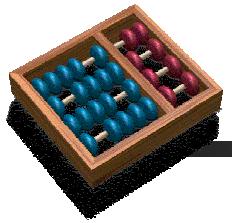

FaTC2: An Object-Oriented Framework for Developing Fault-Tolerant Component-Based Systems

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Motivation

- The construction of systems with high dependability requirements out of software components represents a major challenge
  - Few assumptions can be made about the level of confidence of off-the-shelf components
  - An architectural approach is required
- Exception handling is a well-known technique for leveraging the task of incorporating fault tolerance into software systems

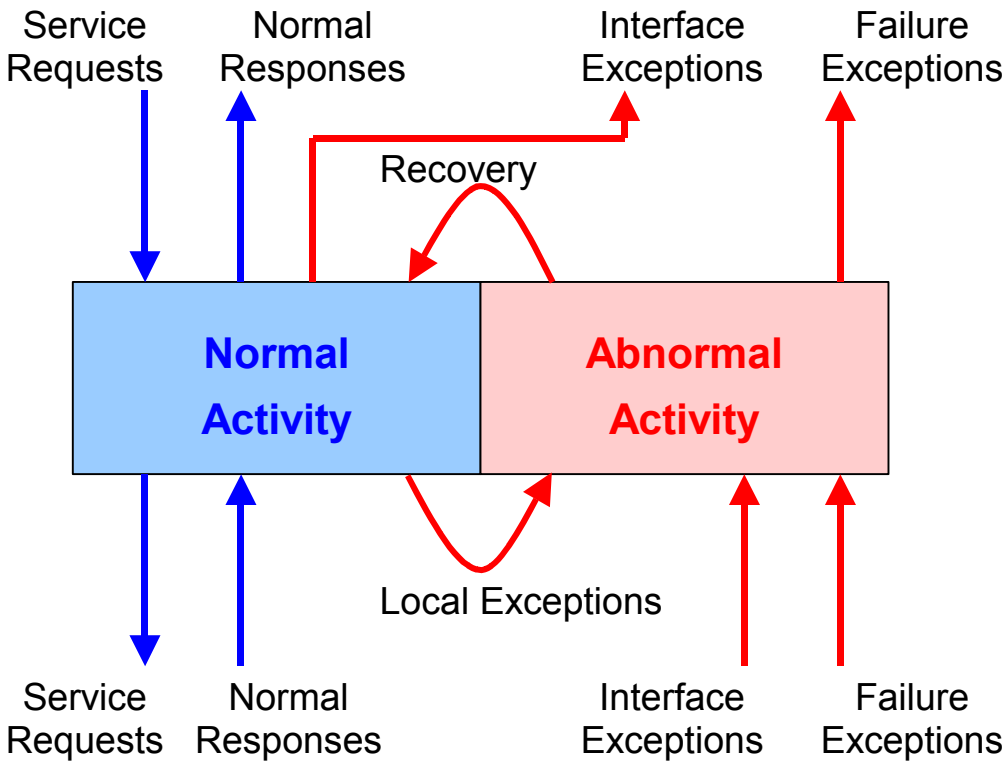
Motivation (2)

- Component-based systems introduce challenges which are not addressed by traditional (language-based) exception handling systems (EHSs)
- Some of these challenges are:
  - Traditional EHSs lack support for attaching exception handlers to architectural elements (components, connectors, configurations)
  - In an architecture, exception propagation does not necessarily follow the method invocation chain
  - An architectural-level EHS should support the attachment of handlers to components without requiring modifications to them

Objectives

- To create an architectural-level EHS which leverages the construction of fault-tolerant component-based systems
- To devise a reusable implementation of the EHS by means of an object-oriented framework
  - ✓ Based on the concept of idealised fault-tolerant component

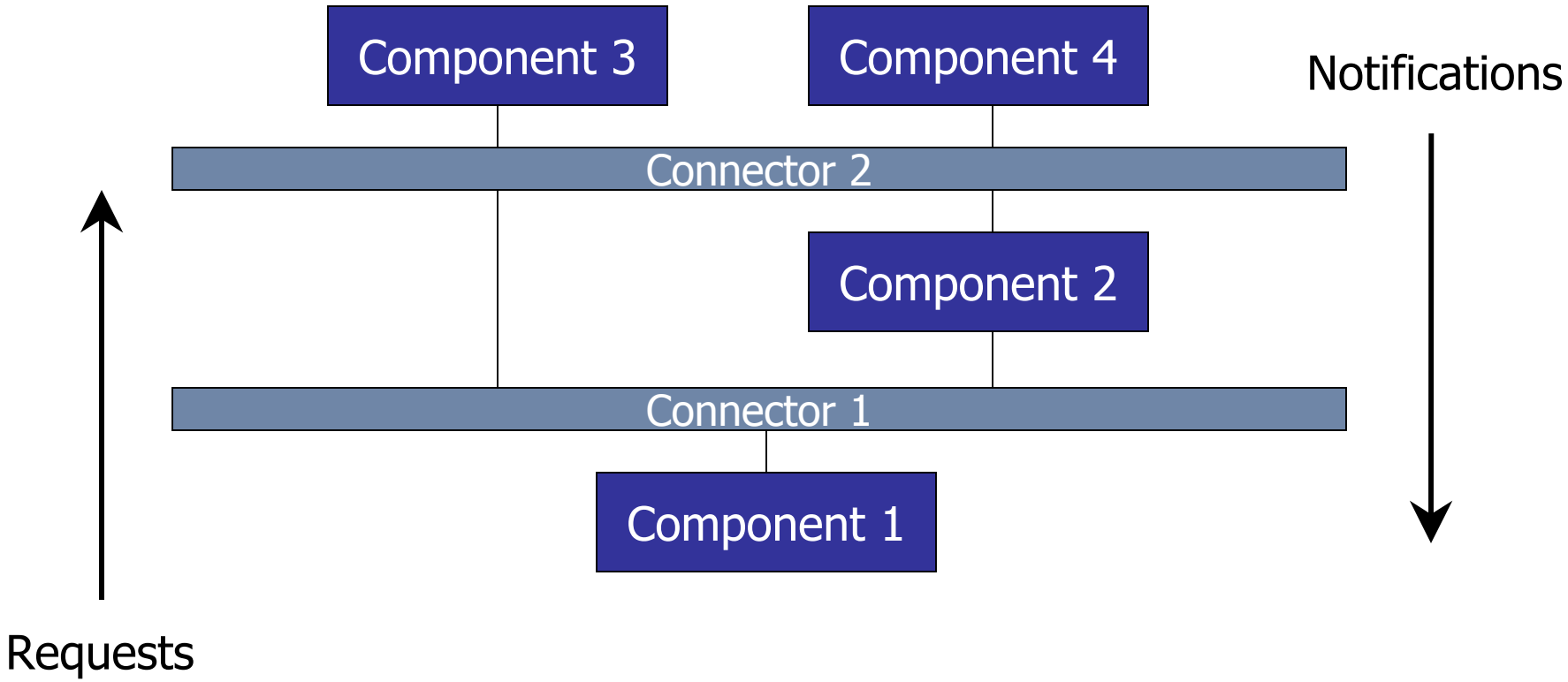
Idealised Fault-Tolerant Component



C2 Architectural Style

- We use the C2 architectural style in order to represent component-based systems
  - Integration of heterogeneous off-the-shelf components
- A C2 architecture is composed by components, connectors and interconnections
  - Layered
  - Elements in an architecture communicate by means of asynchronous messages
  - Each component may have its own control thread
- Tools which support the development of C2 applications:
  - ArchStudio
  - C2.FW framework

A Simple C2 Architecture



Overview of FaTC2

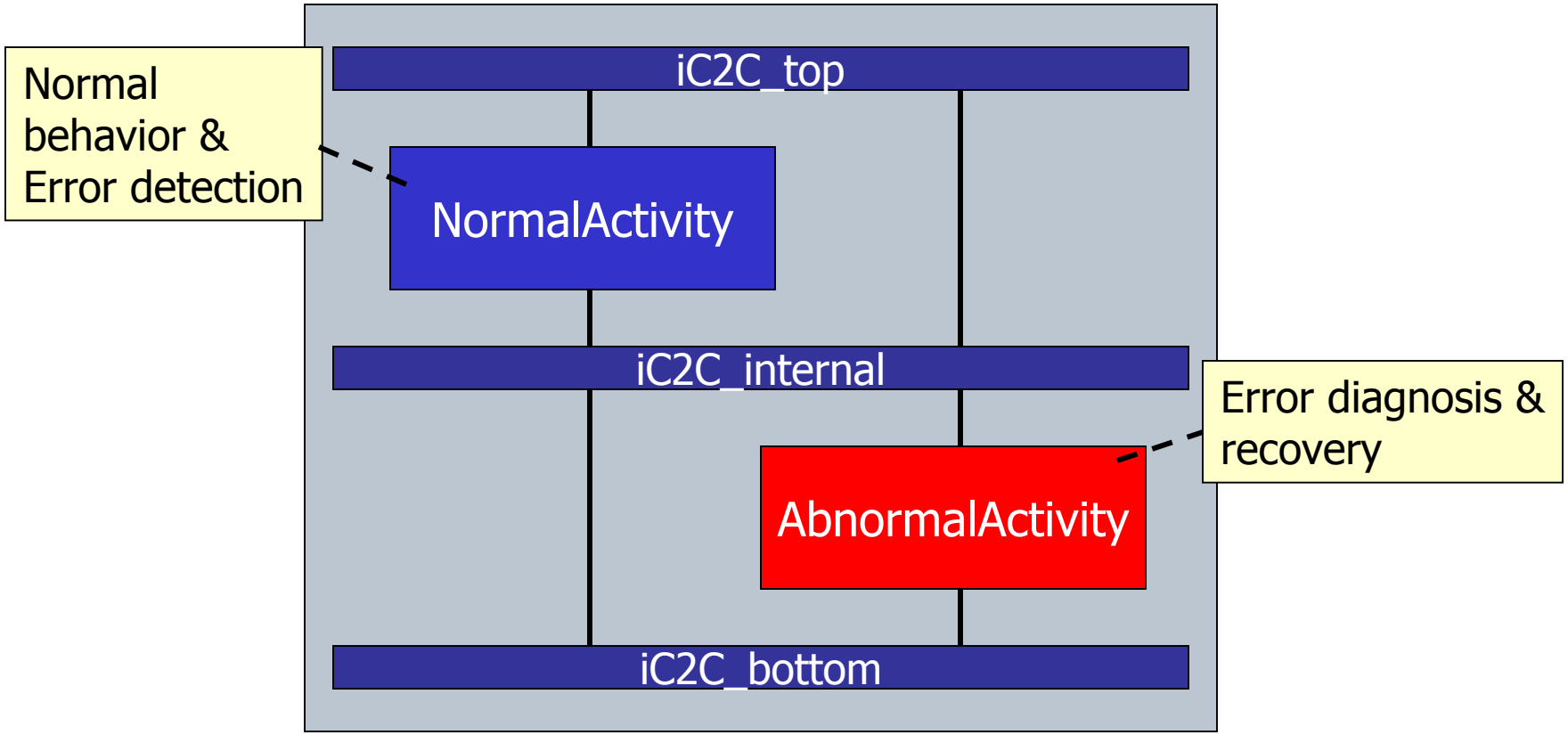
- An extension of the Java™ version of the C2.FW framework
  - ✓ C2.FW lacks support for fault tolerance.
- Introduces forward error recovery in the original framework by means of an EHS

- FaTC2 is based on the concept of idealised C2 component (iC2C)

Idealised C2 Component

- A structuring concept for the incorporation of exception handling in component-based systems
- Equivalent, in structure and behavior, to the idealised fault-tolerant component
- Defined according to the C2 style

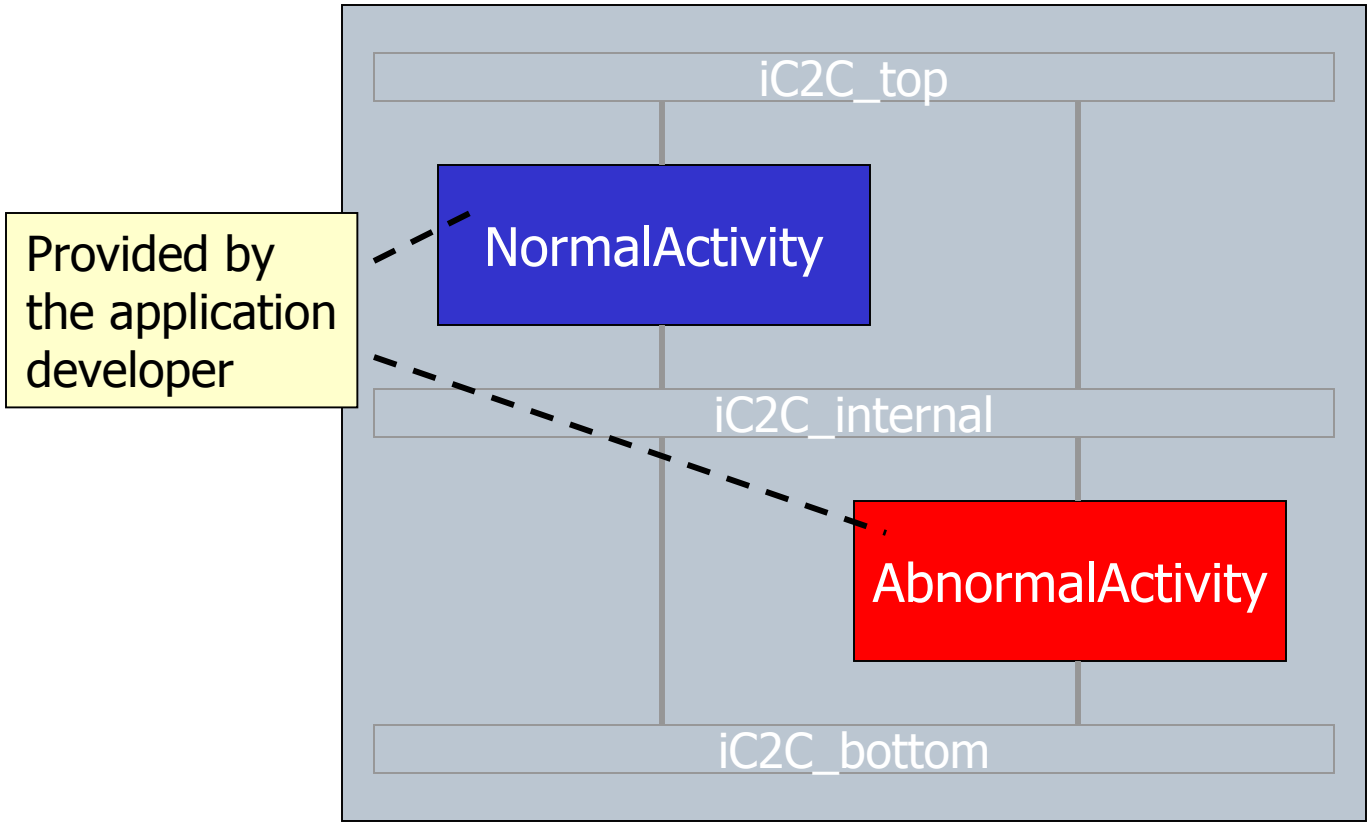
Overall Structure of an iC2C



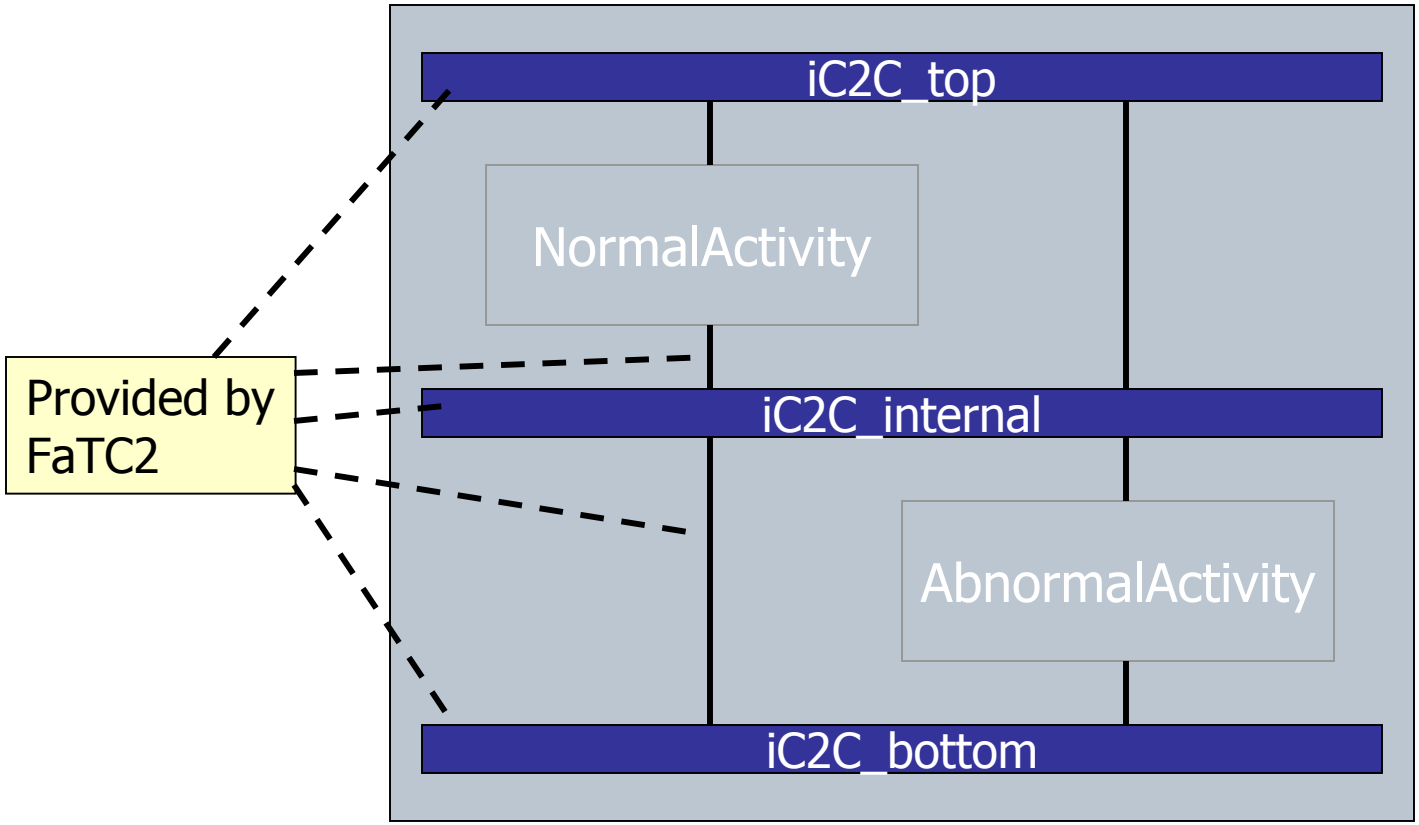
Description of FaTC2

- The concept of iC2C is employed for defining exception handling contexts
  - NormalActivity component: normal behavior and error detection
  - AbnormalActivity component: error treatment
- Connections between normal and abnormal parts are managed by FaTC2
  - Developers focus on implementing the normal and abnormal behavior of the system
  - Abstracts the interaction protocol

Description of FaTC2 (2)



Description of FaTC2 (3)



Exception Handling at the Architectural Level

- FaTC2 defines an architectural-level EHS for component-based systems
- Main features :
  - ✓ Separates exception handlers from normal behavior
  - ✓ Handlers may be attachted to components, connectors and configurations
  - ✓ Exception propagation according to the execution flow of the application

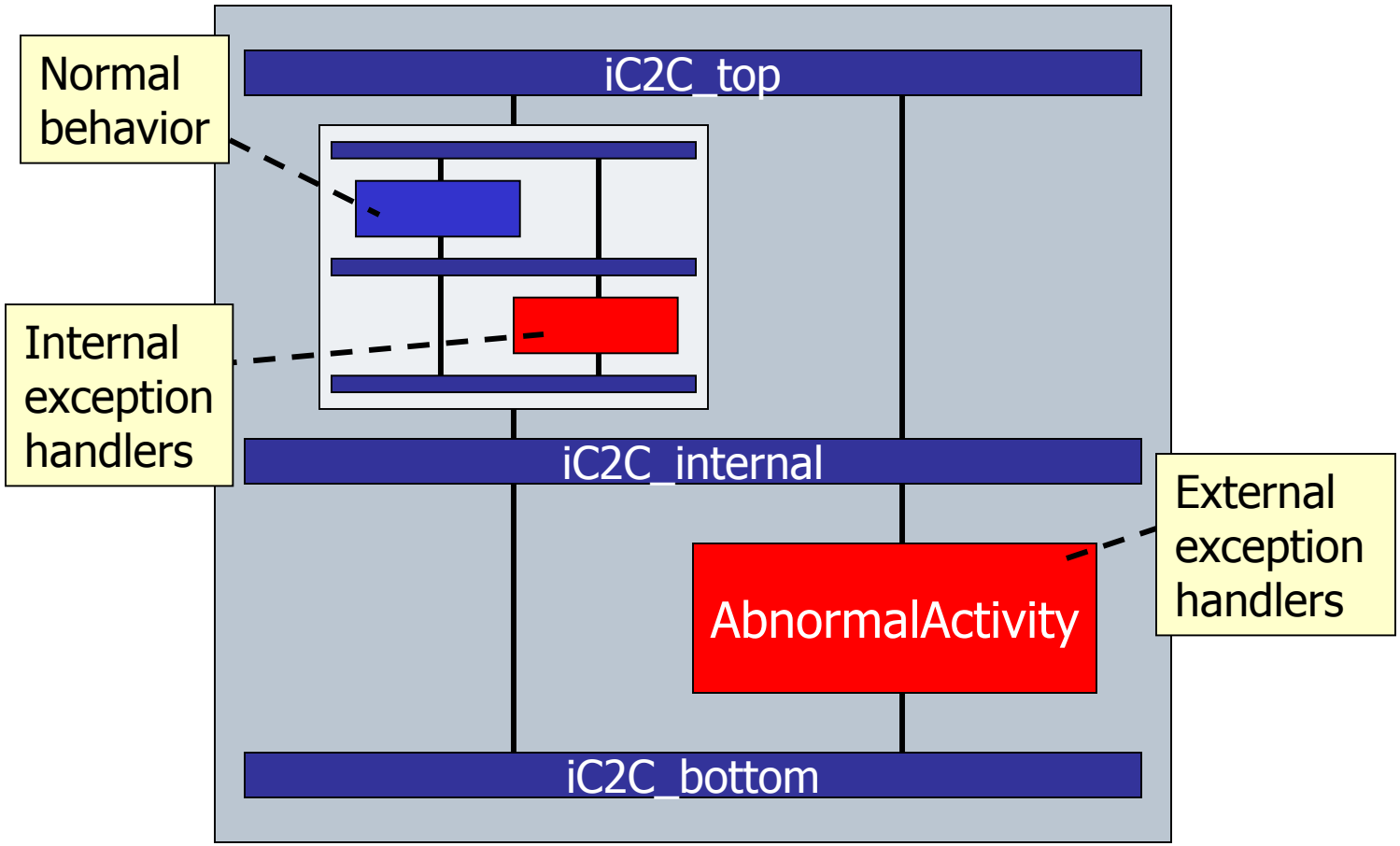
Exception Definition

- Architectural exceptions are data objects implemented as simple Java exceptions
- FaTC2 wraps exceptions as C2 notifications

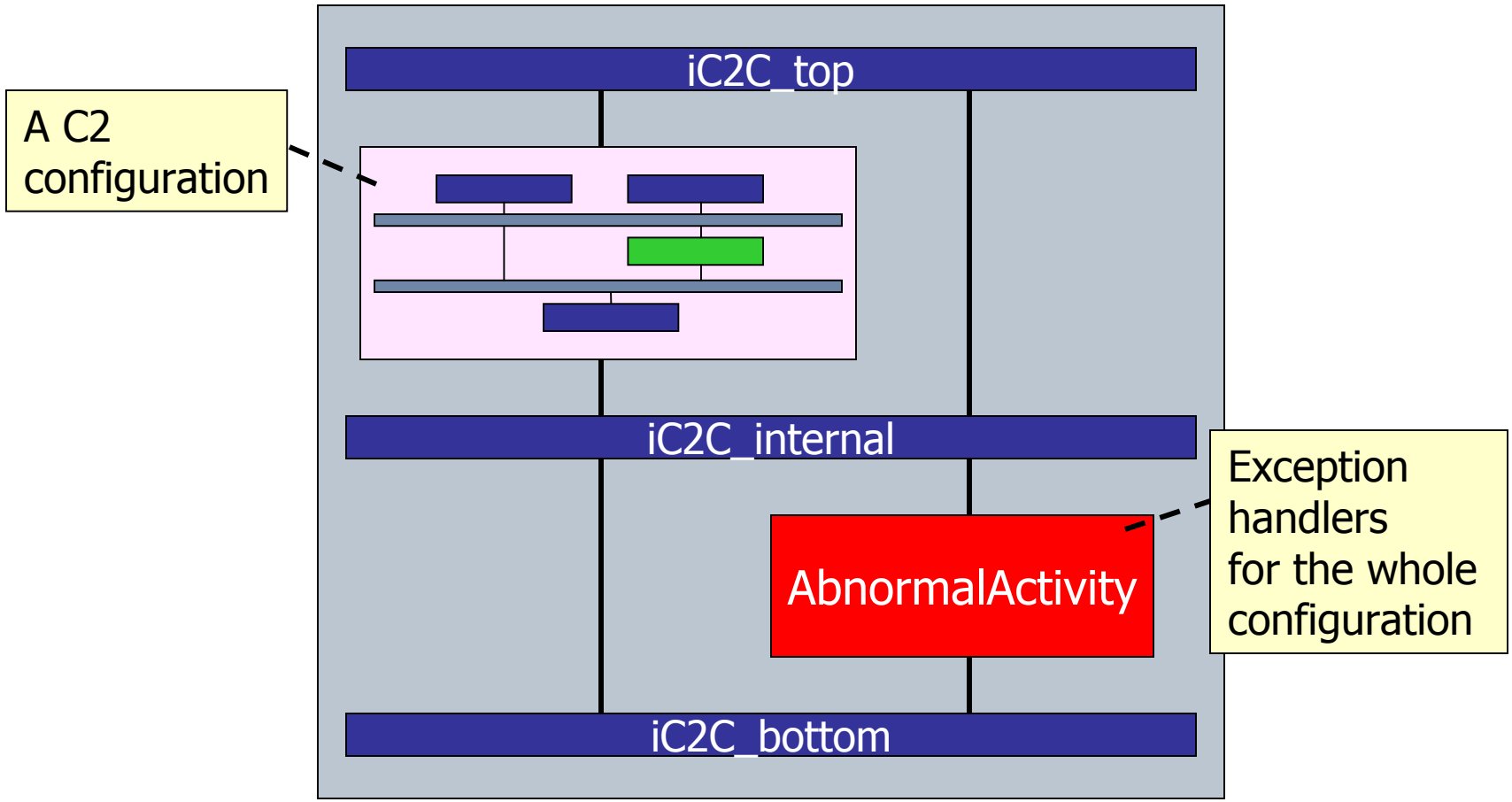
Handler Definition and Attachment

- The AbnormalActivity component of an iC2C defines an architectural-level exception handler
- Handlers may be attached to components, connectors and configurations
- FaTC2 supports the definition of multiple exception-handling contexts

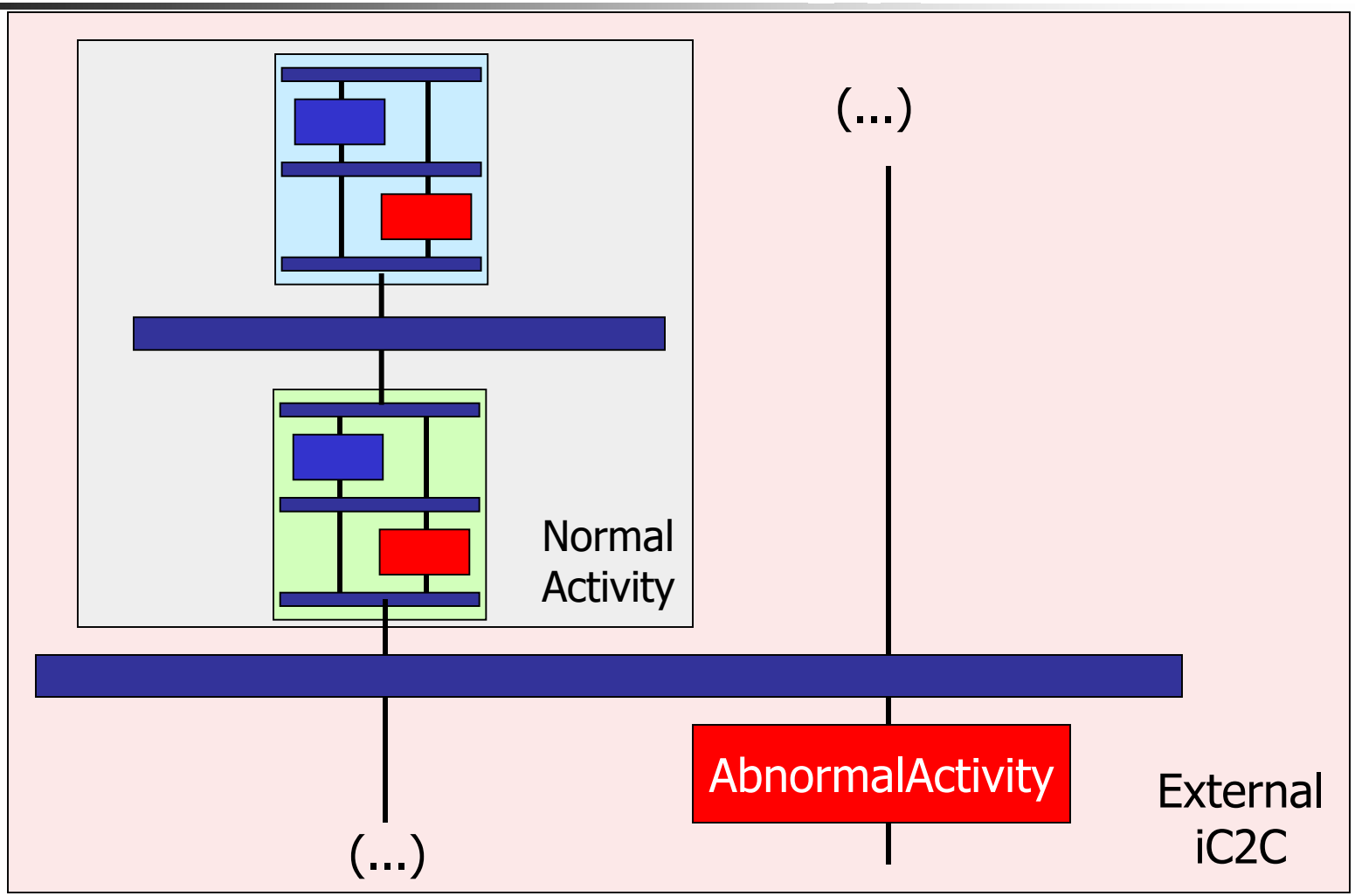
Handler Definition and Attachment (3)



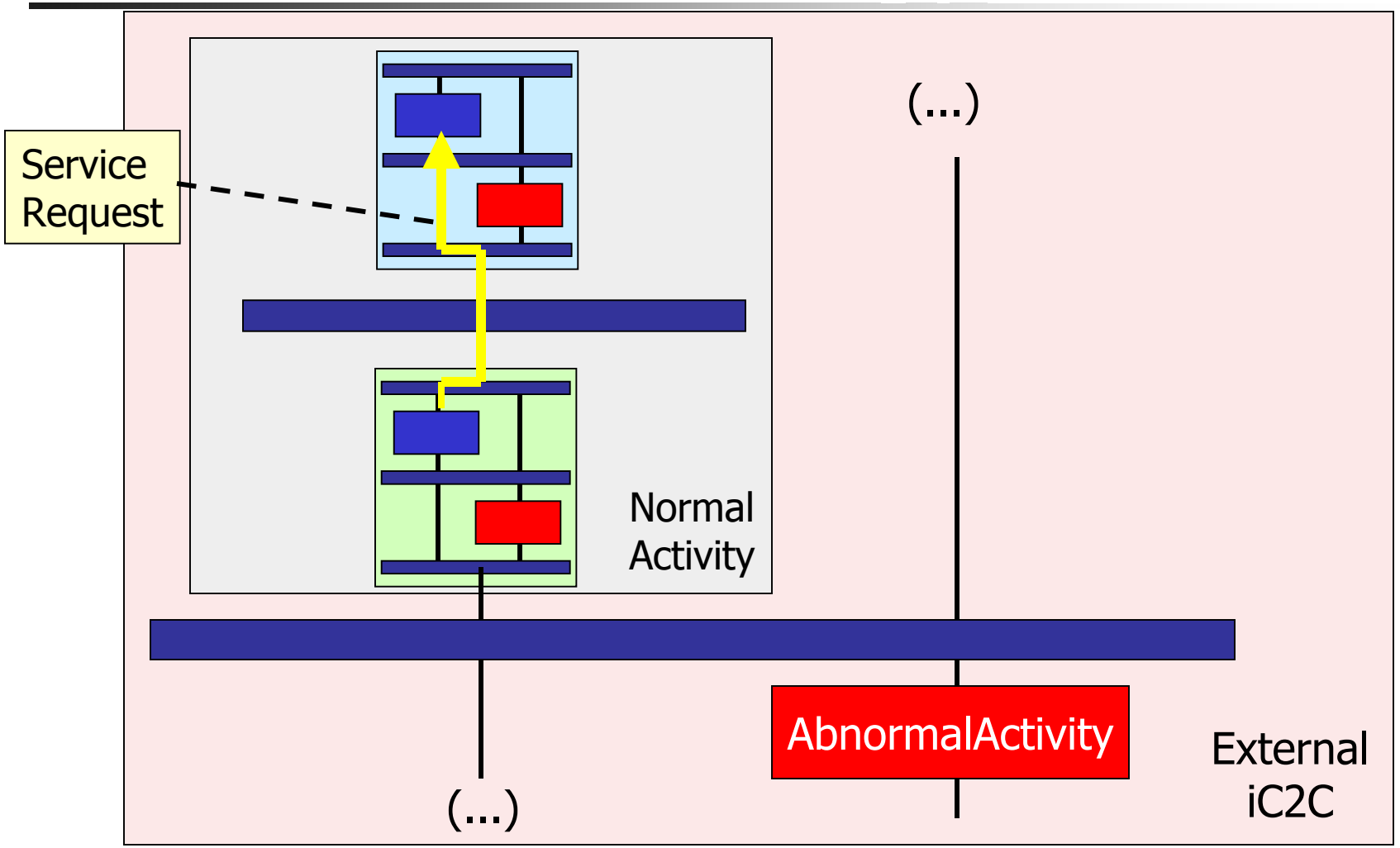
Handler Definition and Attachment (2)



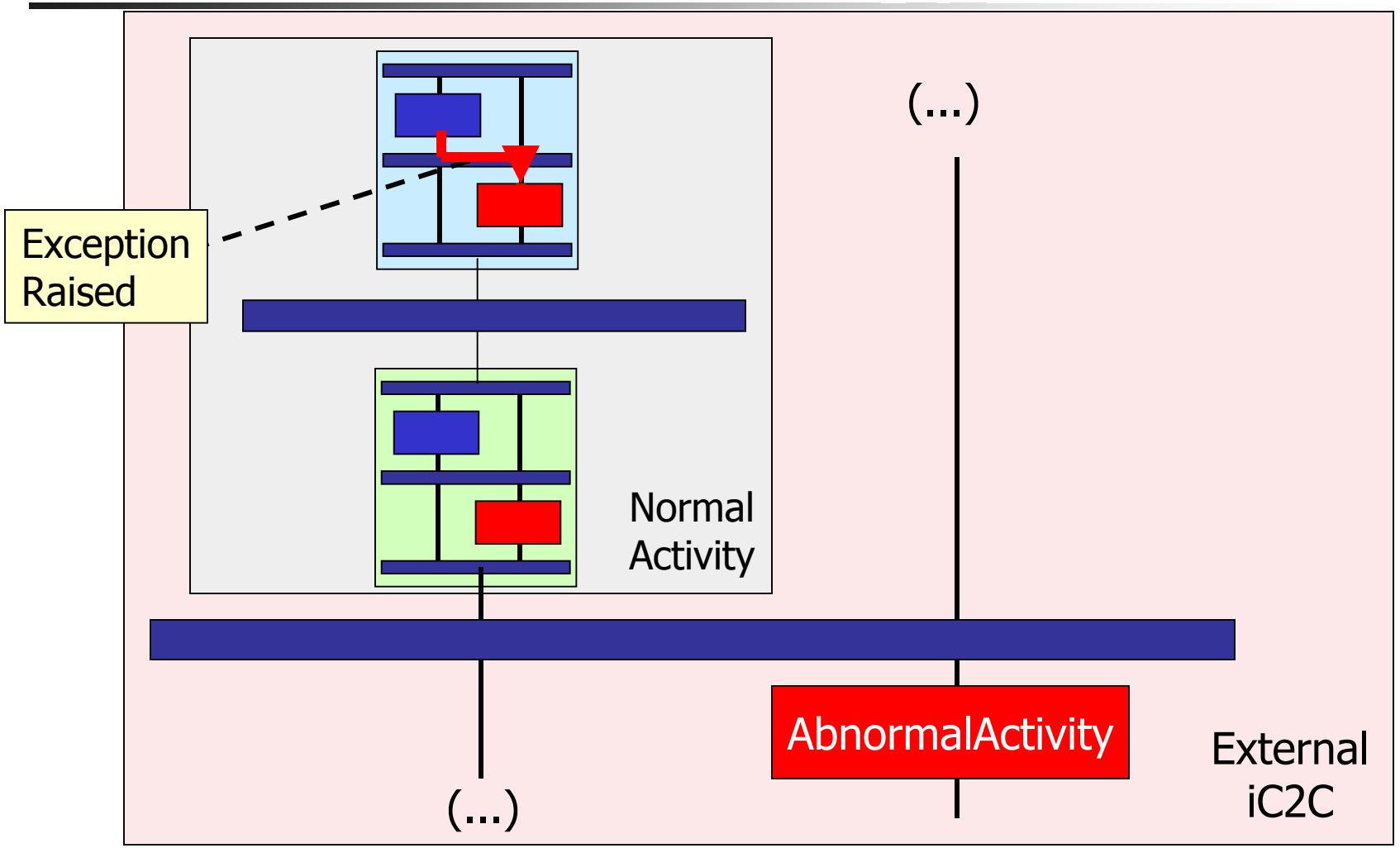
Exception Propagation



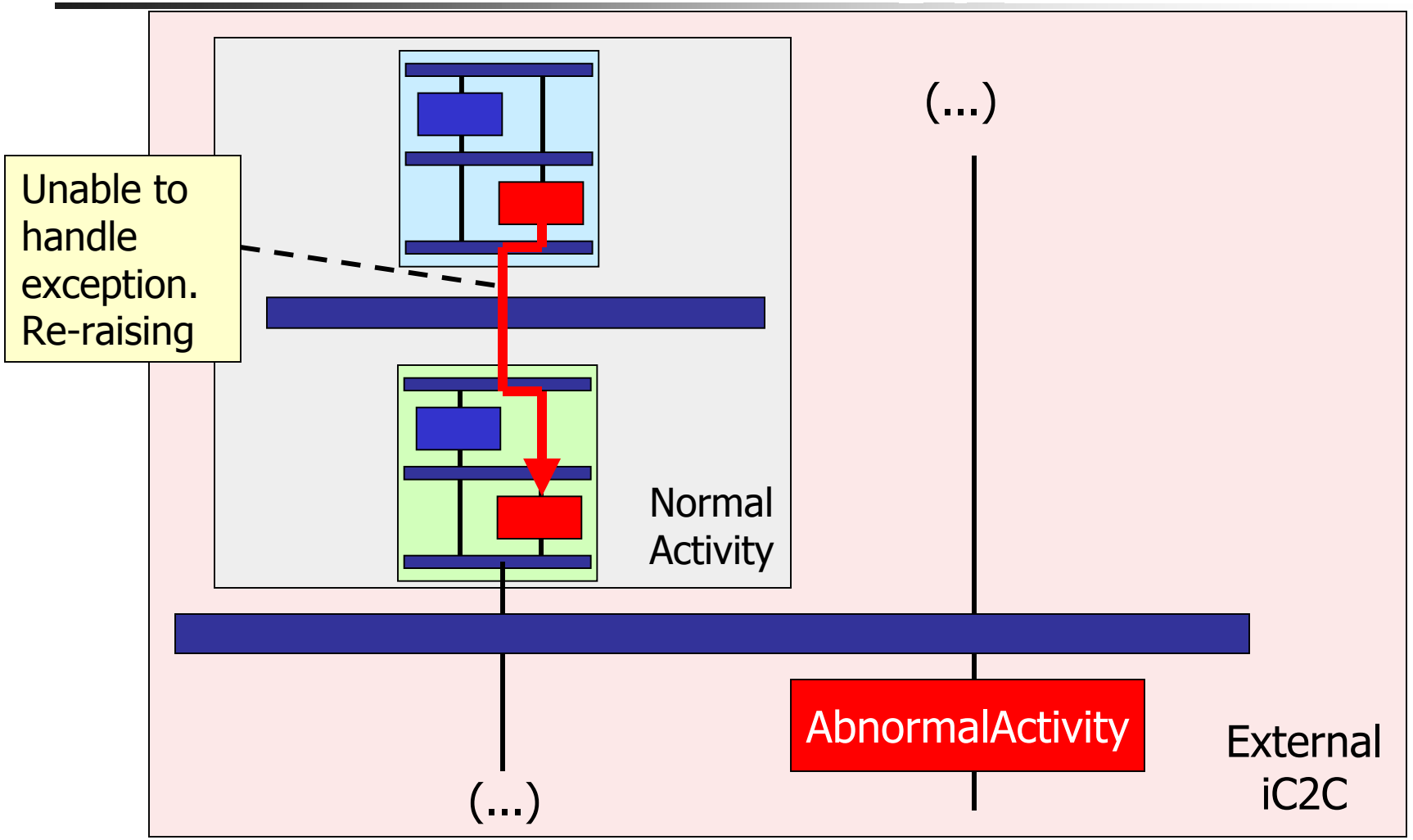
Exception Propagation



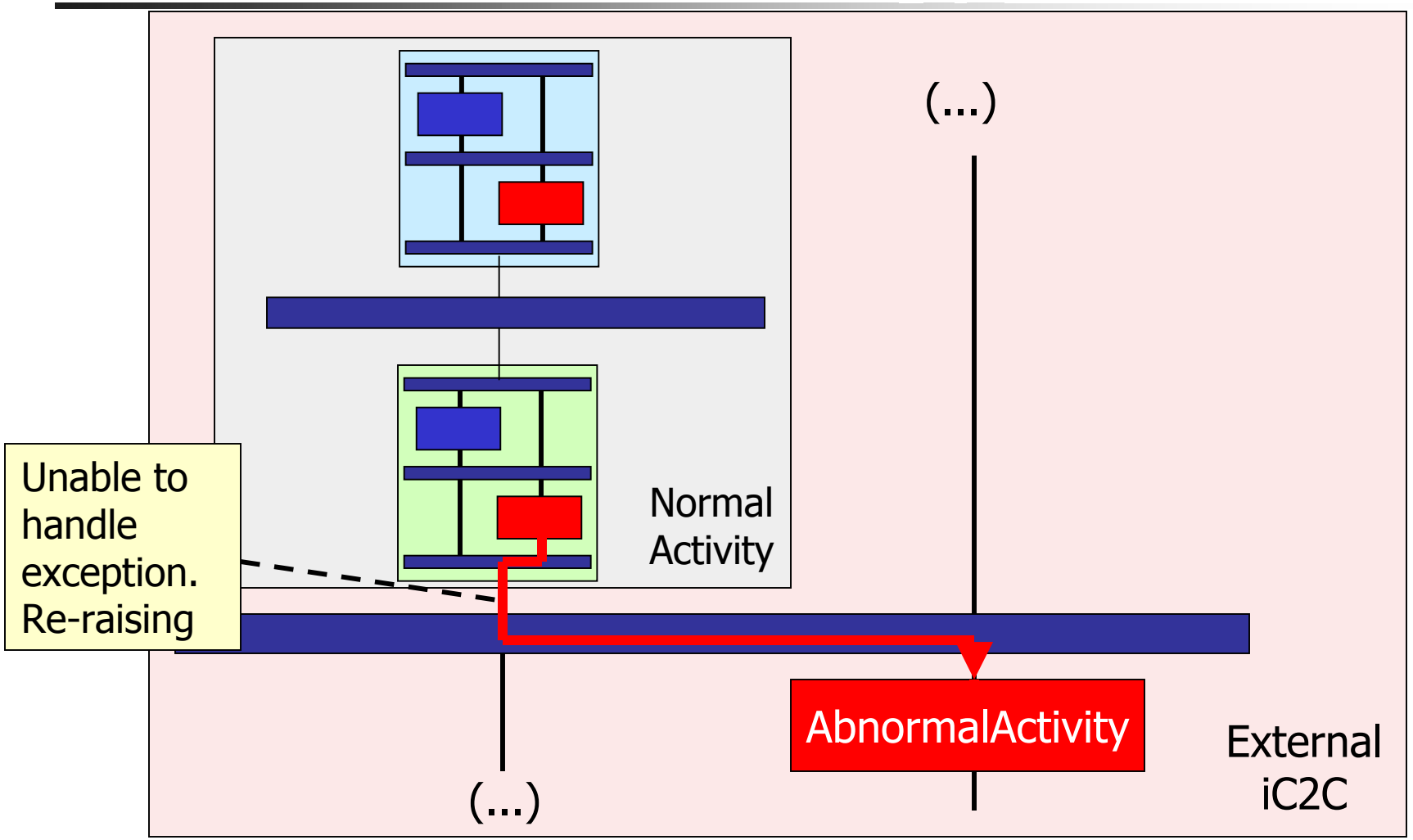
Exception Propagation



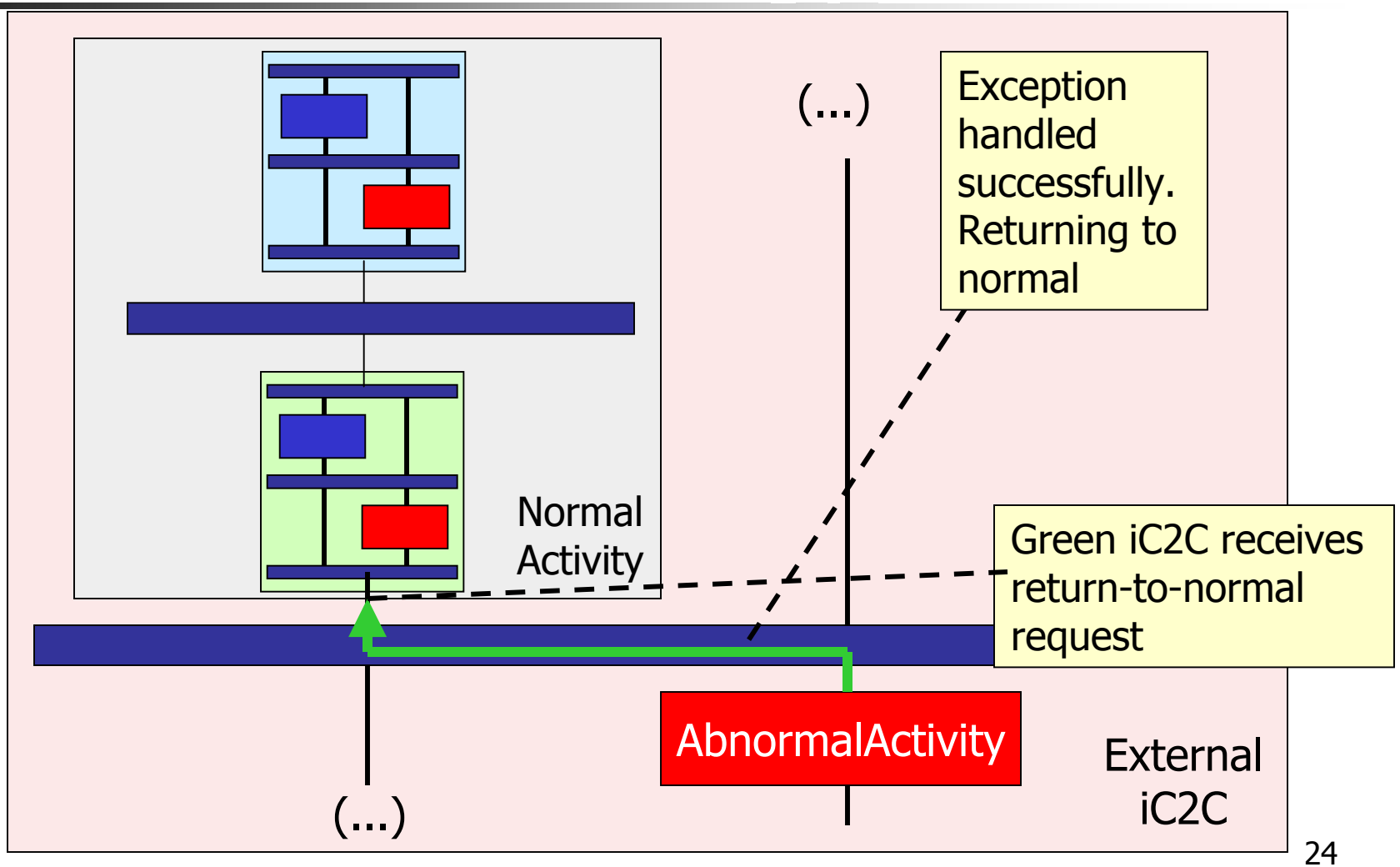
Exception Propagation



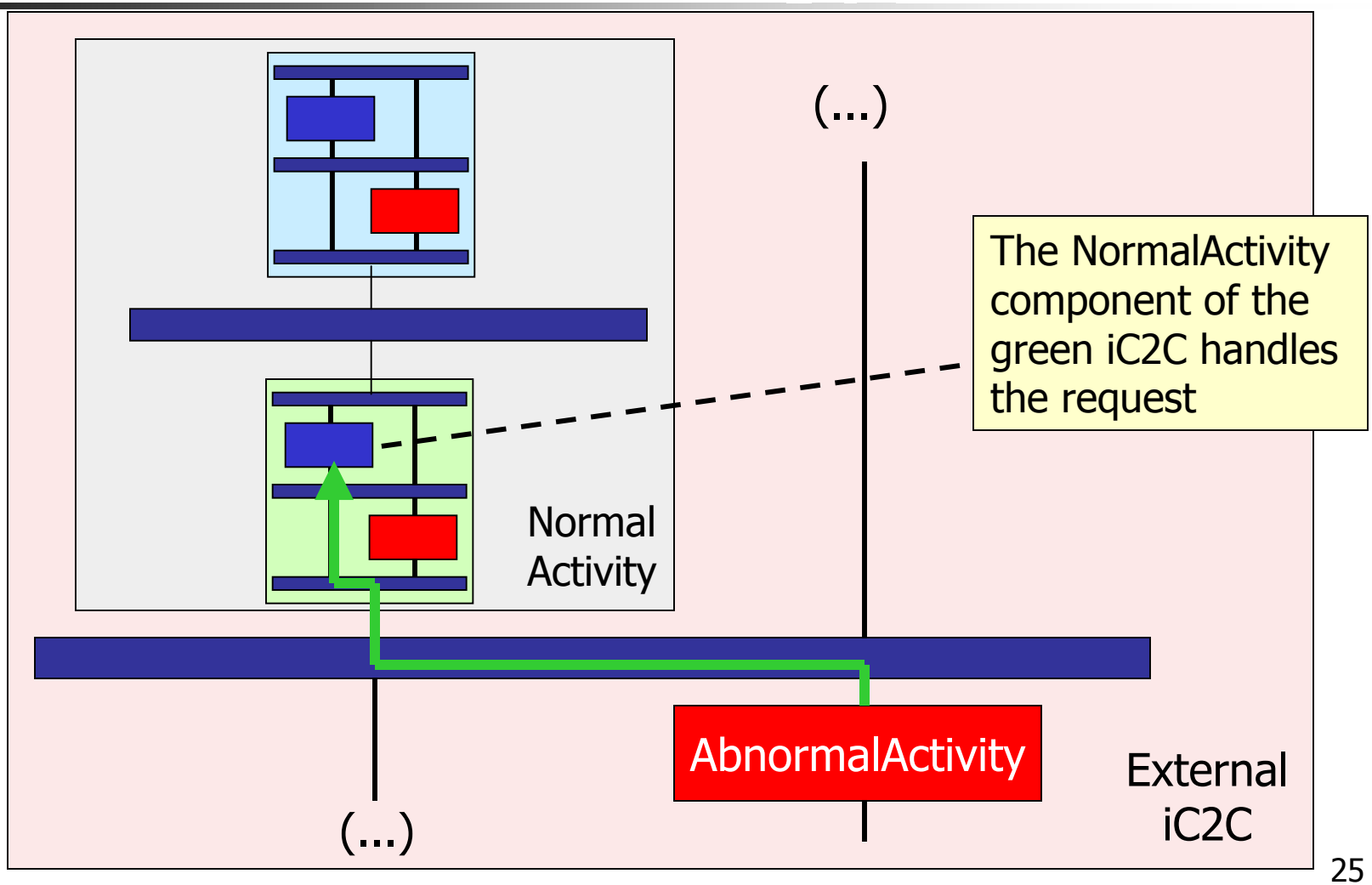
Exception Propagation



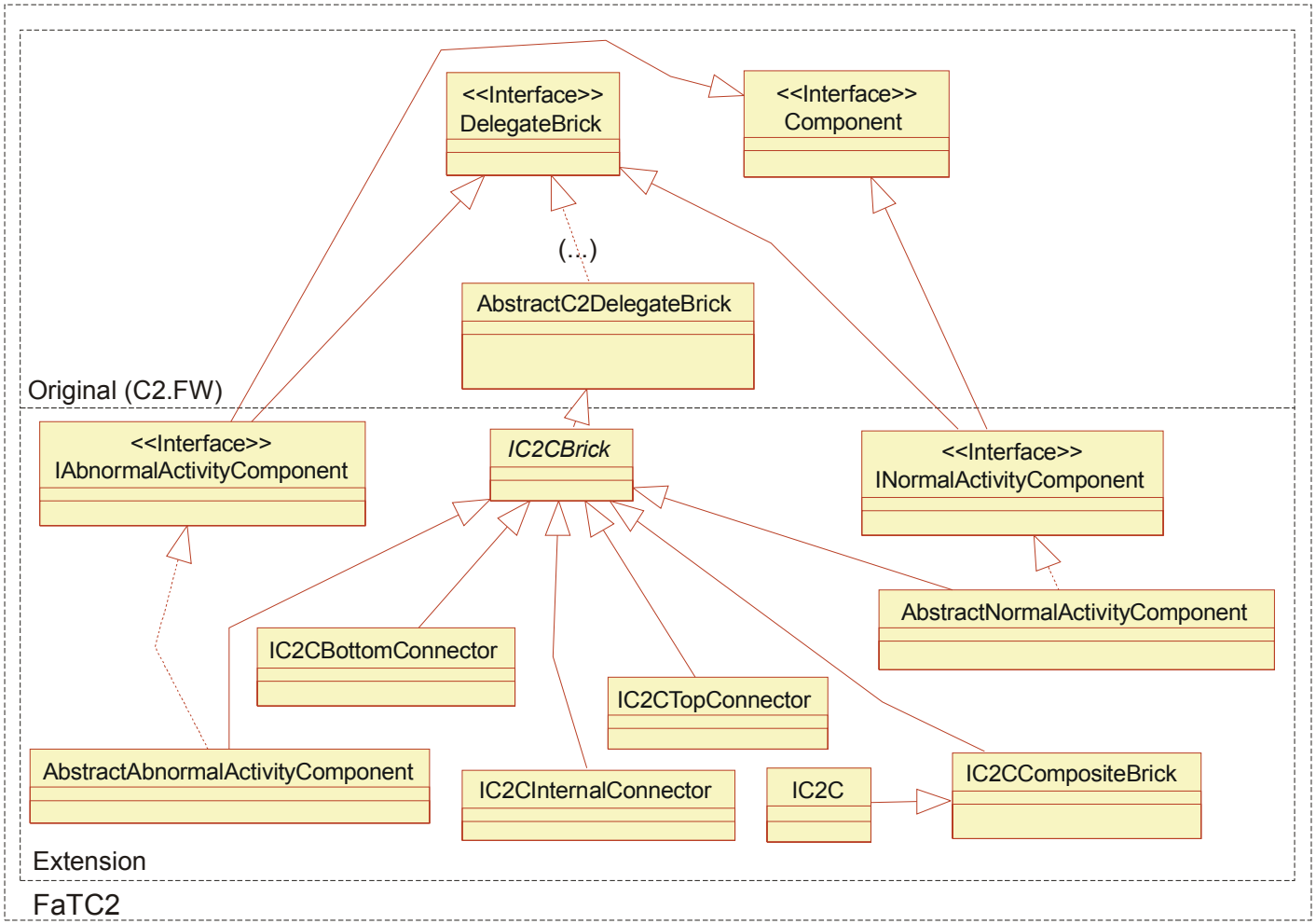
Continuation of the Flow of Control



Continuation of the Flow of Control



FaTC2 and C2.FW



Conclusions

- Our contributions:
  - ✓ Definition of an architectural-level EHS for component-based applications
  - ✓ Construction of a reusable implementation for this EHS by means of the FaTC2 framework
  - ✓ Extension of the C2.FW framework with forward error-recovery
- Architectural-level exception handling is not a replacement for language-level exception handling

Work in Progress

- Asynchronous iC2C
- Some of the features defined by the EHS are still not supported by FaTC2
  - ✓ Hierarchical handler search
  - ✓ Attachment of handlers to arbitrary configurations
- Evaluation of the EHS

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Related Work

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