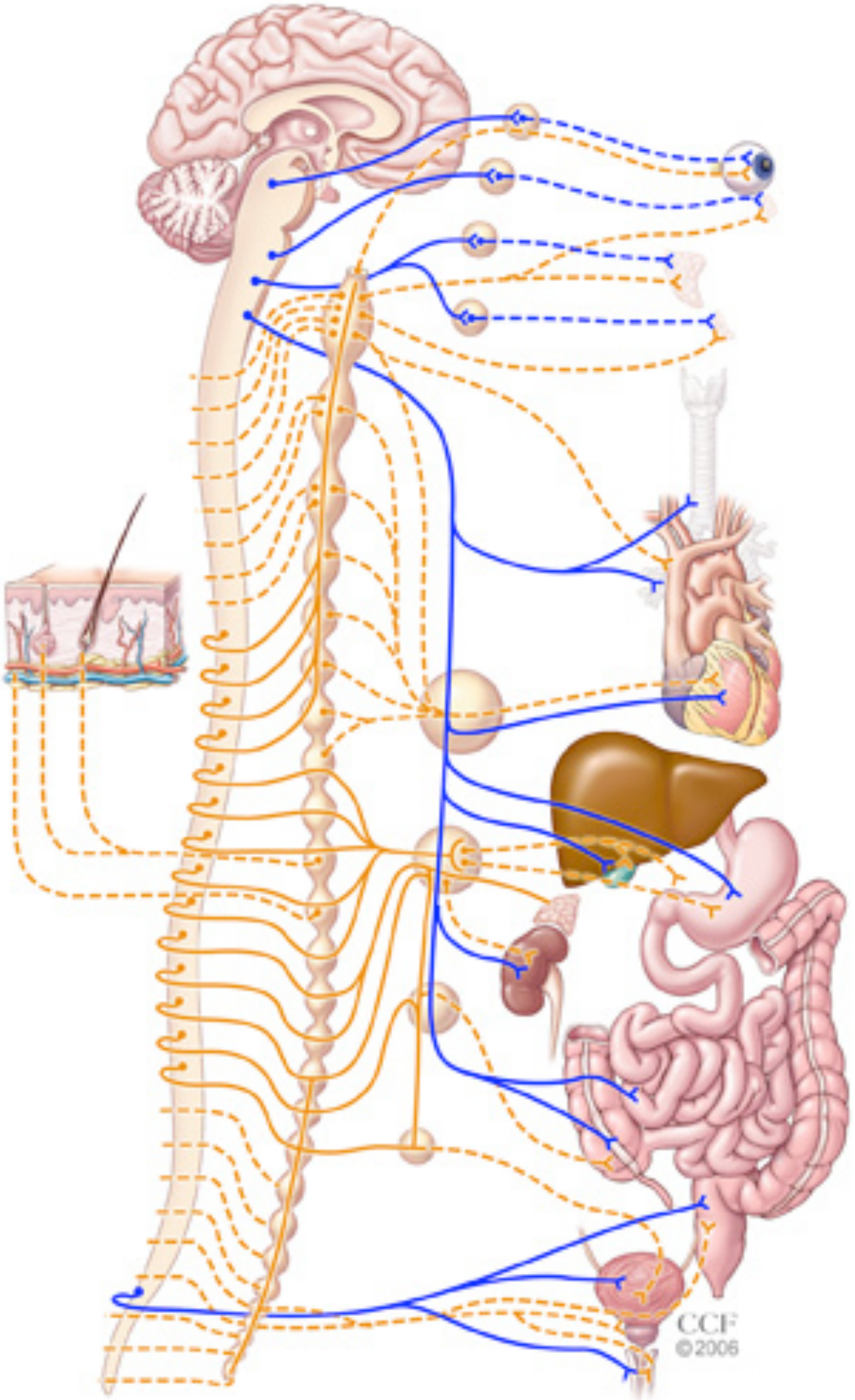
The Autonomic Vision

- Self-configuration



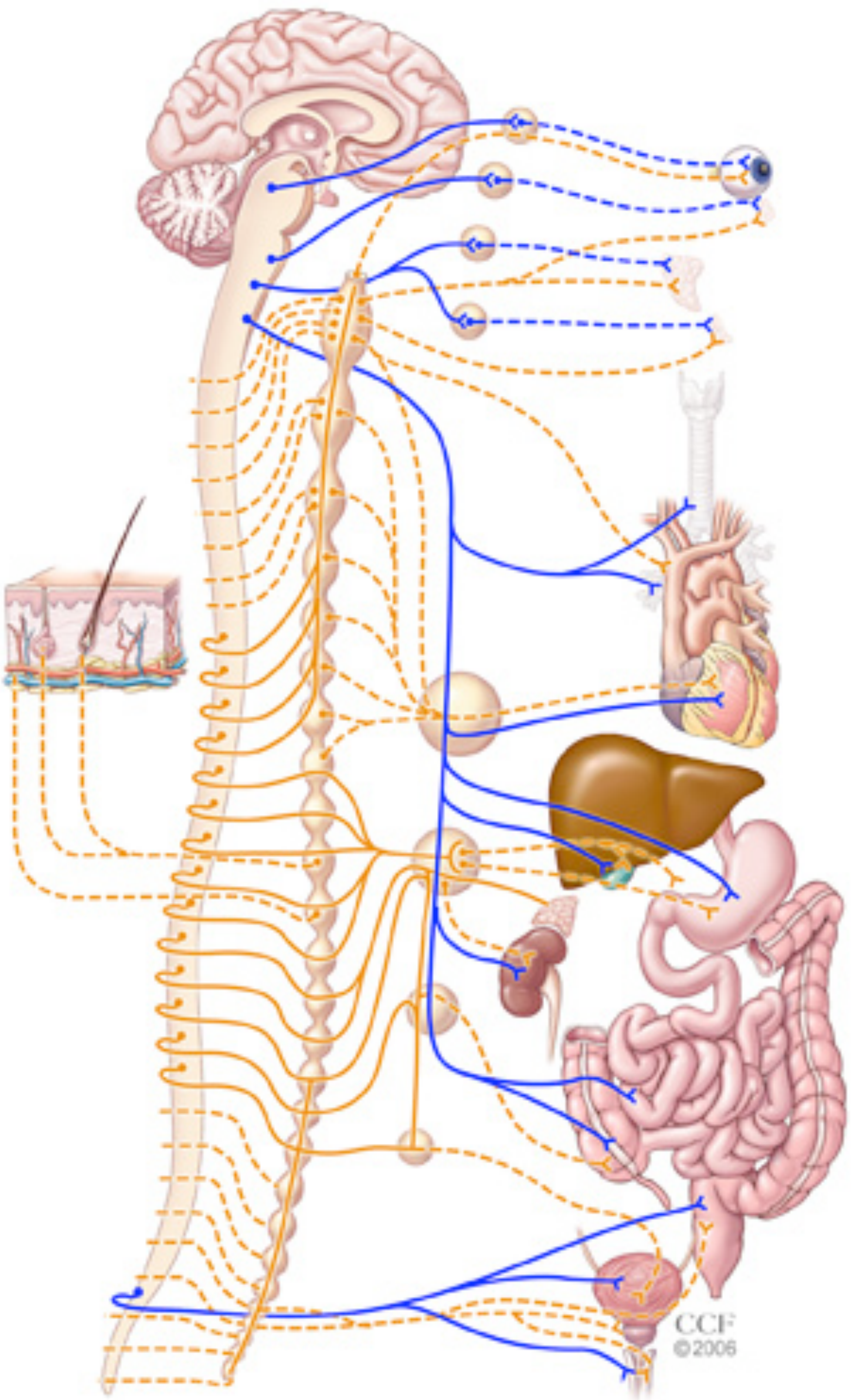
The Autonomic Vision

- Self-configuration
- Self-optimization



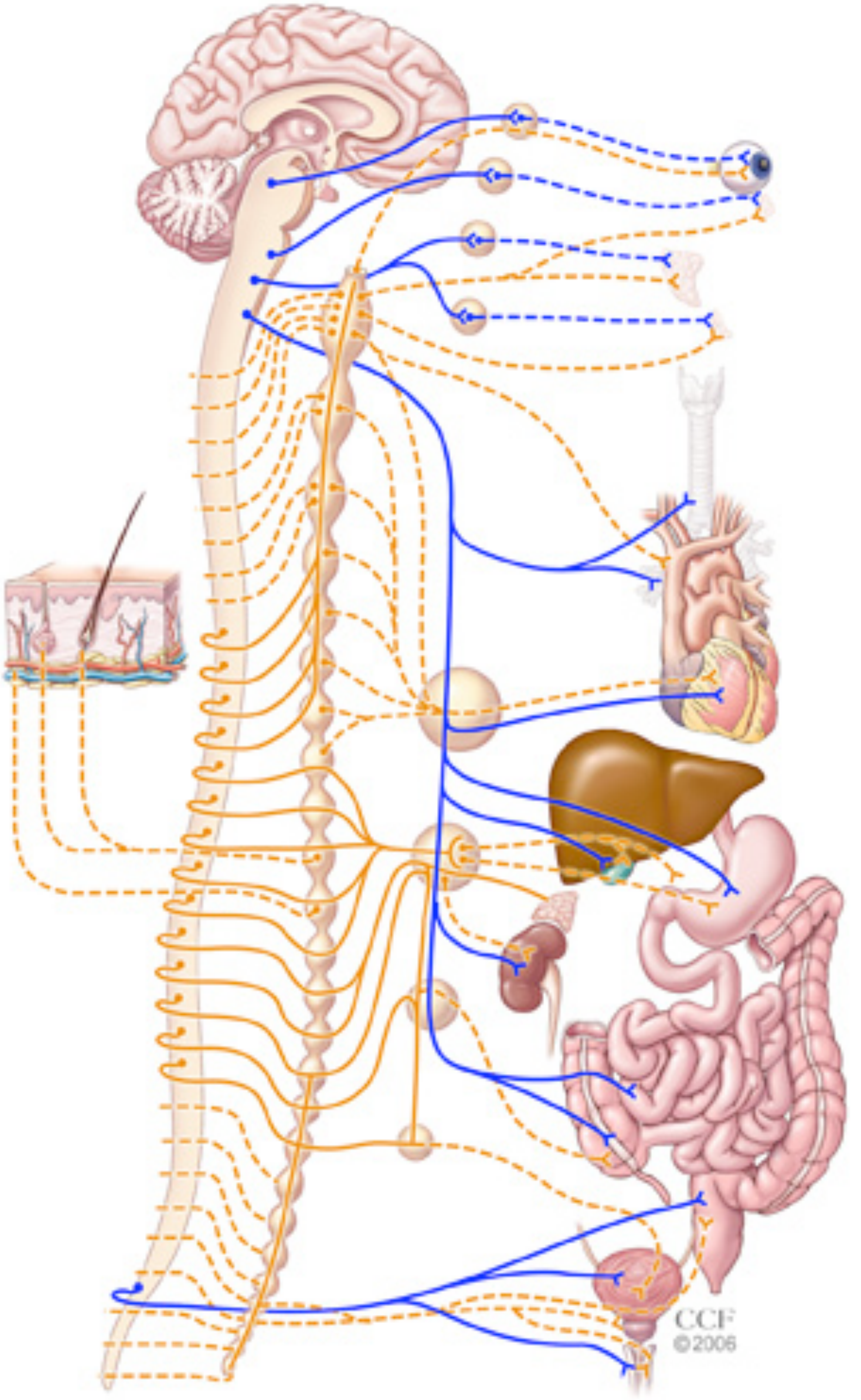
The Autonomic Vision

- Self-configuration
- Self-optimization
- Self-healing



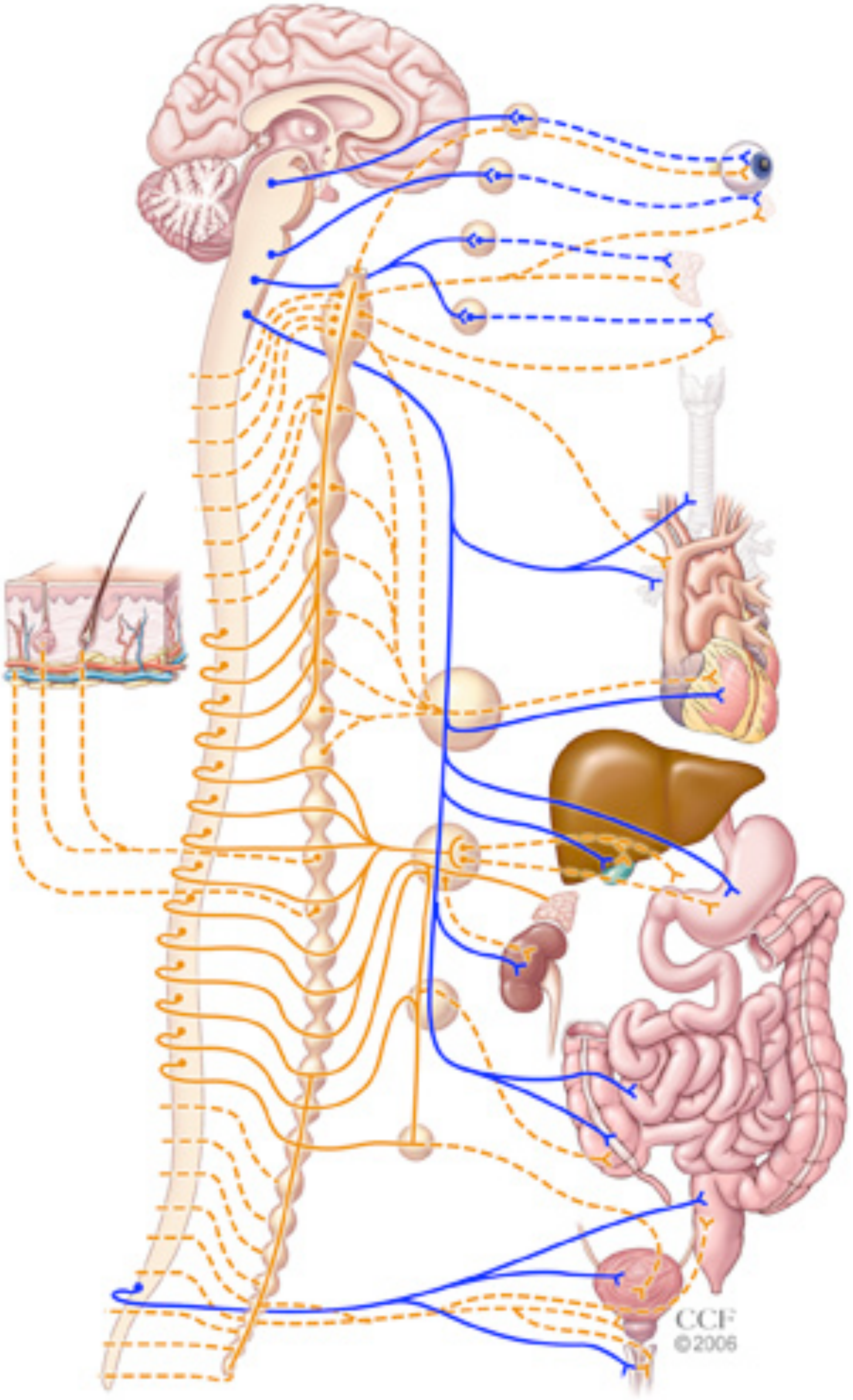
The Autonomic Vision

- Self-configuration
- Self-optimization
- Self-healing
- Self-protection

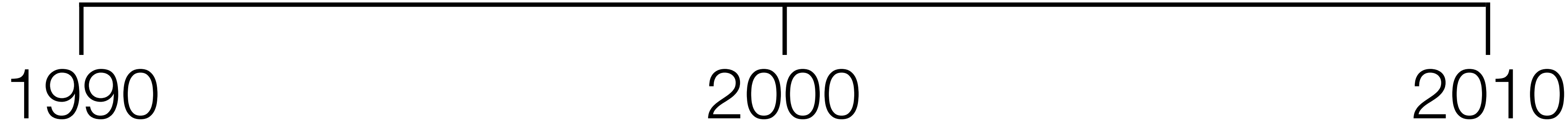


The Autonomic Vision

- Self-configuration
- Self-optimization
- Self-healing
- Self-protection
- Requires “Self-” awareness!



New Thinking, Old Problem!



1990

2000

2010

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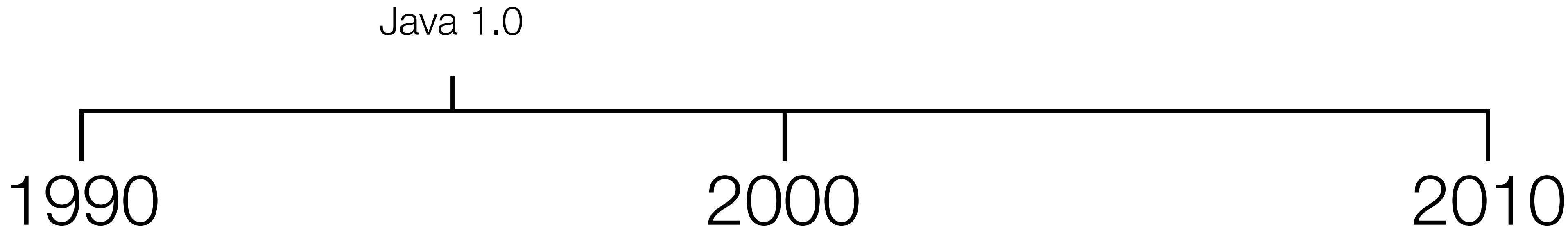

Java 1.0

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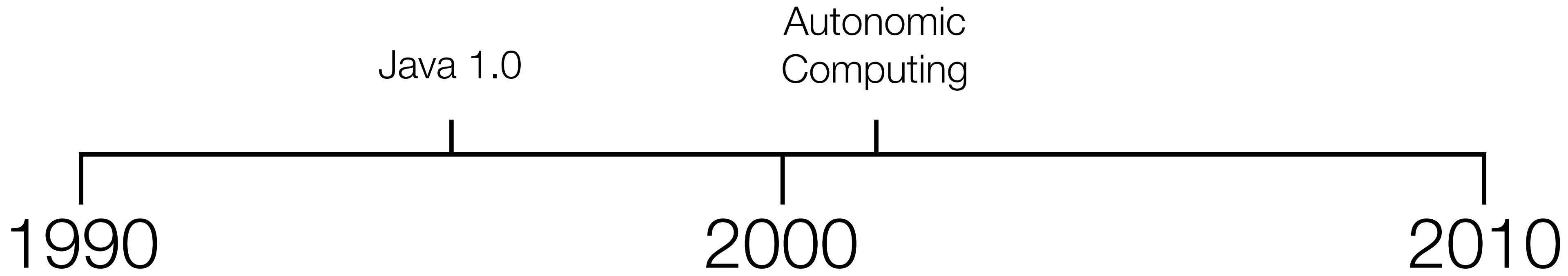

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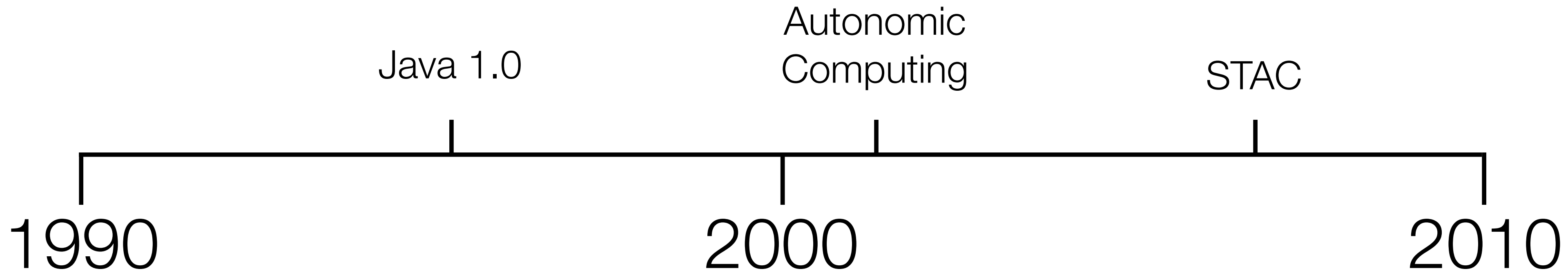

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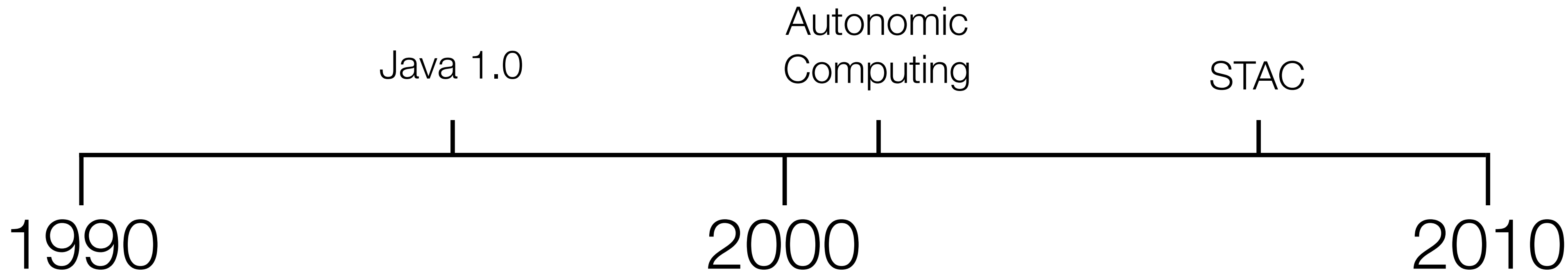

- 400 features in 36 distinct IBM products have autonomic computing capabilities [7]

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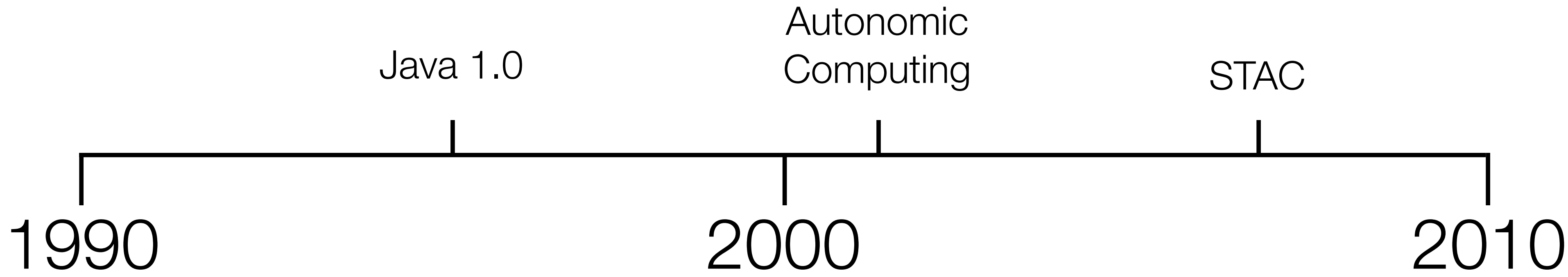

- 400 features in 36 distinct IBM products have autonomic computing capabilities [7]
- Design vs. evolution for an autonomic future

Challenges for Software Evolution

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- Syntax must be maintainable

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Tuning Parameter: A scalar field, or scalar property of a structured field, explicitly declared in source code that is used to observe or influence the behaviour of a system in terms of metrics like performance or security.

The STAC Pipeline: Past, Present and Future

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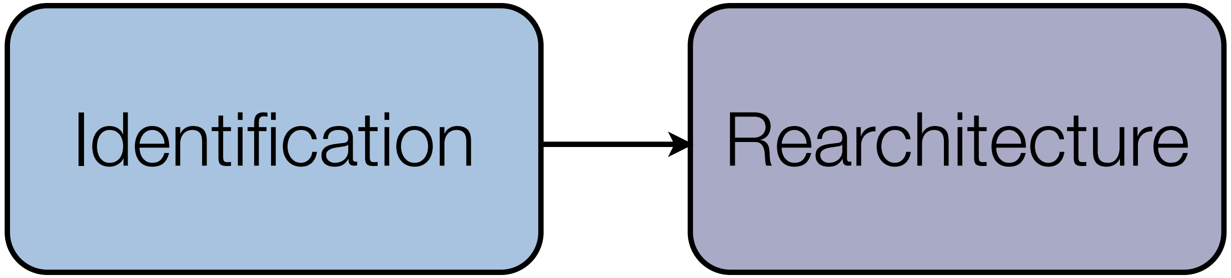
Rearchitecture

The STAC Pipeline: Past, Present and Future



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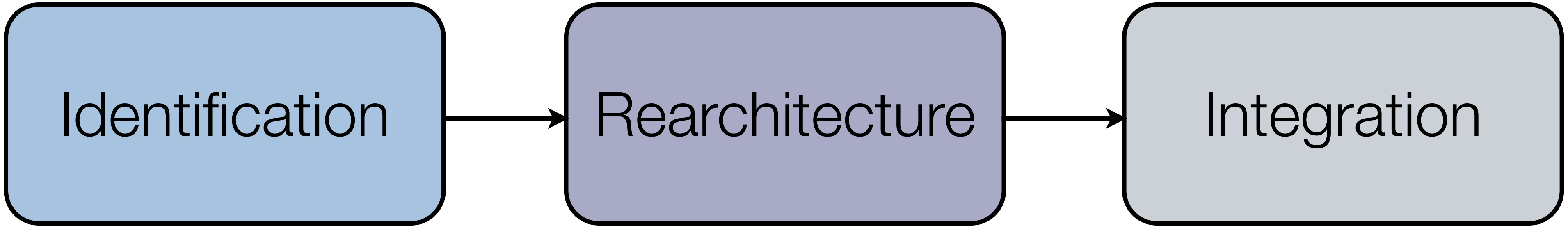
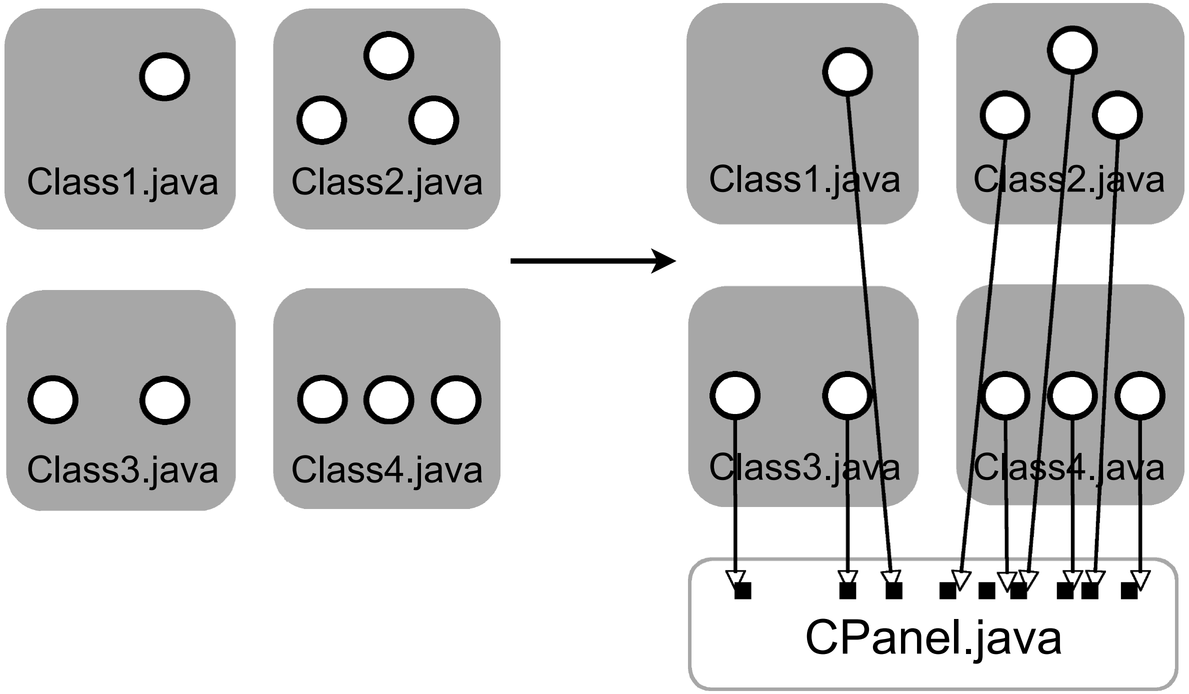


Rearchitecture using TXL (Past)



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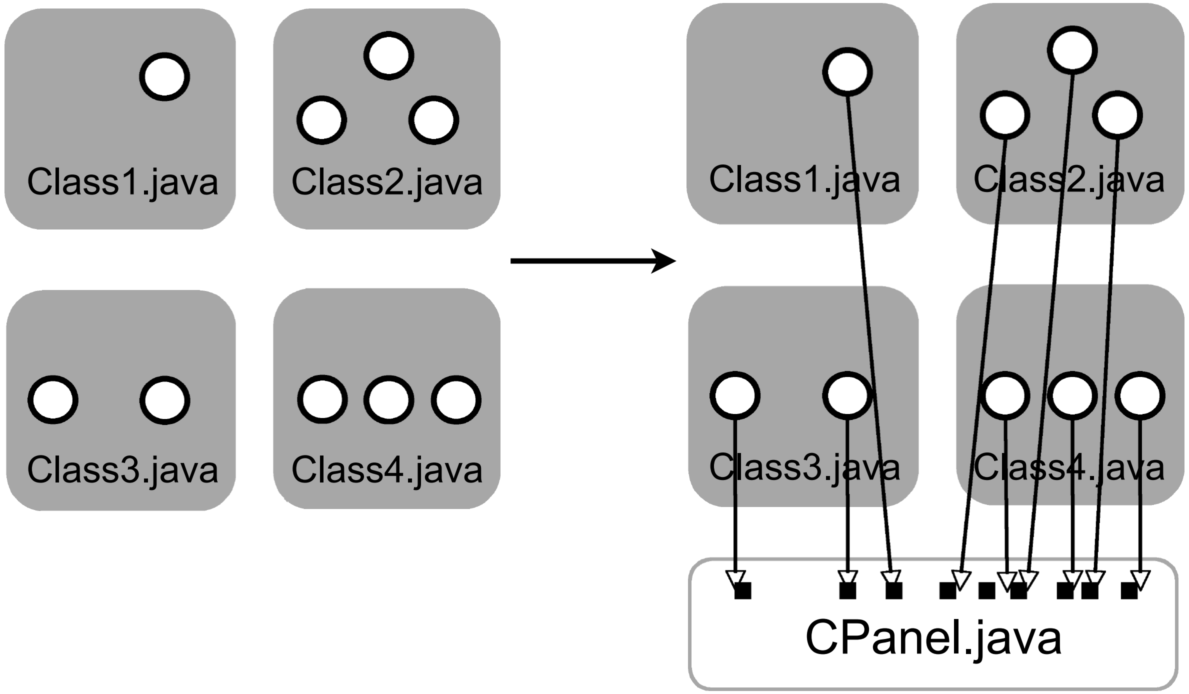
- Markup declarations with XML



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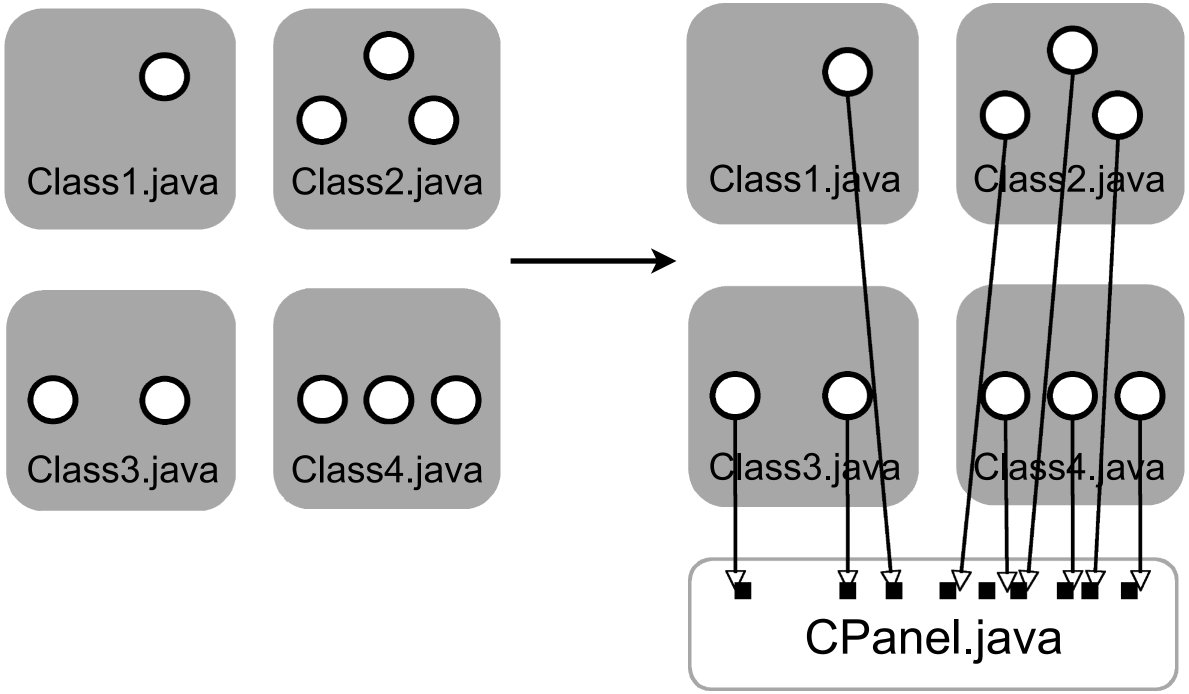
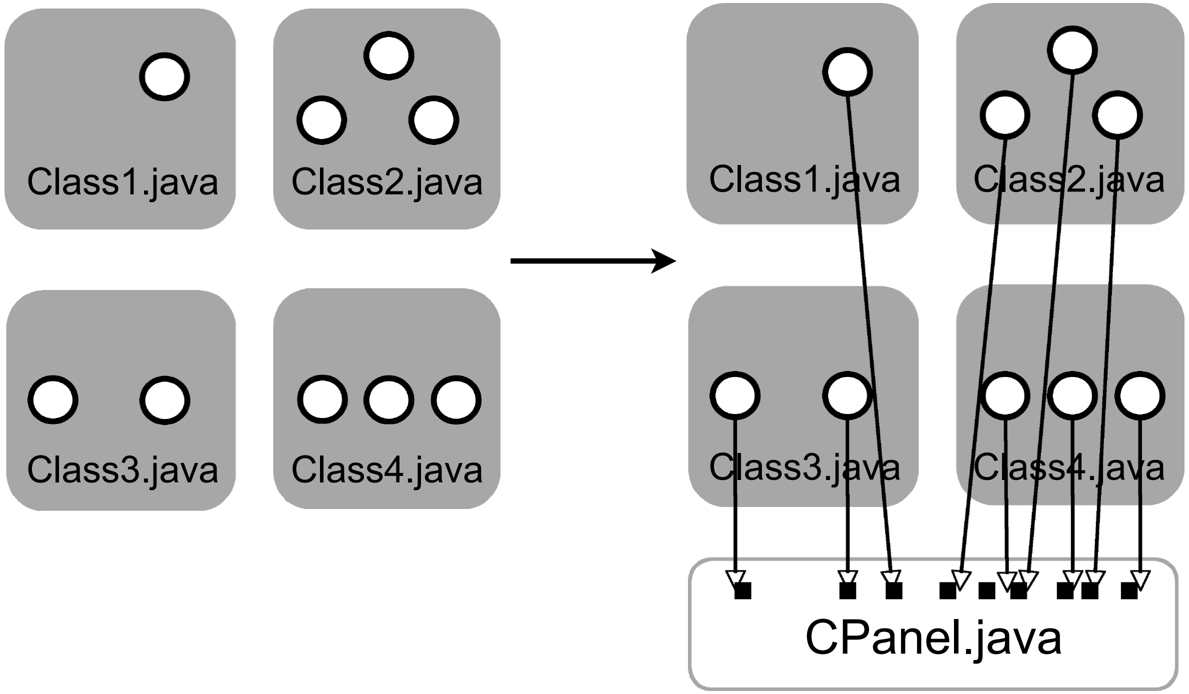


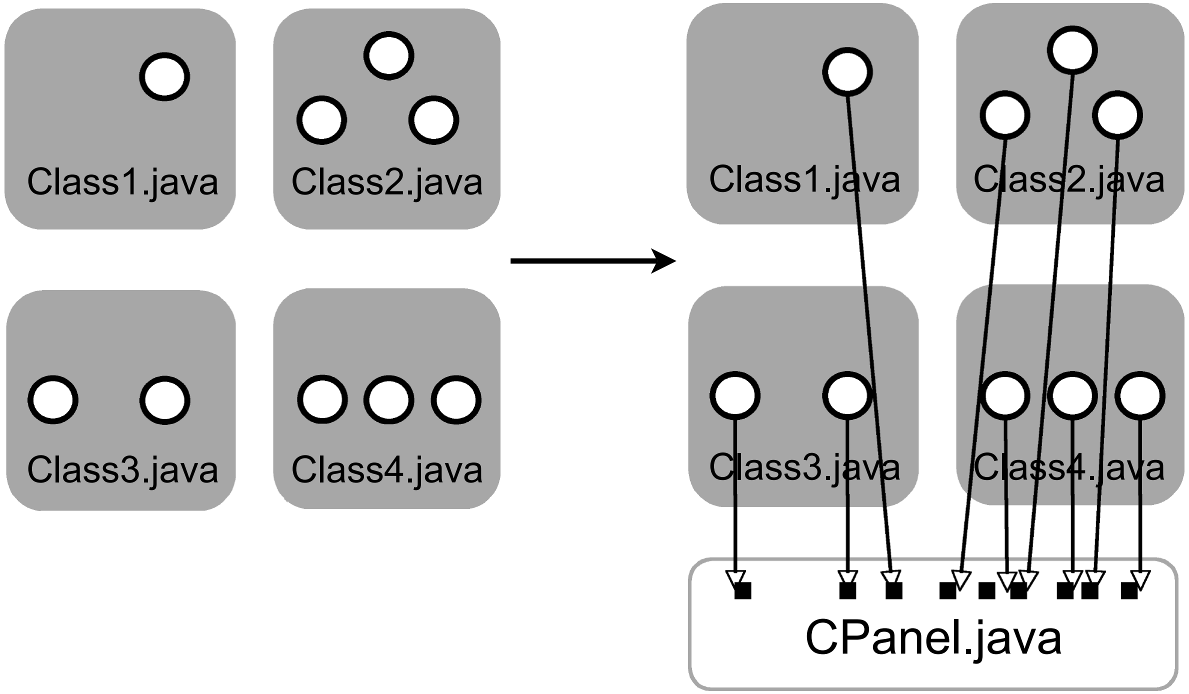
Rearchitecture using TXL (Past)

- Markup declarations with XML
- Normalize source files
- Trace references



Rearchitecture using TXL (Past)

- Markup declarations with XML
- Normalize source files
- Trace references
- Synthesize control panel



Rearchitecture using TXL (Past)

- Markup declarations with XML
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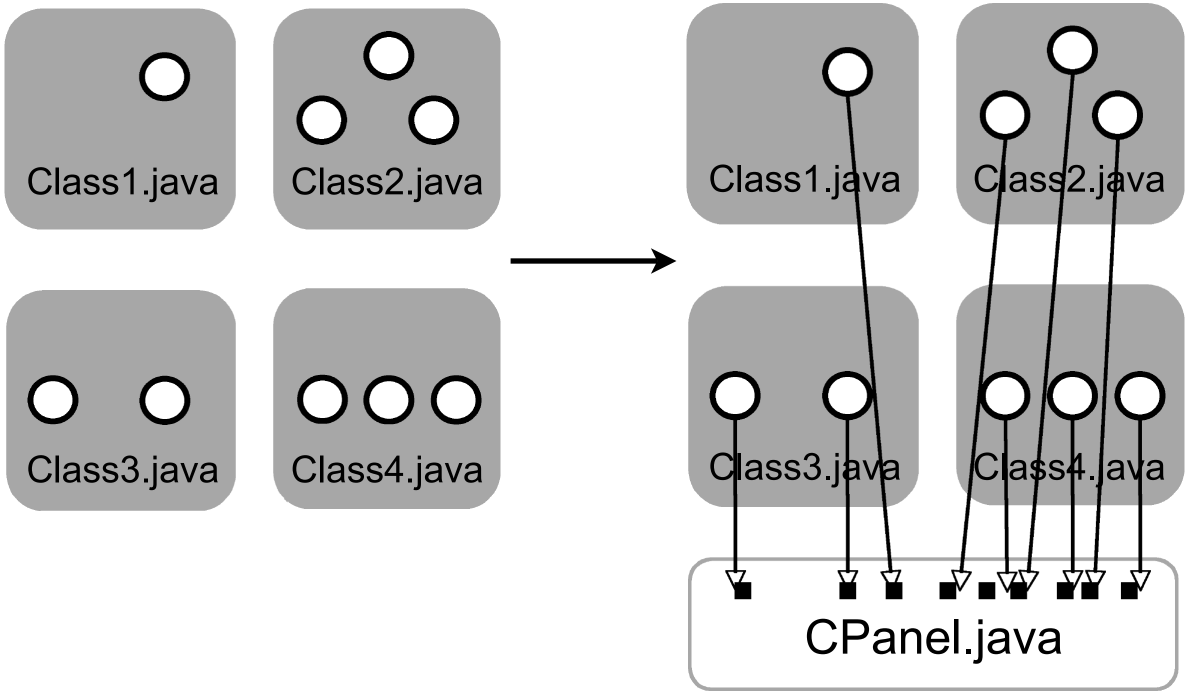
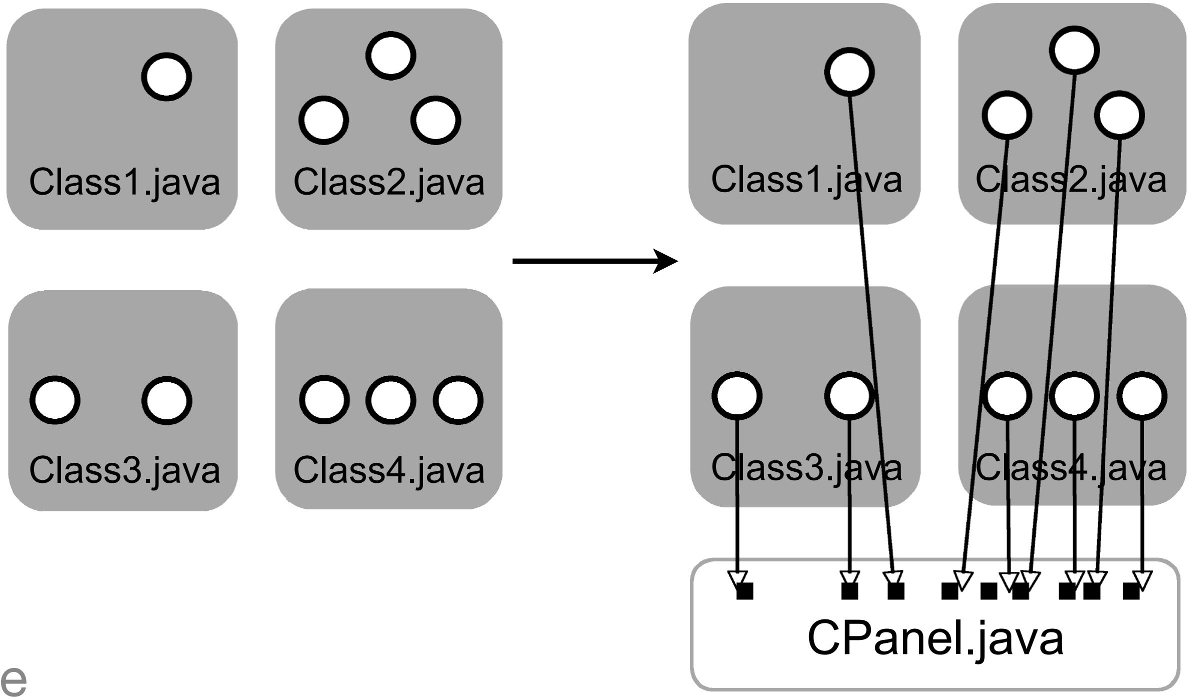
- Redirect references



Rearchitecture using TXL (Past)

- Markup declarations with XML
- Normalize source files
- Trace references
- Synthesize control panel
- Redirect references
- Reconstitute original structure



Example: A Simple Server (Before)

```
public class Server {
    ...
    <control_param>
    private int maxConnections = 100;
    </control_param>
    ...

    public boolean accept() {
        if (numConnections < maxConnections) {
        ...
    }
    ...
}
```

Example: A Simple Server (After)

```
public class Server {
    ...
    CPanel.maxConnections.set(100);
    ...

    public boolean accept() {
        if (numConnections <
            CPanel.maxConnections.get()) {
        ...
    }
    ...
}
```

```
public class CPanel {
    public static class maxConnections {
        private static int value;

        public static int create() {
            return value;
        }

        public static int set(int value) {
            this.value = value;
            return value;
        }

        public static int get() {
            return value;
        }
    }
}
```

Example: A Simple Server

Before	After
<control_param> private int maxConnections = 100; </control_param>	CPanel.maxConnections.set(100);
if (numConnections < maxConnections)	if (numConnections < CPanel.maxConnections.get())

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- Generate WSDL specification for control panel to allow management via WSDM

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- Match patterns (i.e., query graph for instances of patterns)

A Survey of Tuning Parameters

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    - Apache Tomcat (Web)
    - Apache Derby (Database)
    - Jetty (Web)
    - Oracle Berkeley DB Java Edition (Database)

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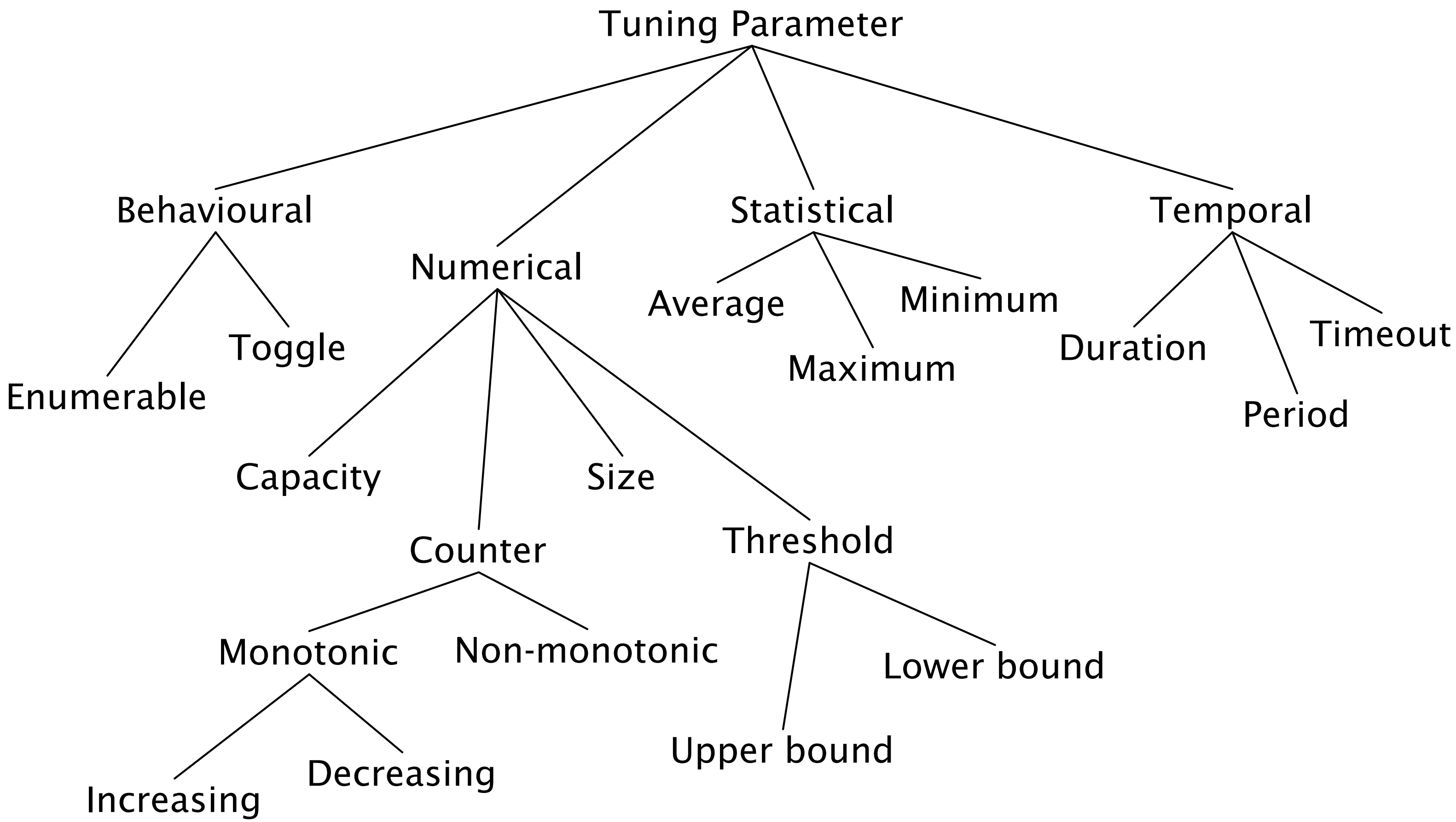
- Traced source code references and classified them according to patterns of use

Patterns of Use: A Taxonomy



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- Parser generates an abstract syntax tree for a compilation unit (e.g., statements, expressions, declarations)

- Program model provides traceability from program model elements to actual source positions (e.g., types, fields, methods, local variables)

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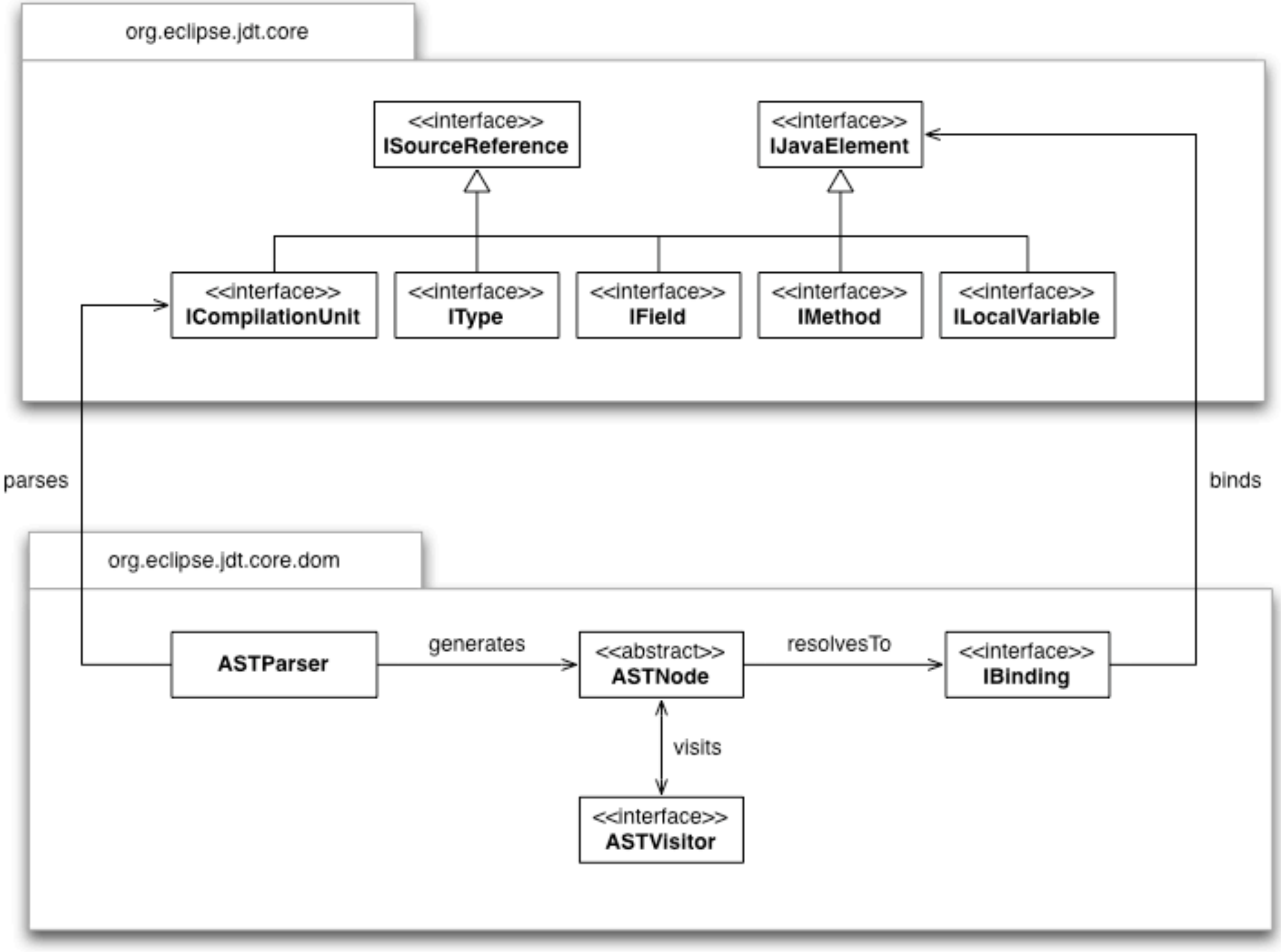
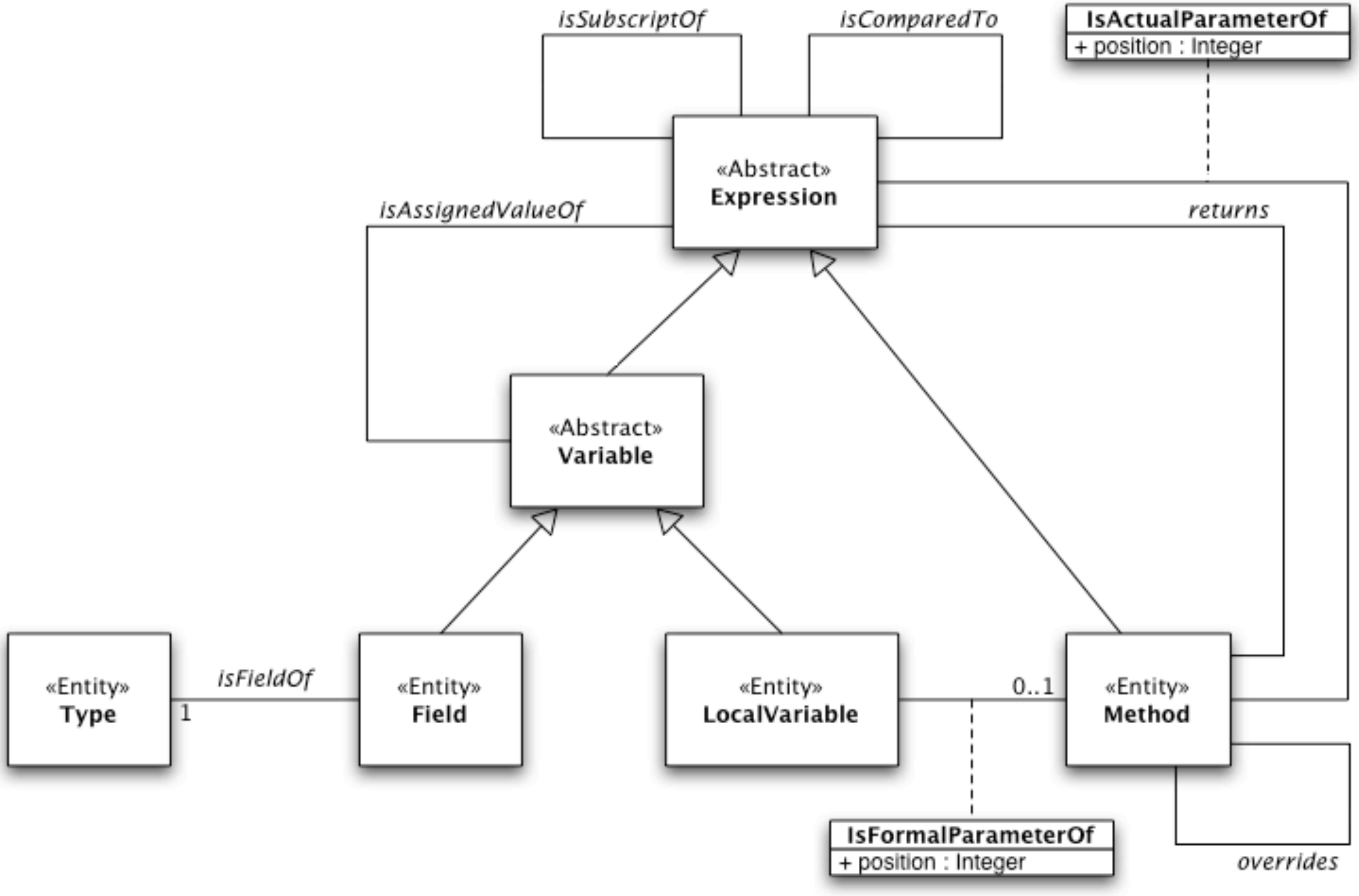


An Entity-Relationship Model



Fact Extraction and Inference

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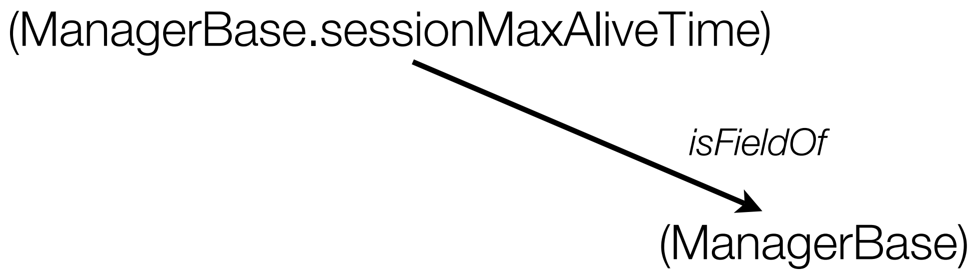

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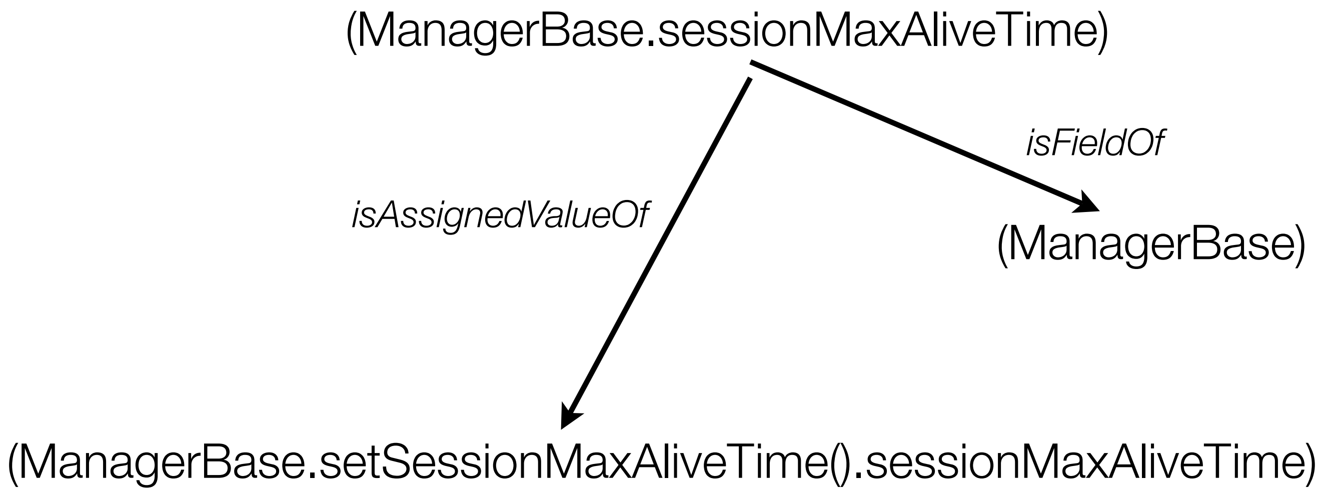
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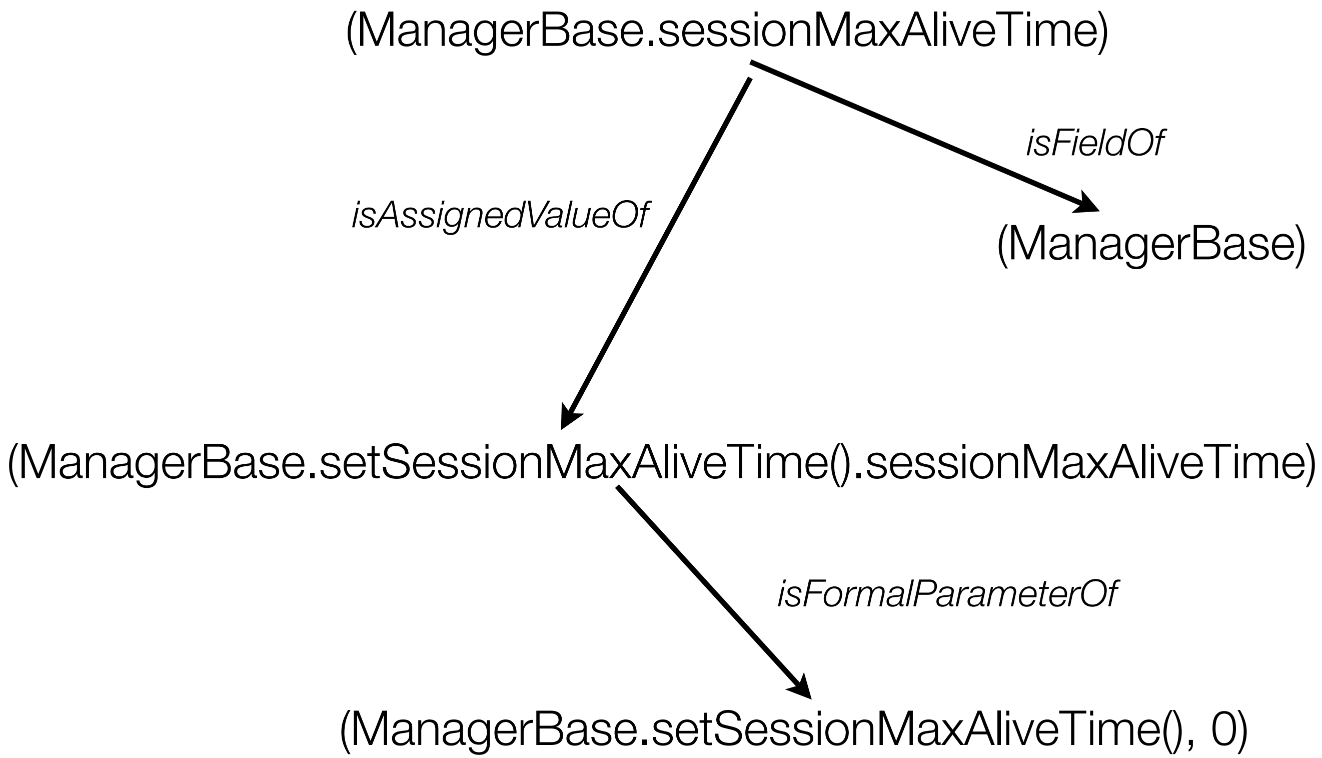

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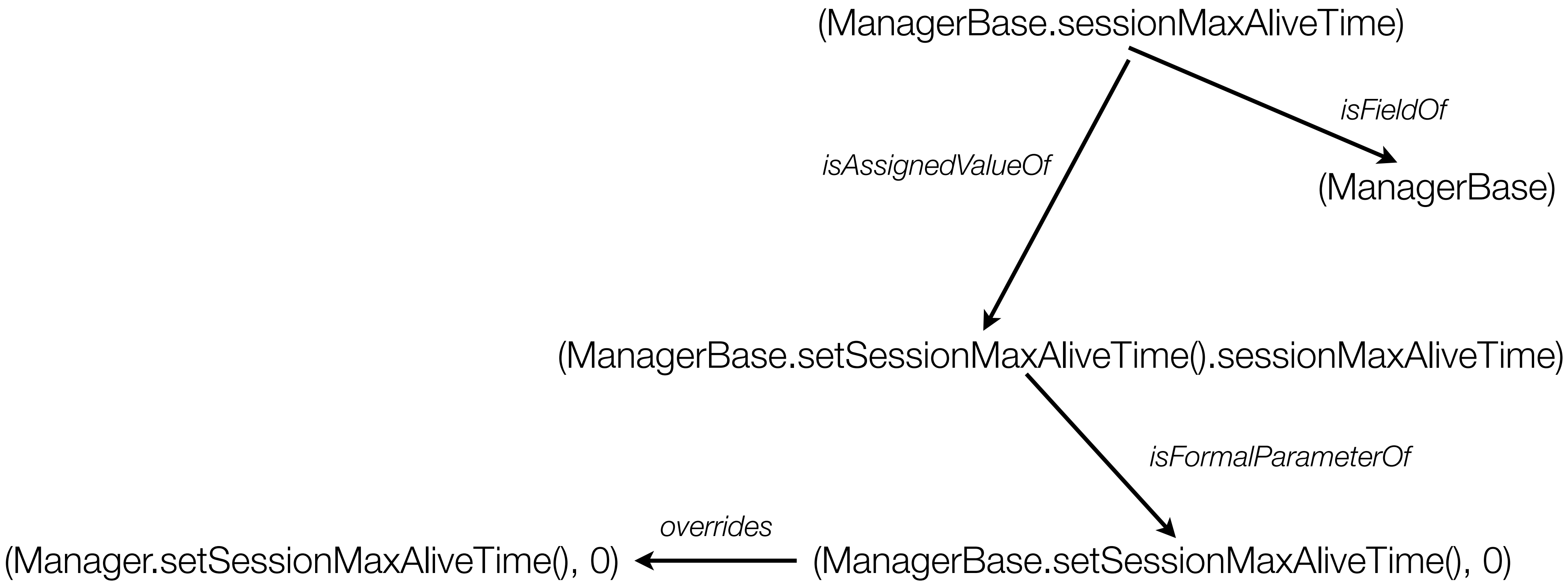

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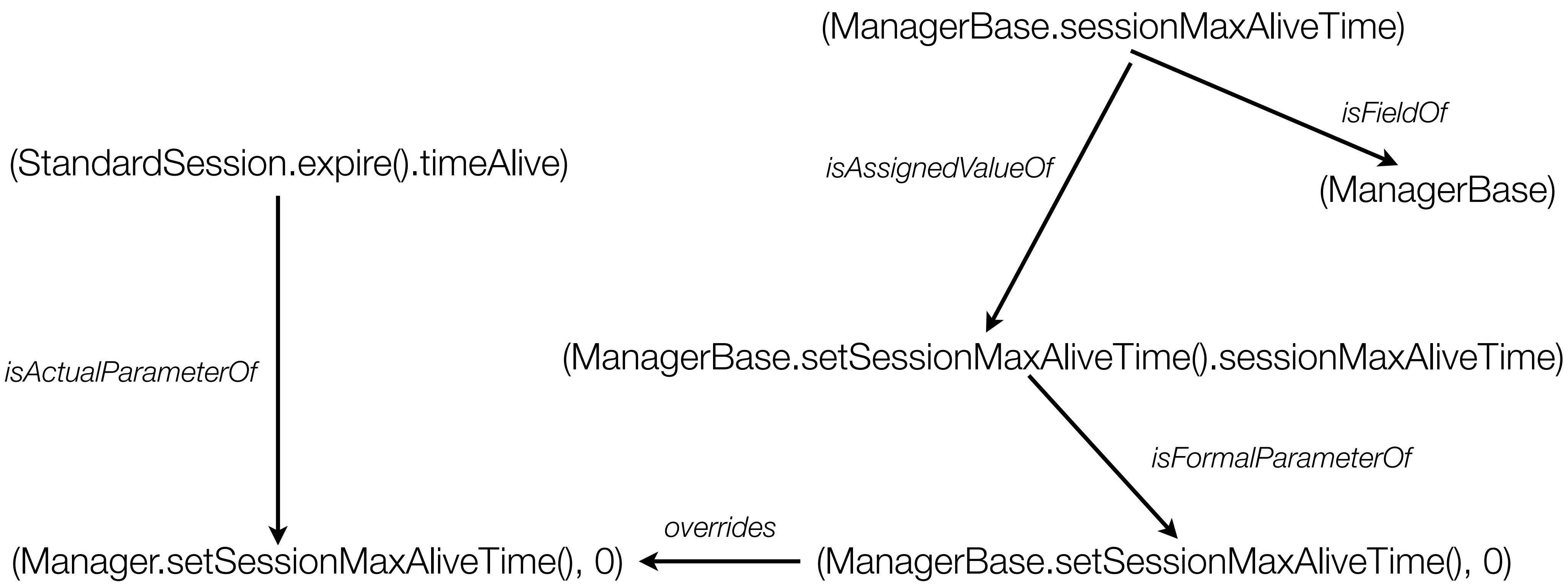

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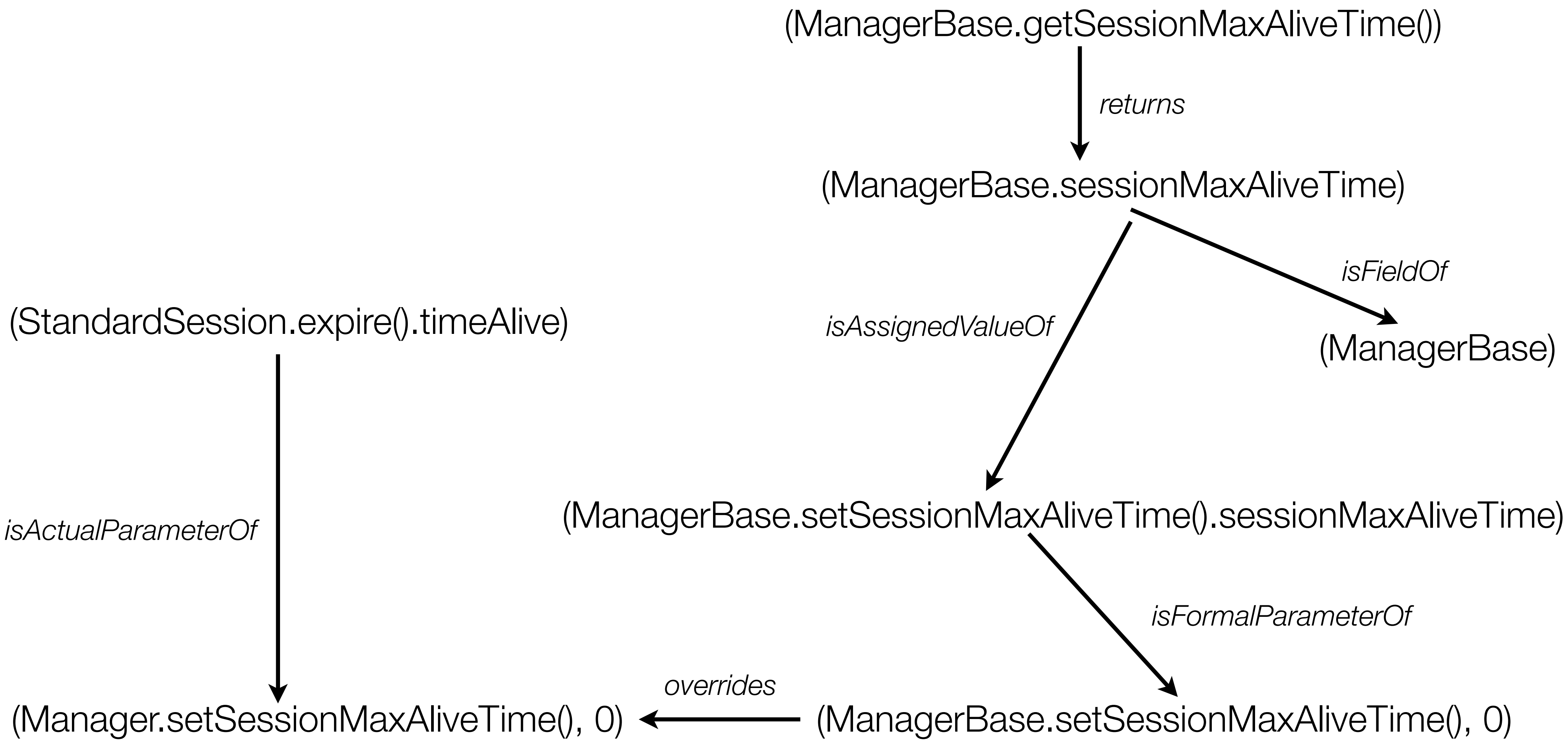

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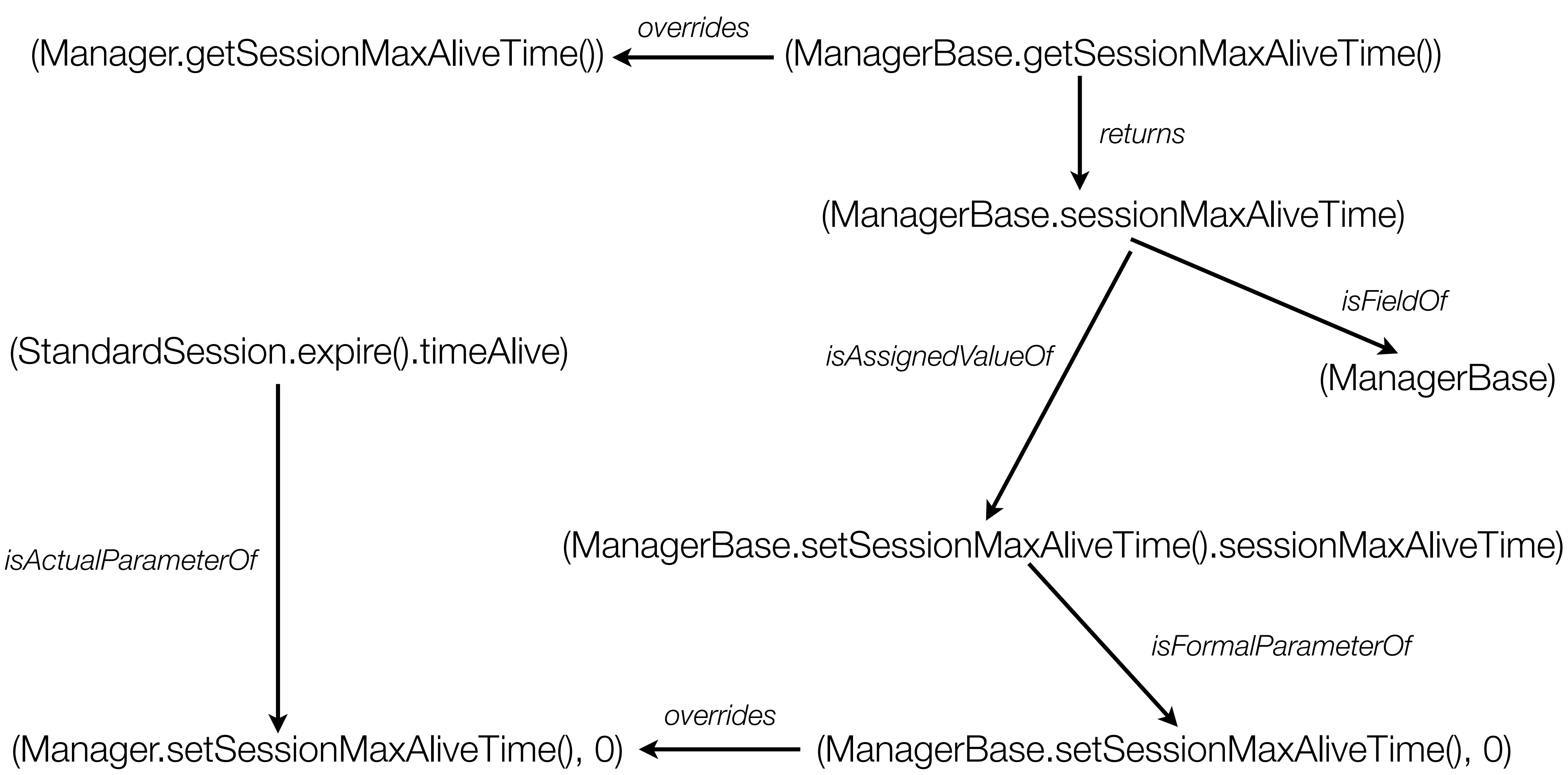

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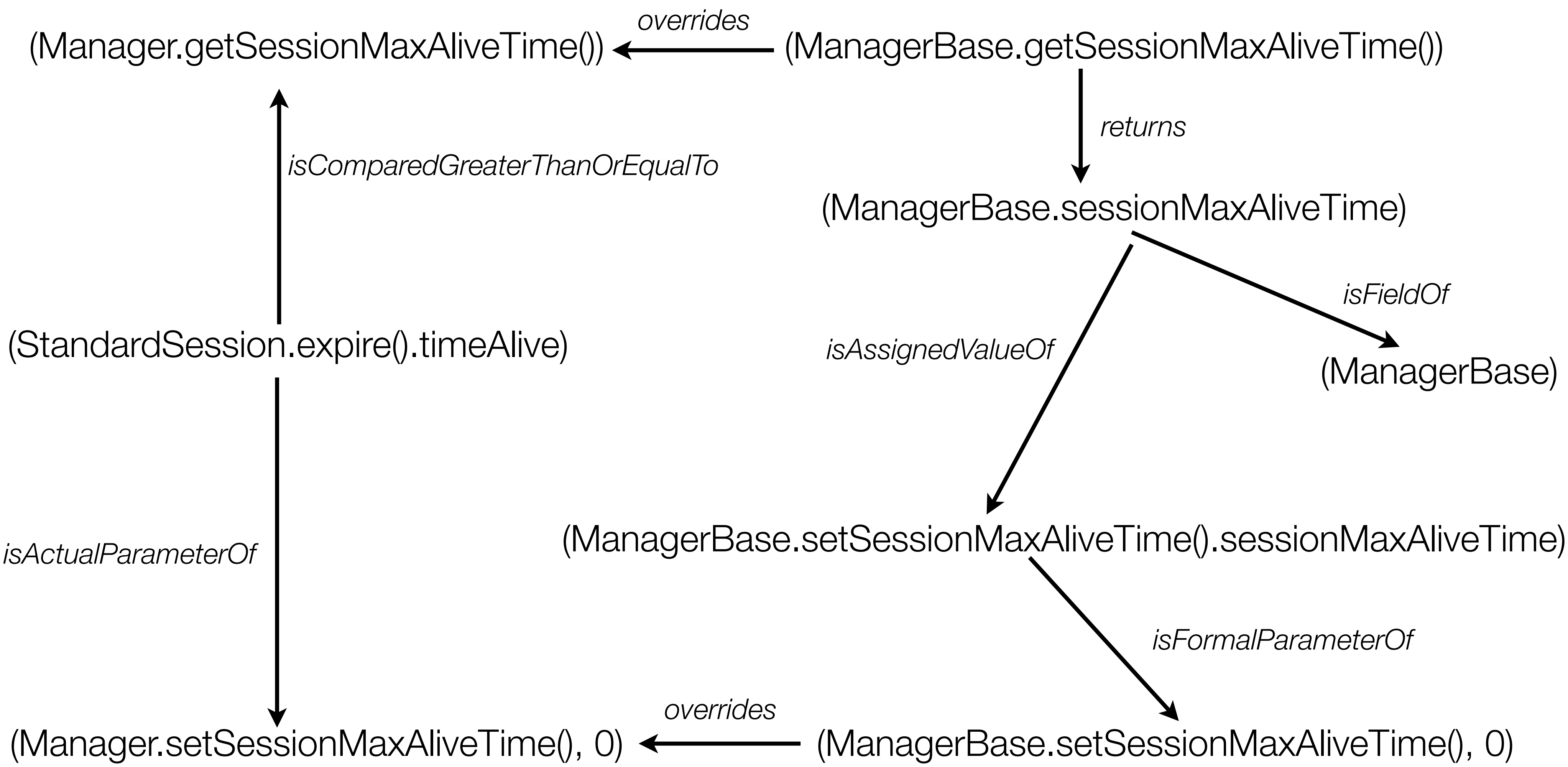

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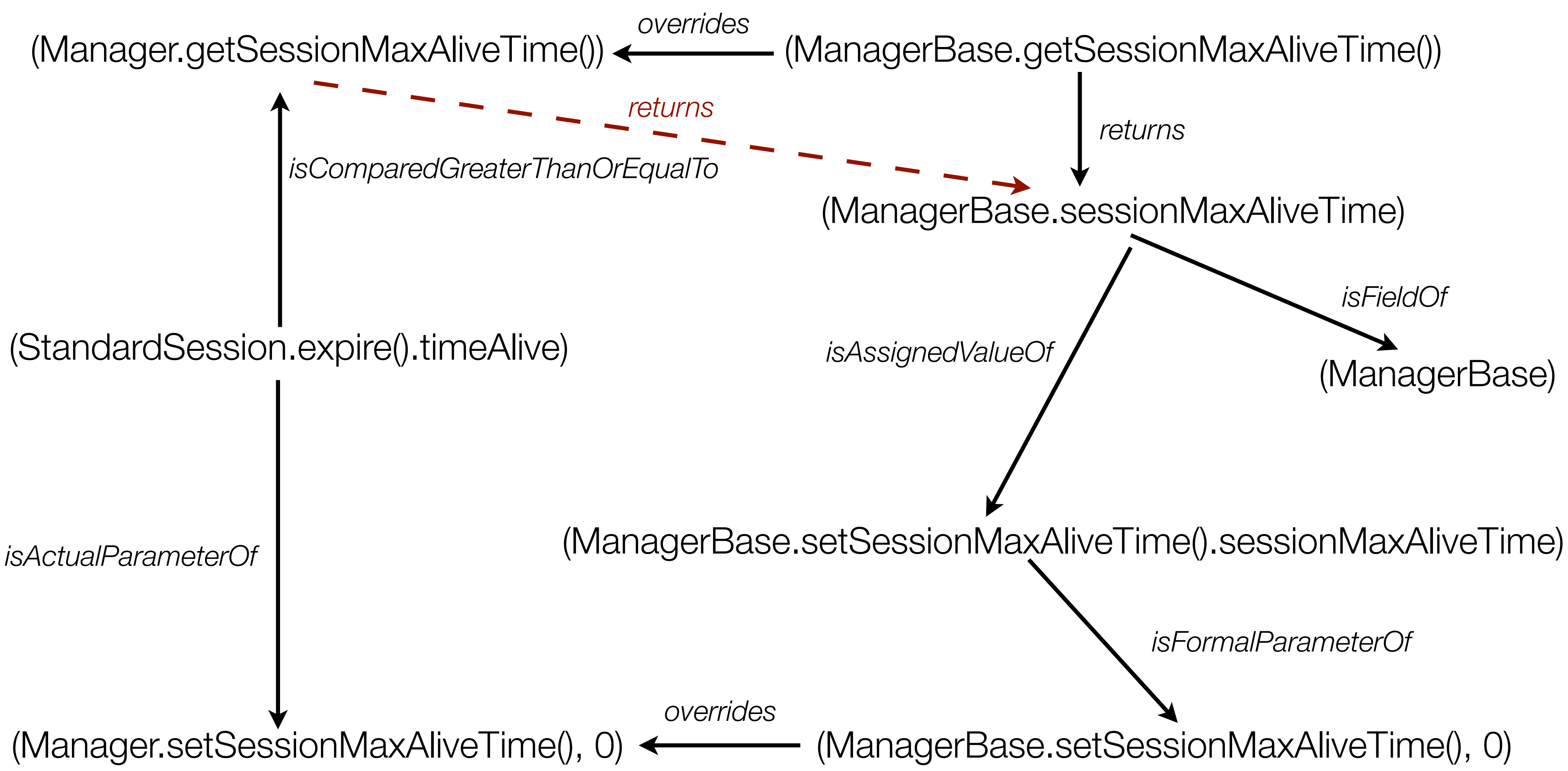

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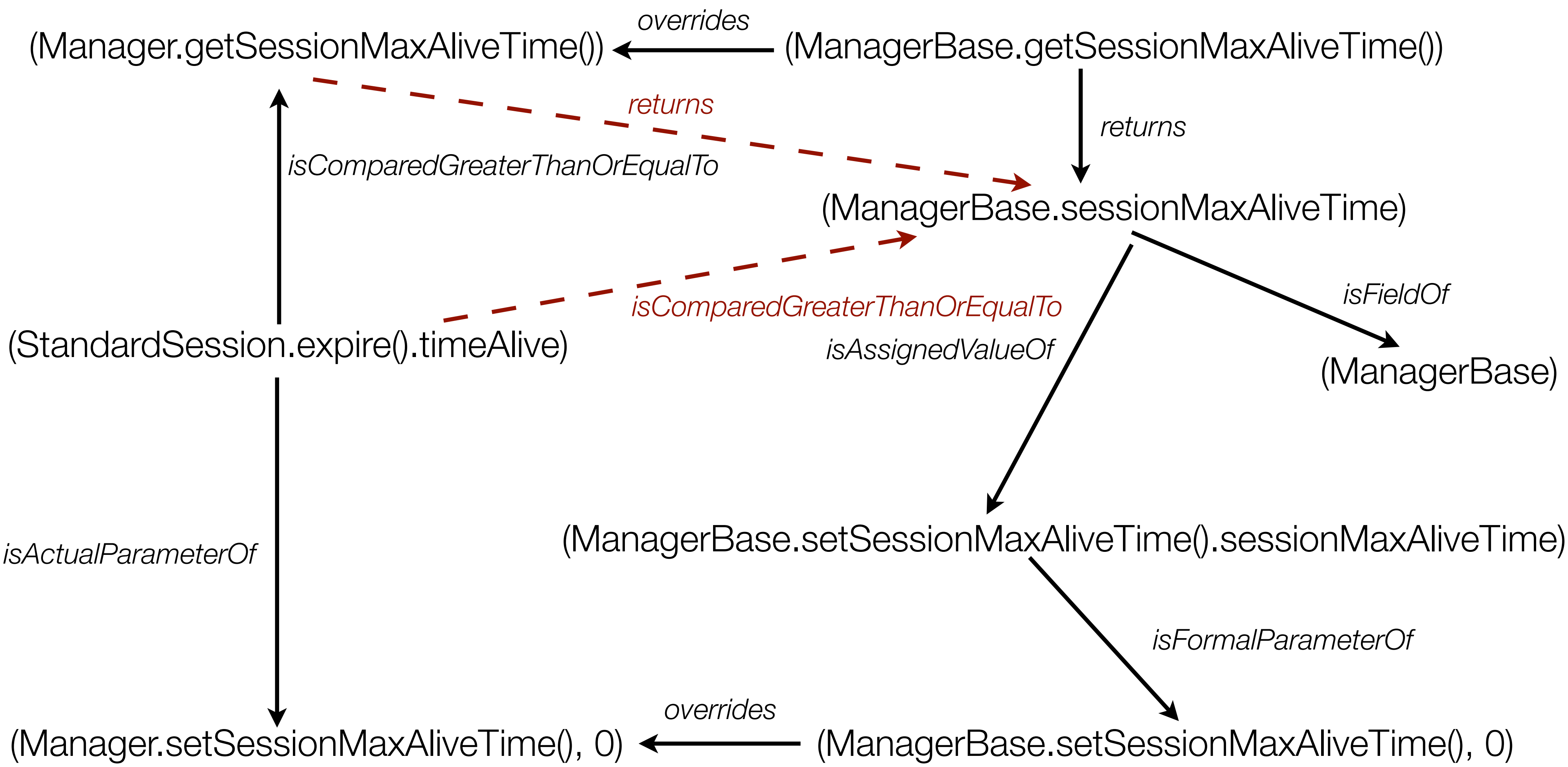

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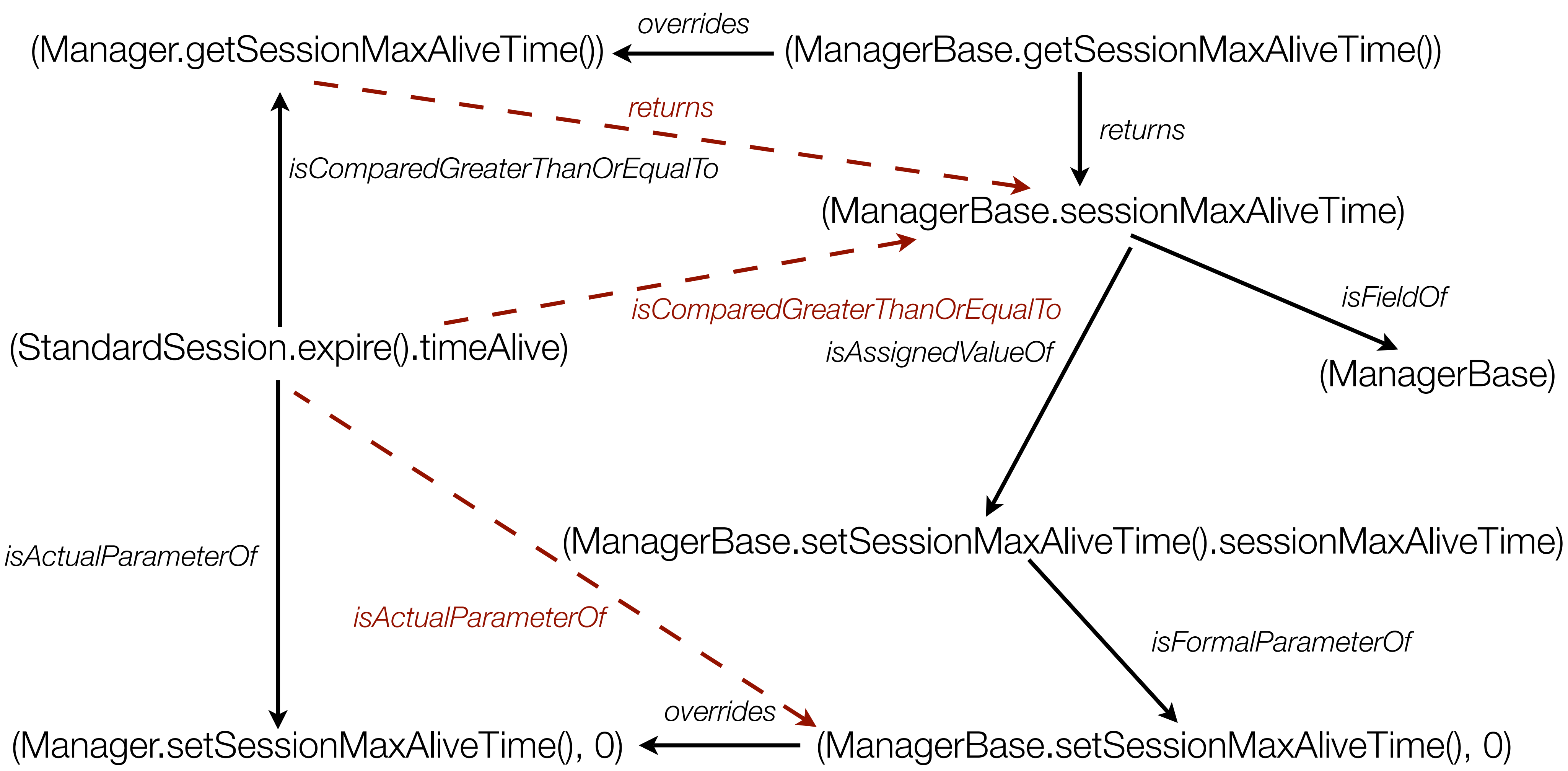
(Manager.getSessionMaxAliveTime())
overrides
(ManagerBase.getSessionMaxAliveTime())
returns
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(ManagerBase.sessionMaxAliveTime)
isFieldOf
(StandardSession.expire().timeAlive)
isComparedGreaterThanOrEqualTo
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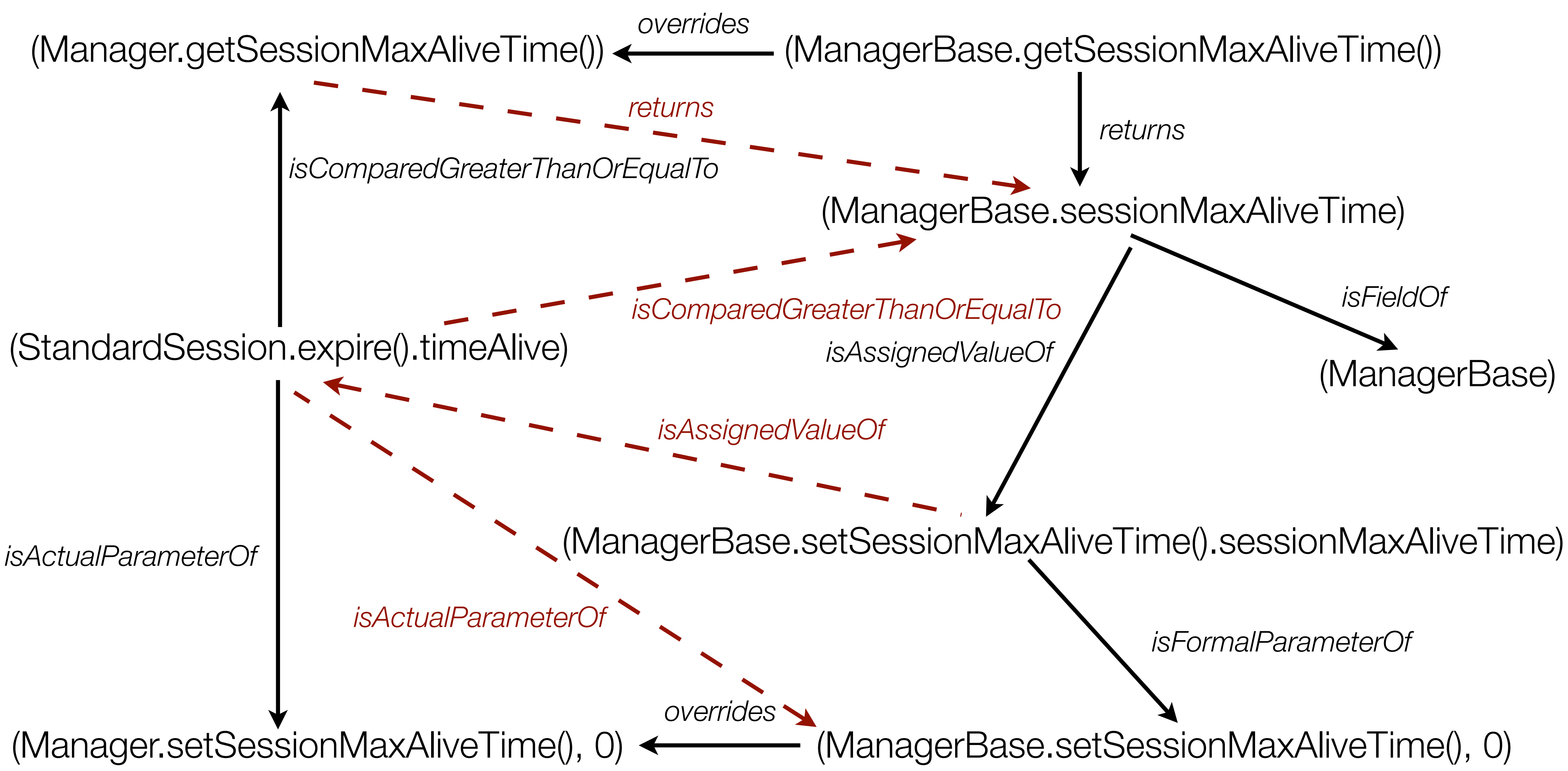

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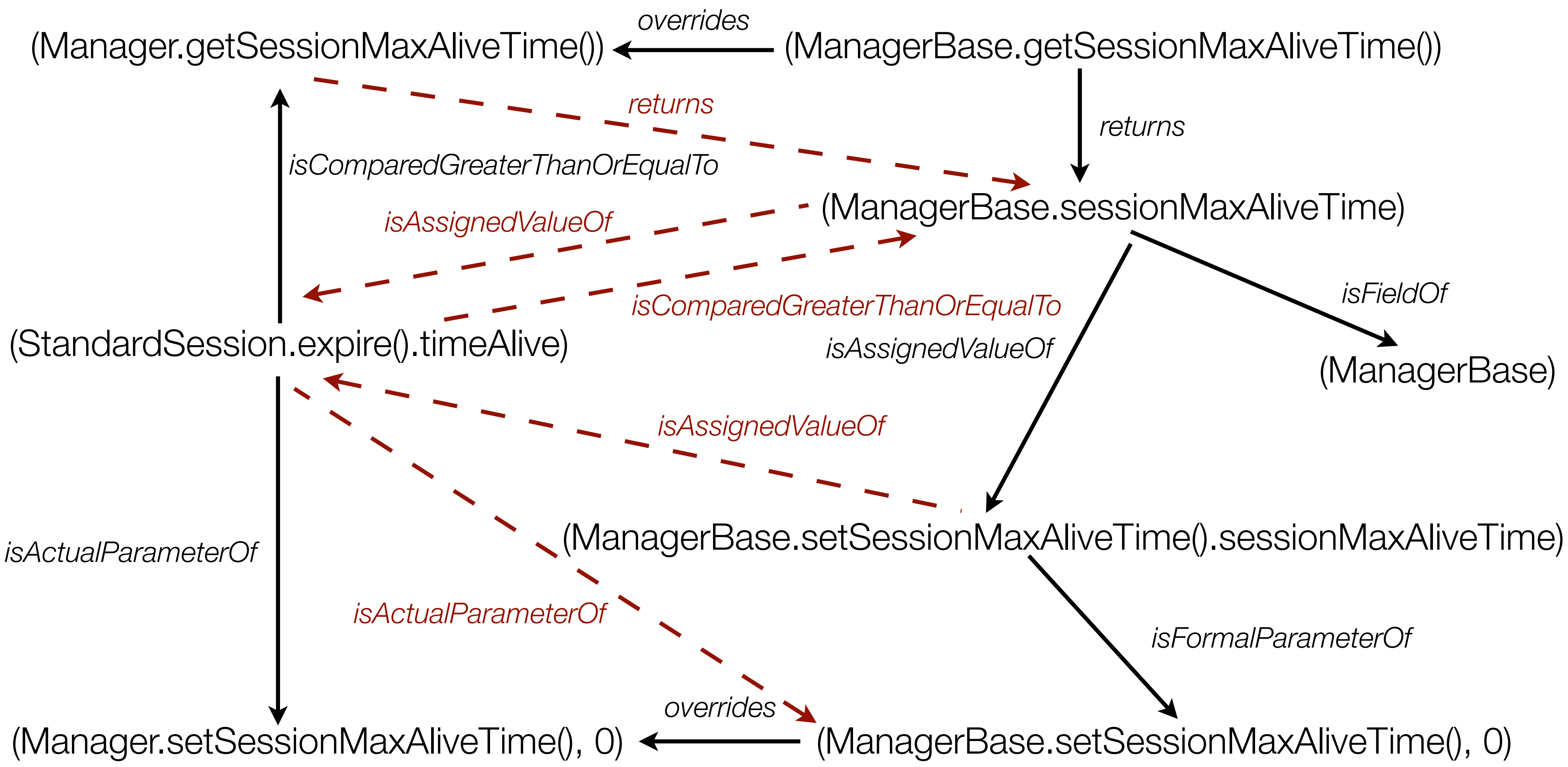

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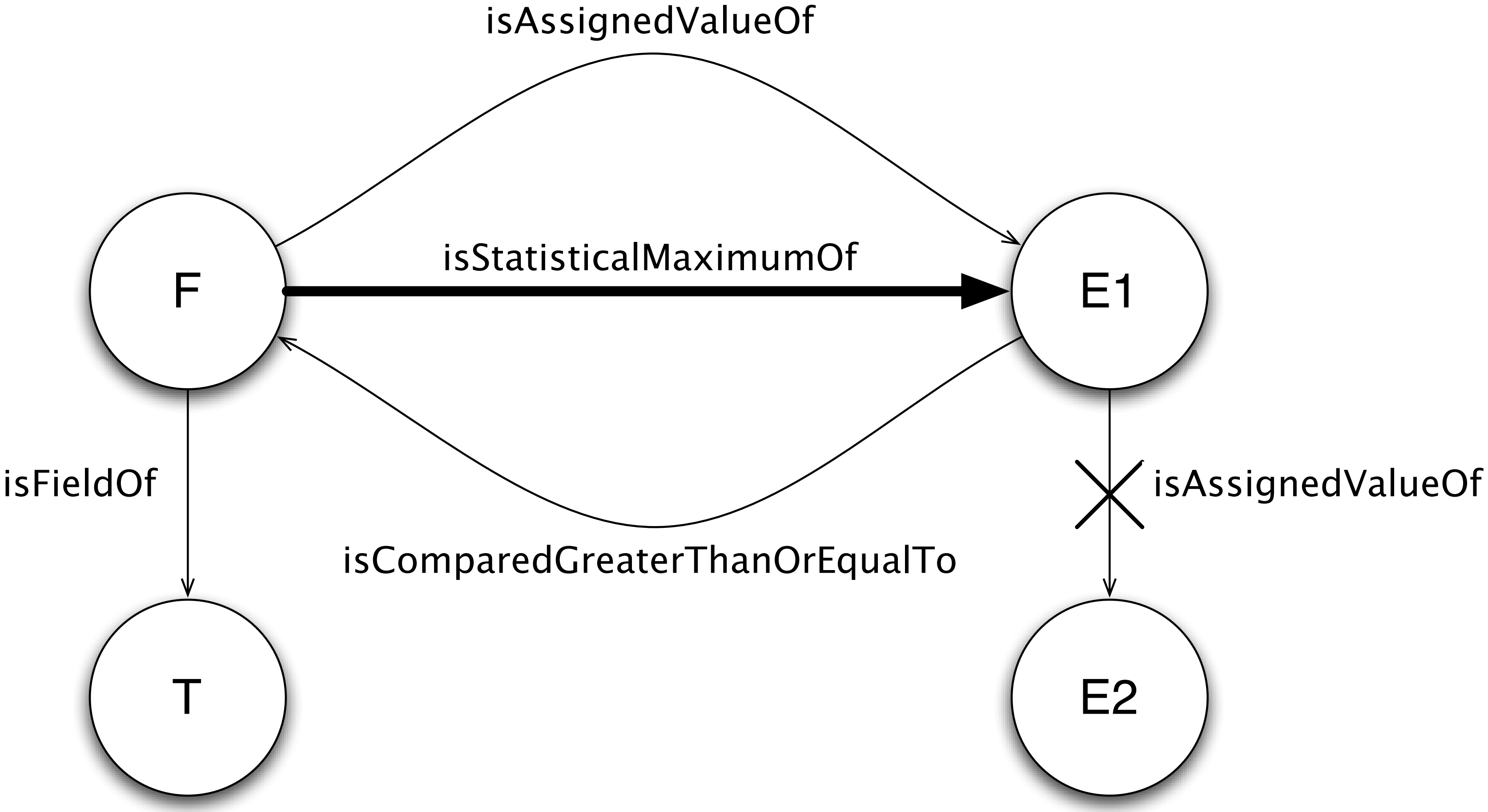
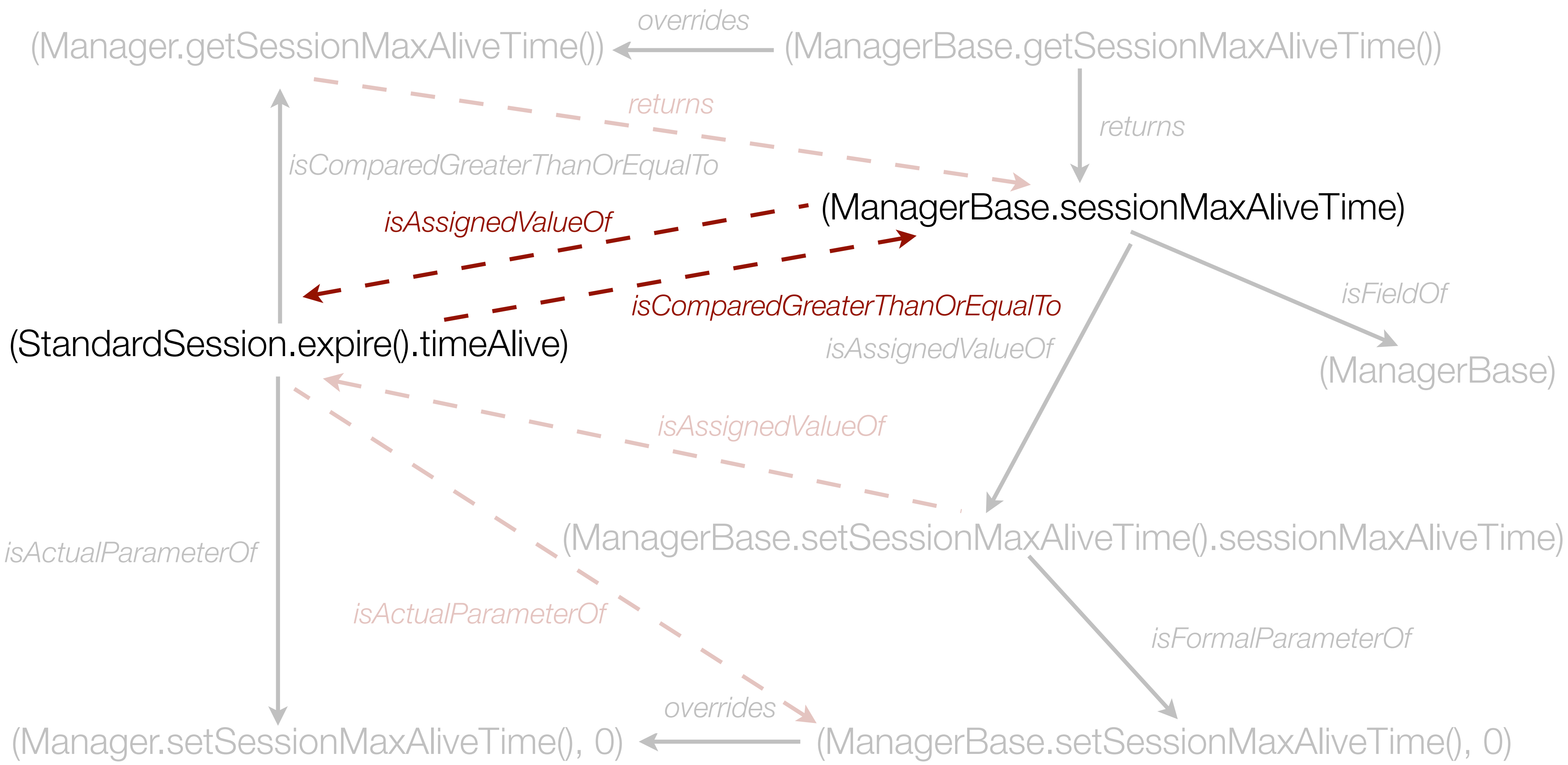
Graph Pattern Matching: Statistical Maximum



Graph Pattern Matching



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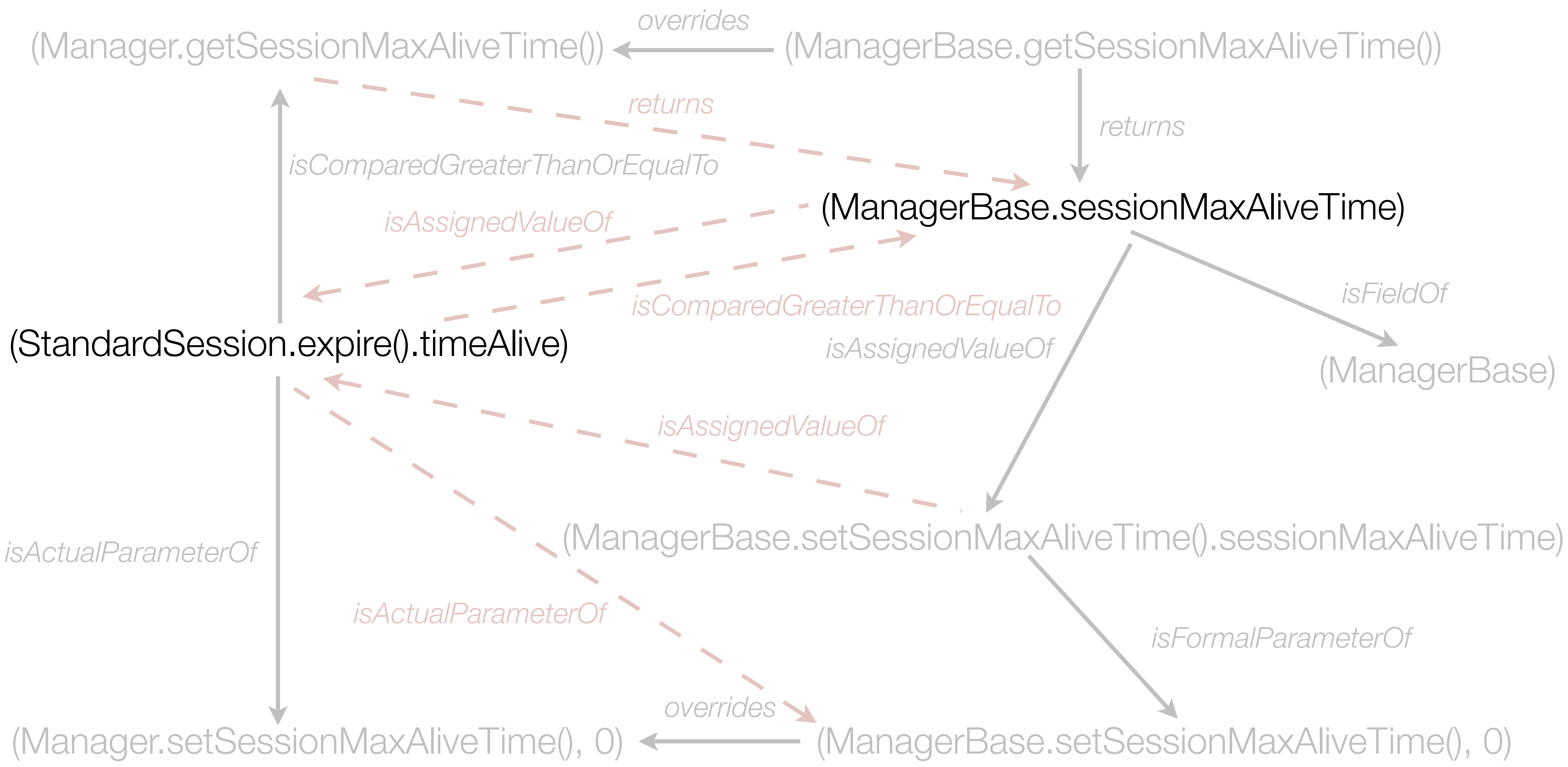

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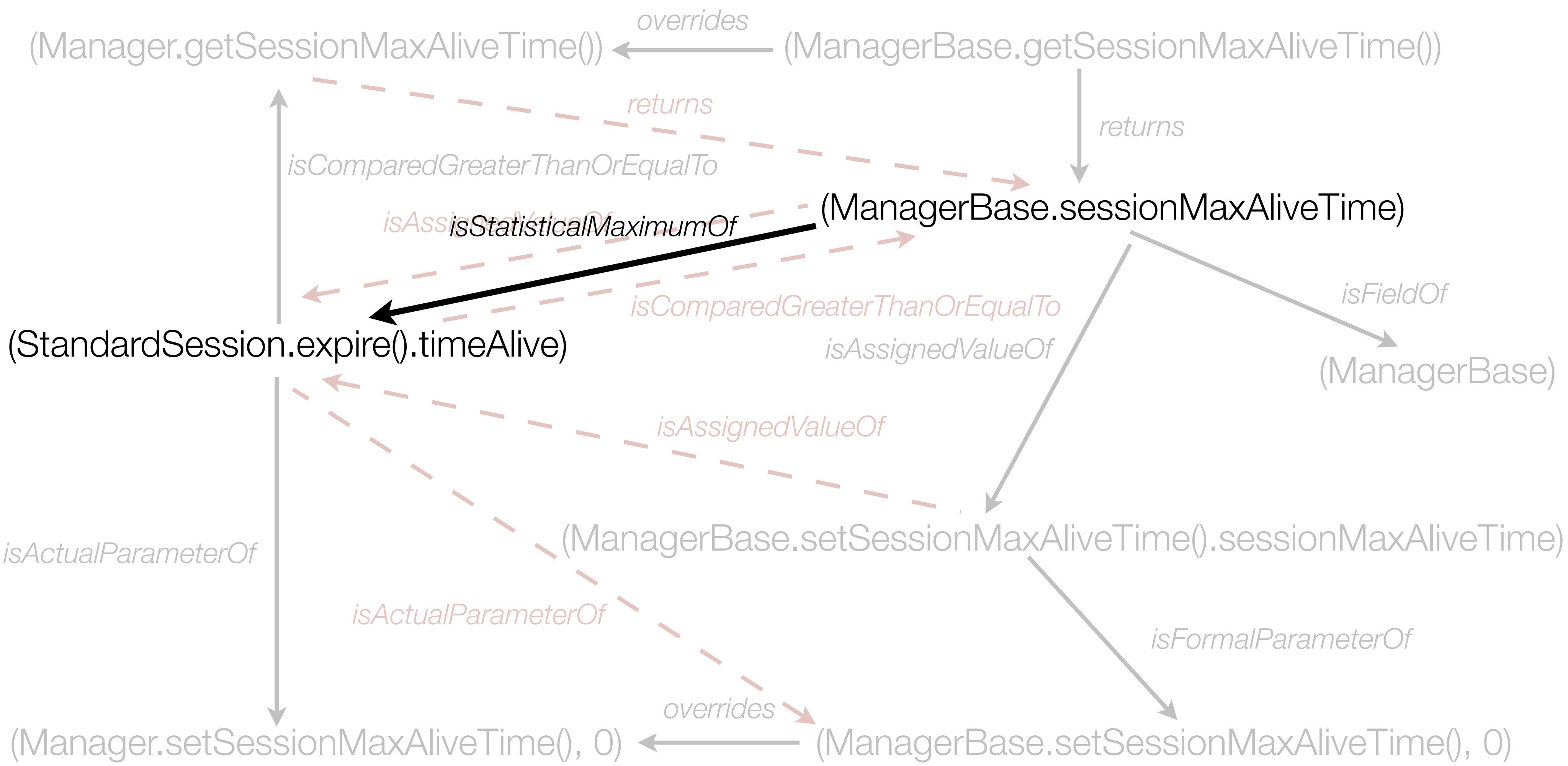

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- Successfully applied to another application domain (i.e., instant messaging server)

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- Orthogonal pattern characterisations based on resource stereotypes

References

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