Network Management for Picture Archiving and Communication Systems

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Road Map

- Introduction
- Hospital overview
- SNMP overview
- Software design
- Verification
- Conclusion

Introduction

- Picture archiving and communication system (PACS) is used to manage diagnostic images in hospital
- PACS improves the hospital efficiency
- PACS reduces the diagnostic time
- The connectivity of PACS with other diagnostic imaging devices in a hospital is a challenging task

Network management for

picture archiving and communication system

Project Scope

- Understand the major connectivity issues faced by the PACS administrator
- Define the network management data necessary to manage the PACS
- Design the network management tool to help the PACS administrator

Key Accomplishments

- Define the MIB to manage the PACS
- Implement the PACS SNMP manager to manage the PACS via the simple network management protocol (SNMP)
- Implement the PACS monitor GUI:
  - allow user to query the PACS statistics
  - notify user of an error
- Document the architecture design of the PACS monitor system

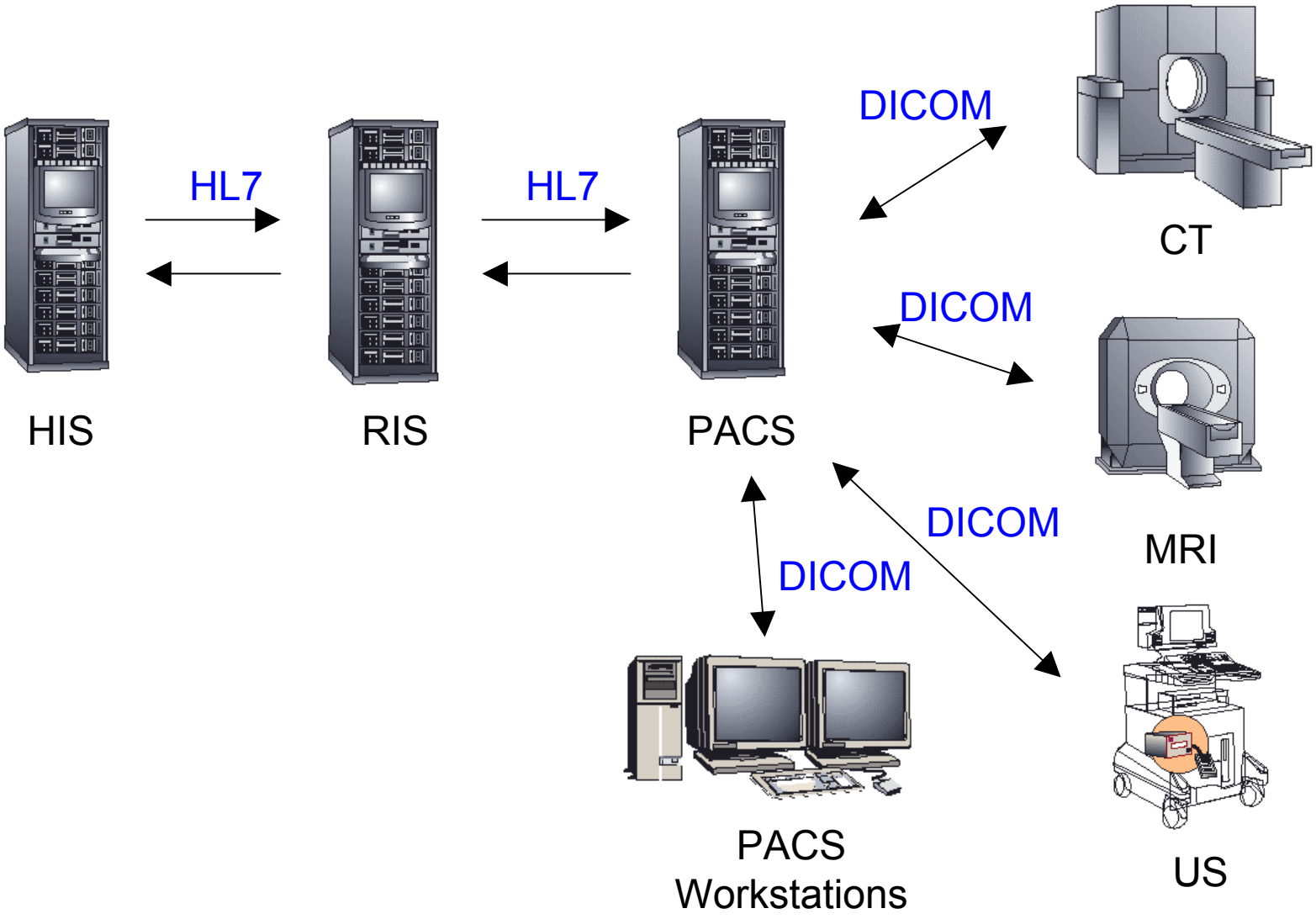
Hospital: IT Systems

- Hospital information system (HIS):
  - administrate hospital workflow
  - manage clinical processes
- Radiology information system (RIS):
  - track and manage patients, films and supplies
- Picture archiving and communication system (PACS):
  - manage, store and view diagnostic images
- Modality:
  - capture diagnostic image, such as ultrasound

Hospital: Network Protocols

- Health level seven (HL7):
  - implement on top of the TCP/IP network
  - encode and exchange the patient demographic information
- Digital imaging and communication in medicine (DICOM):
  - implement on top of the TCP/IP network
  - encode and exchange the diagnostic images

Hospital Environment



Advantage of PACS

- Eliminate the film development process
- Eliminate the film storage
- Reduce the possibility of image lost
- Increase the efficiency of the clinical process
- Allow the use of computer software to aid in the diagnostic process
- Allow the 3D reconstruction of the diagnostic images

Problems associated with PACS

- Network issues
- Connectivity problems
- PACS configuration issues
- PACS archiving problems

PACS Administrator

PACS Administrator Challenge

- Example 1
  - Modalities send images to PACS for storage
  - Number of diagnostic images in storage reaches a threshold level
  - Auto-archive start

Auto-archive failure!

PACS Administrator Challenge

- Example 2
  - Modality sends a study to the PACS (e.g., ultrasound images and measurement report)
  - PACS receives the ultrasound images only

Measurement report is lost!

PACS Administrator Challenge

- Even though the PACS administrator can identify the problem through logs, the amount of time required to resolve the problem may be very long.
- Hospital service is disrupted
- No commercial tools was developed to help PACS administrators

Network management tool

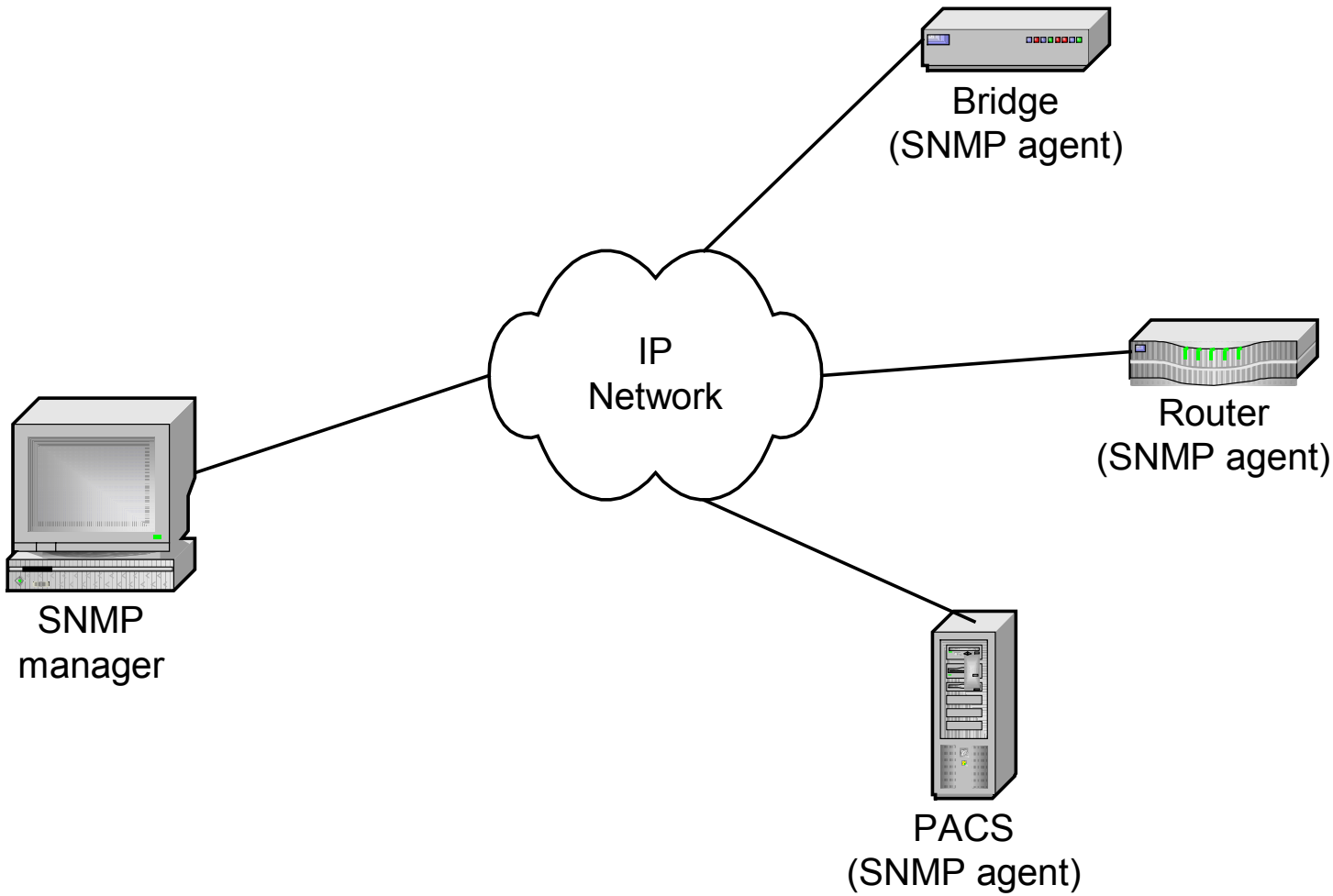
Network Management

- Network health:
  - identify problems
  - resolve problems
  - avoid problems
- Others:
  - configuration
  - expansion

SNMP

- Lightweight:
  - minimal performance impact
- Portable:
  - independent of the operating system
  - independent of the programming language
- Extensible:
  - easily extended to support new devices
- Standardized:
  - actively maintained by internet activities board

SNMP Architecture



Object Identifier (OID)

- OID manages large amount of data
- OID is a numerical string

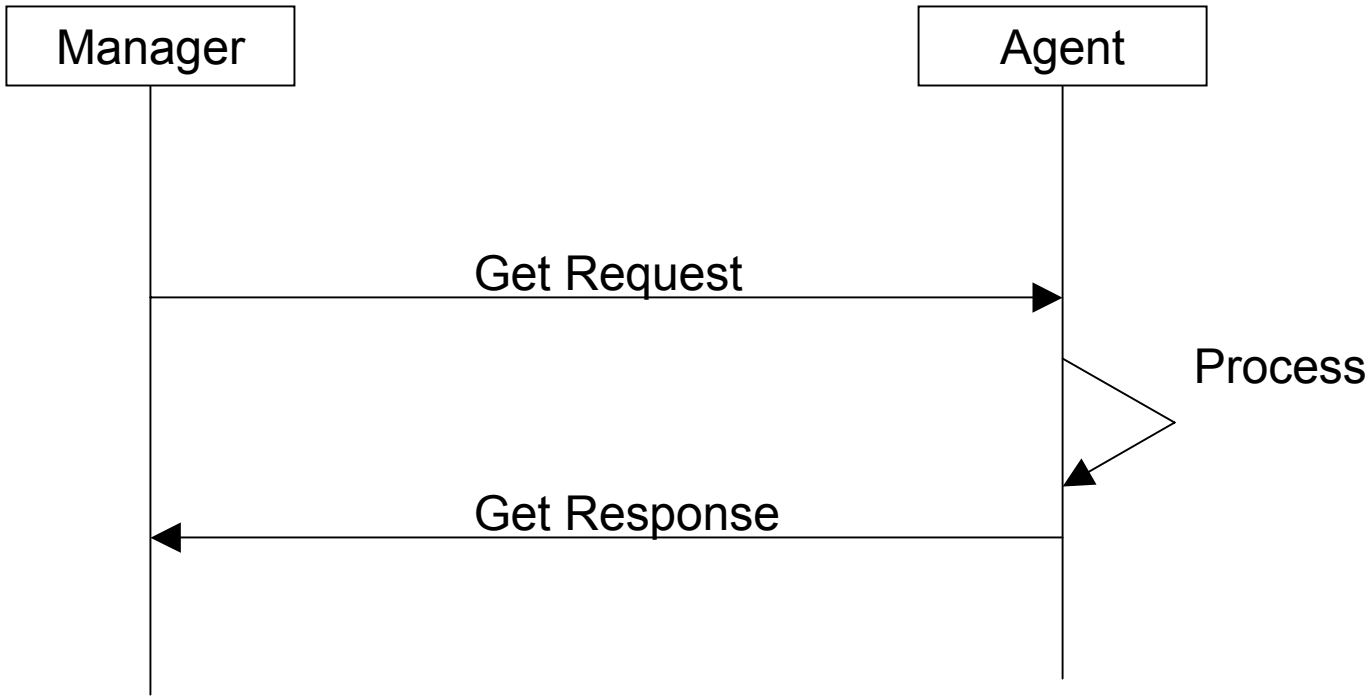
- Numerical nature of OID makes it difficult for human to read and remember
- Management information base (MIB) is a flat text file containing translations of OIDs to a human-readable format

SNMP Operations

- SNMPv1 consists of 4 operations:
  - get
  - get-next
  - set
  - trap

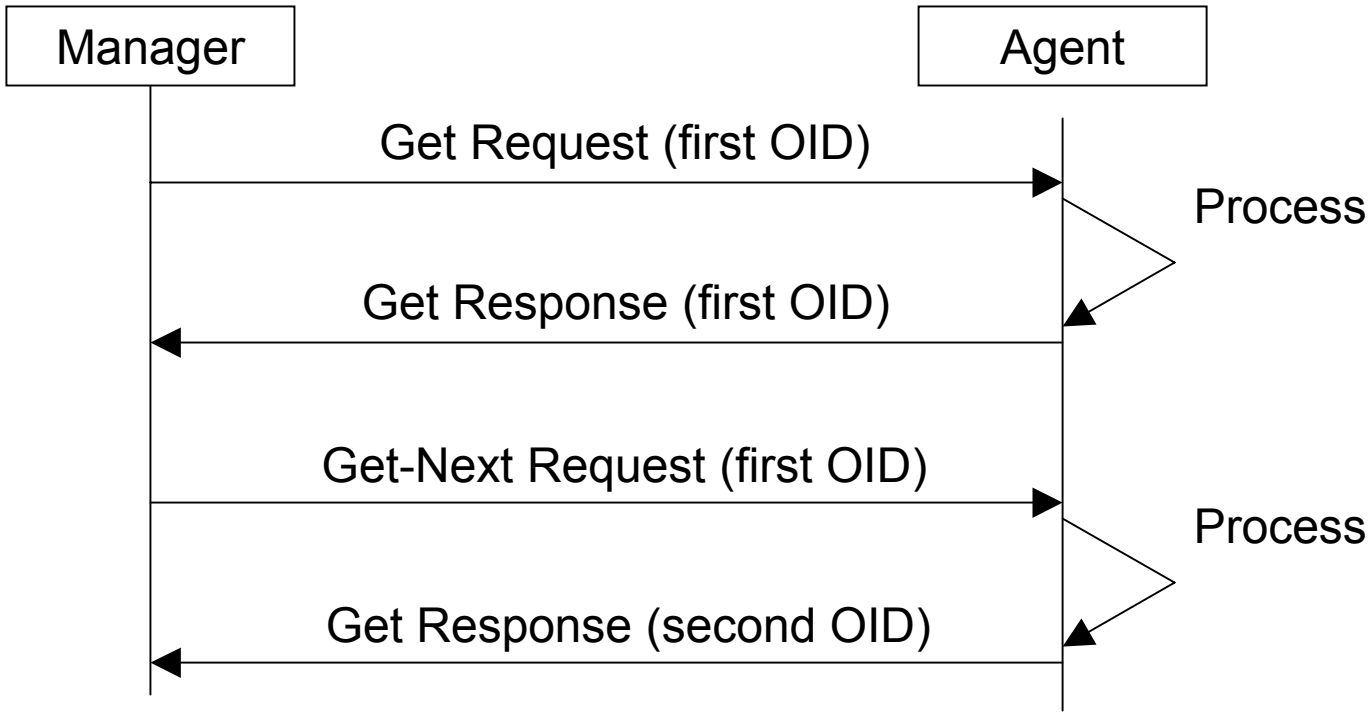
SNMP Get Operation

- Get



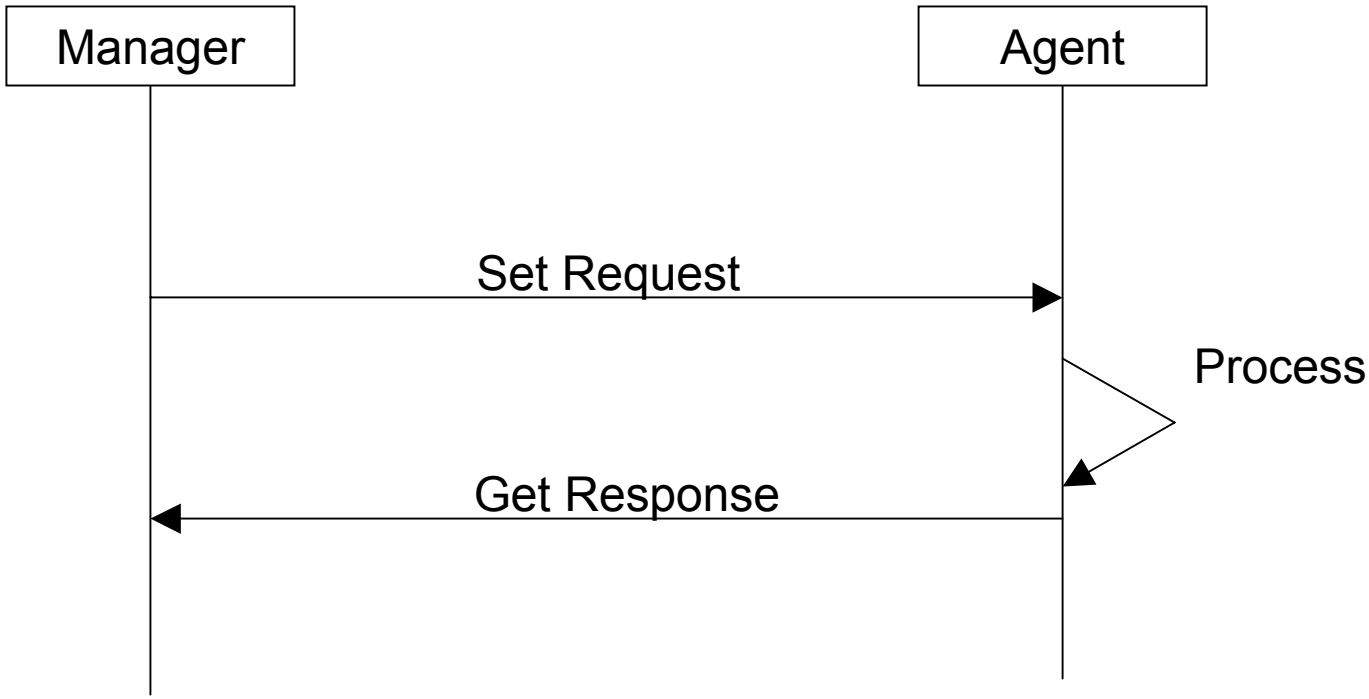
SNMP Get-Next Operation

- Get-Next



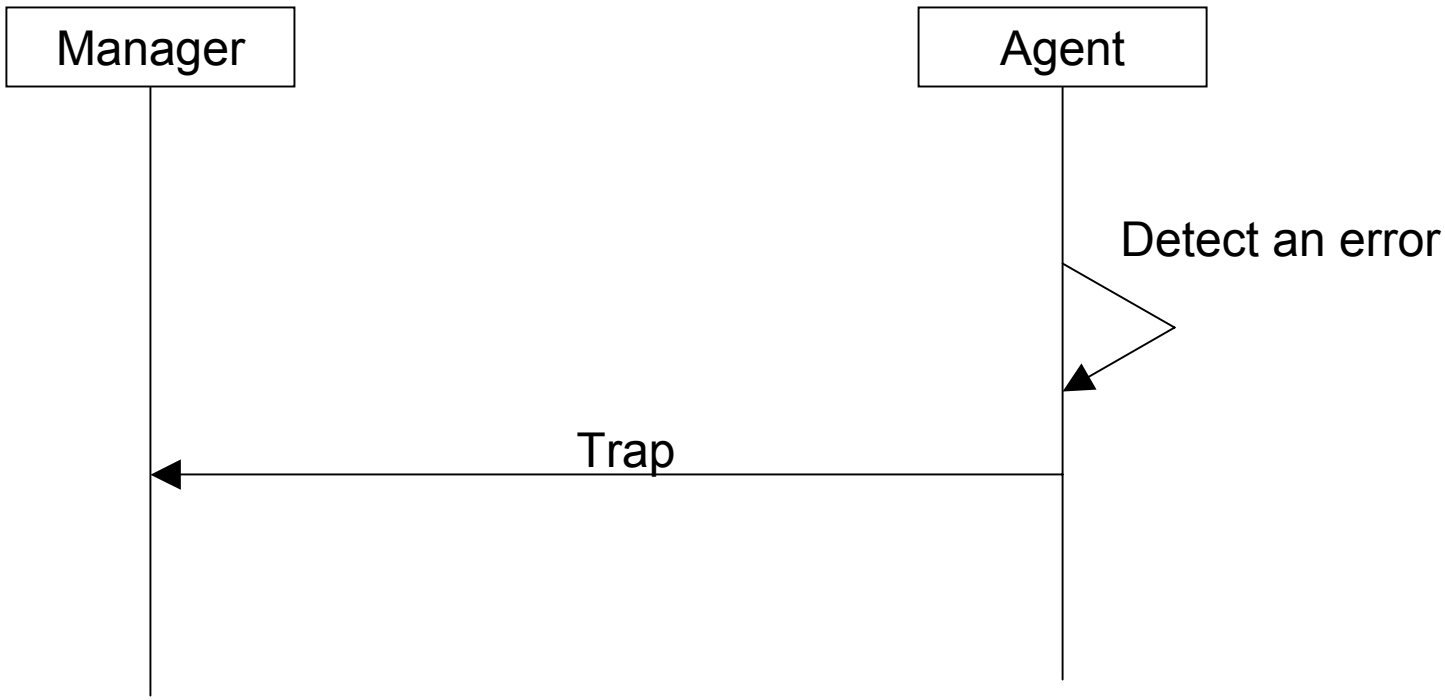
SNMP Set Operation

- Set



SNMP Trap Operation

- Trap



PACS Administrator Solution

- Example 1
  - Modalities send images to PACS for storage
  - Number of diagnostic images in storage reaches a threshold level
  - Auto-archive start
  - Auto-archive fails!

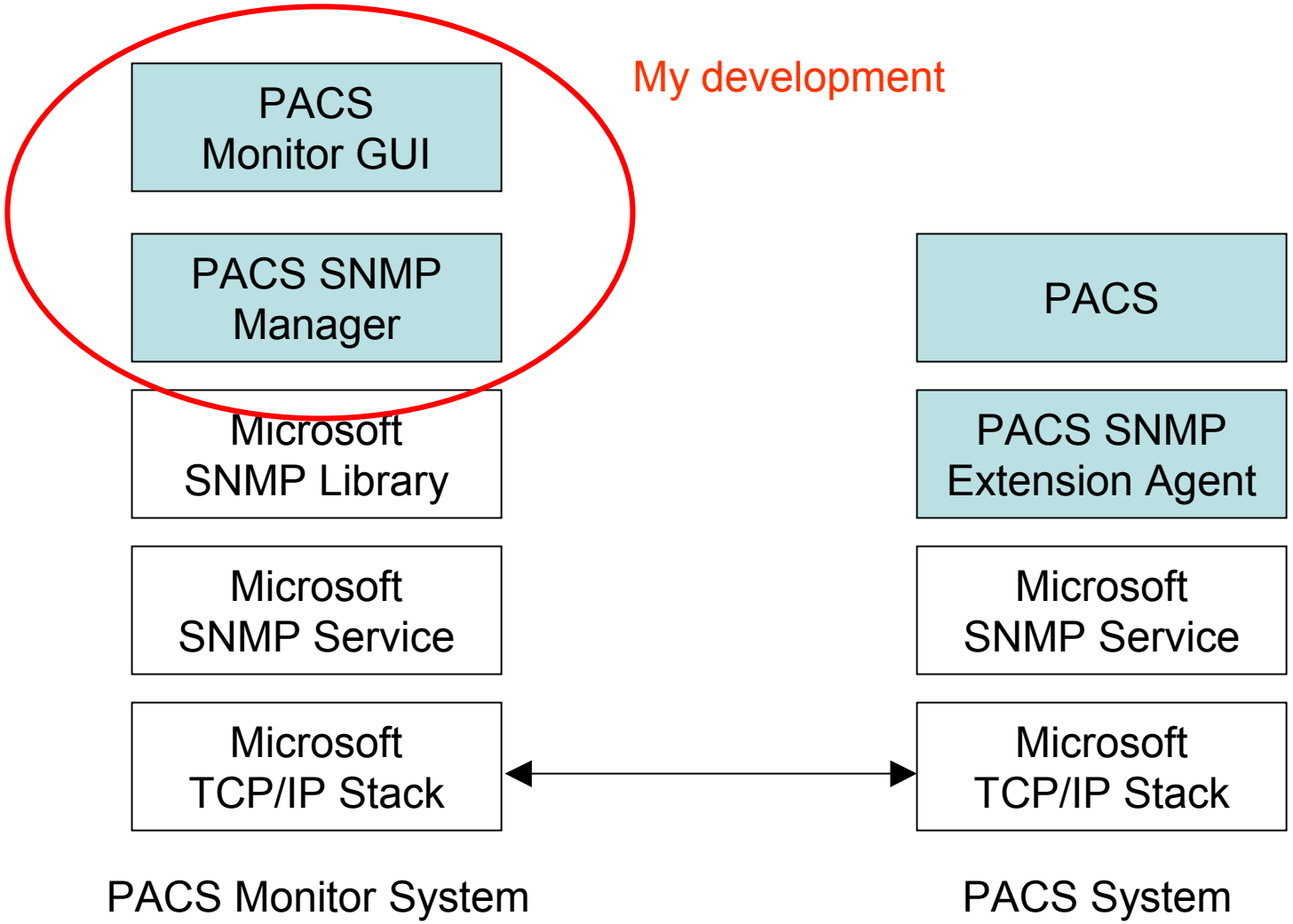
Send SNMP trap to the PACS monitor!

PACS Administrator Solution

- Example 2
  - Modality sends a study to the PACS (e.g., ultrasound images and measurement report)
  - PACS receives the ultrasound images only
  - Measurement report is lost!

Send SNMP trap to the PACS monitor!

Software Architecture



Our Development

Implementation Summary

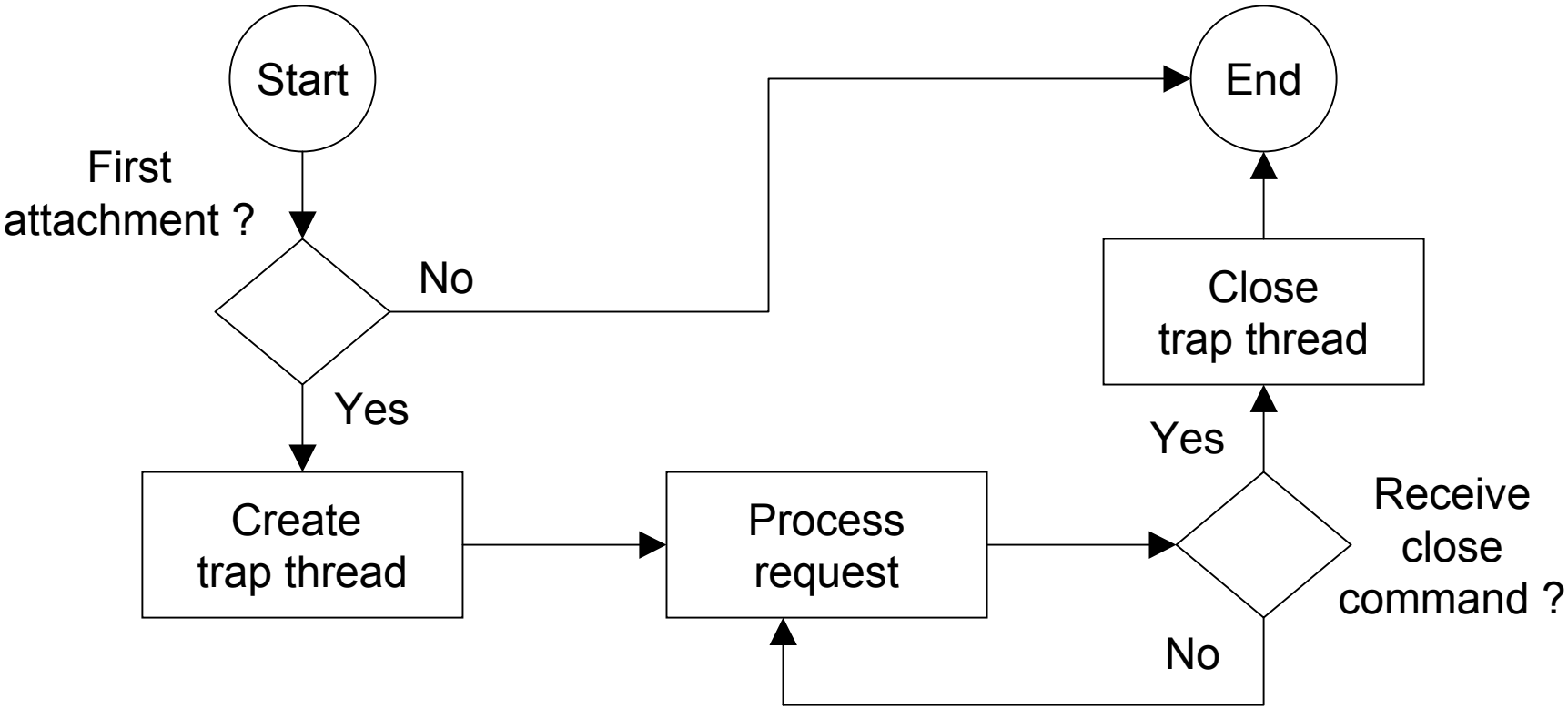
- PACS SNMP manager:
  - defined the MIB to manage the PACS storage service
  - implemented the business logic of retrieving the modality data from the PACS
  - implemented the logic to handle the SNMP trap sent from the PACS
- PACS monitor GUI:
  - design the user interface
  - implement the periodic system update process

Development

- PACS monitor system is run on Windows platform
- Around 5000 lines of C/C++ code is added
- PACS SNMP manager is implemented in C:
  - two threads are created. One thread is used to process the SNMP request, while the other thread is used to handle the SNMP trap
- PACS monitor GUI is implemented in C++:
  - fourteen classes are defined
  - three windows are created based on the defined classes

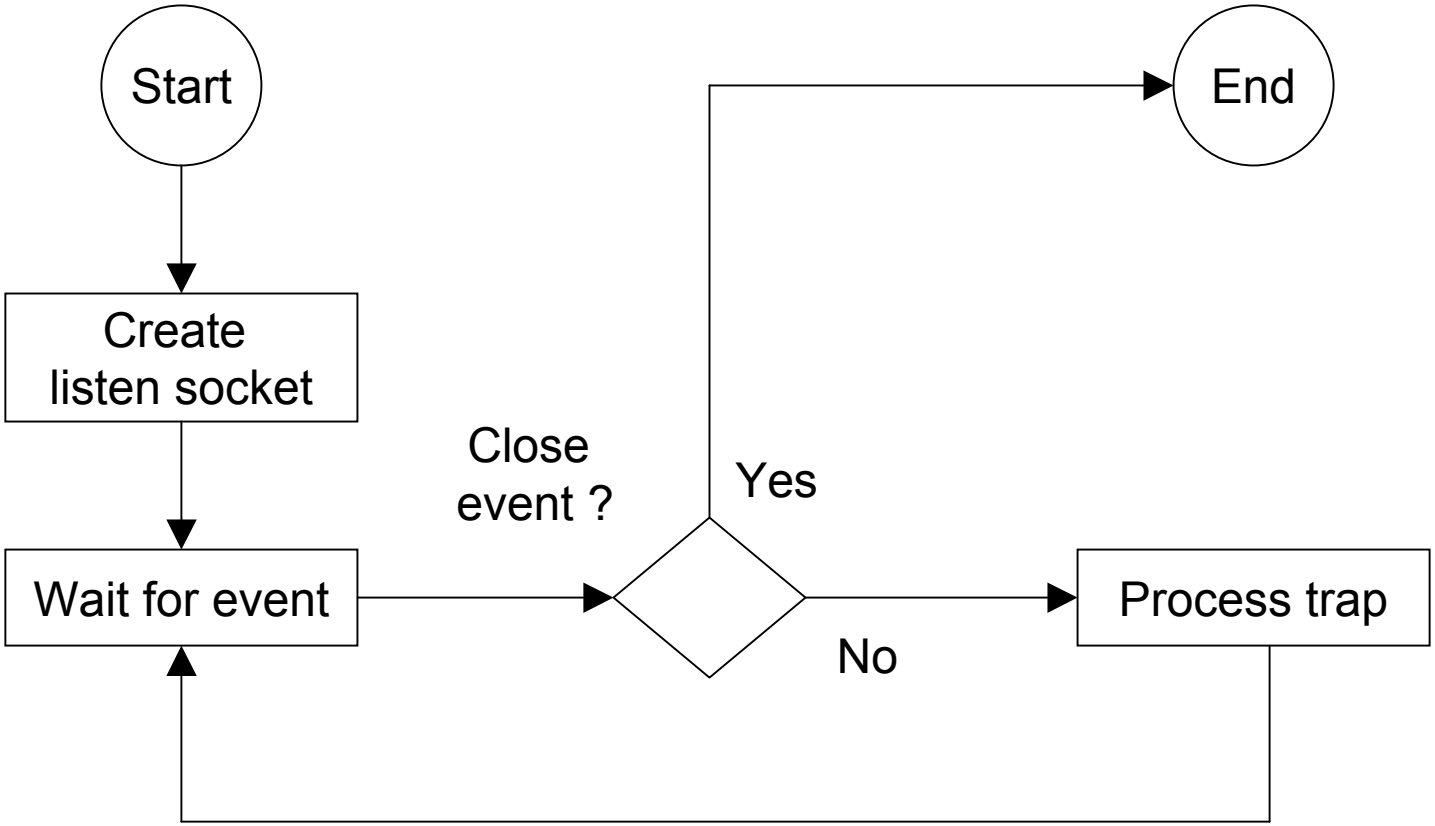
PACS SNMP Manager: main thread

- Main thread flowchart

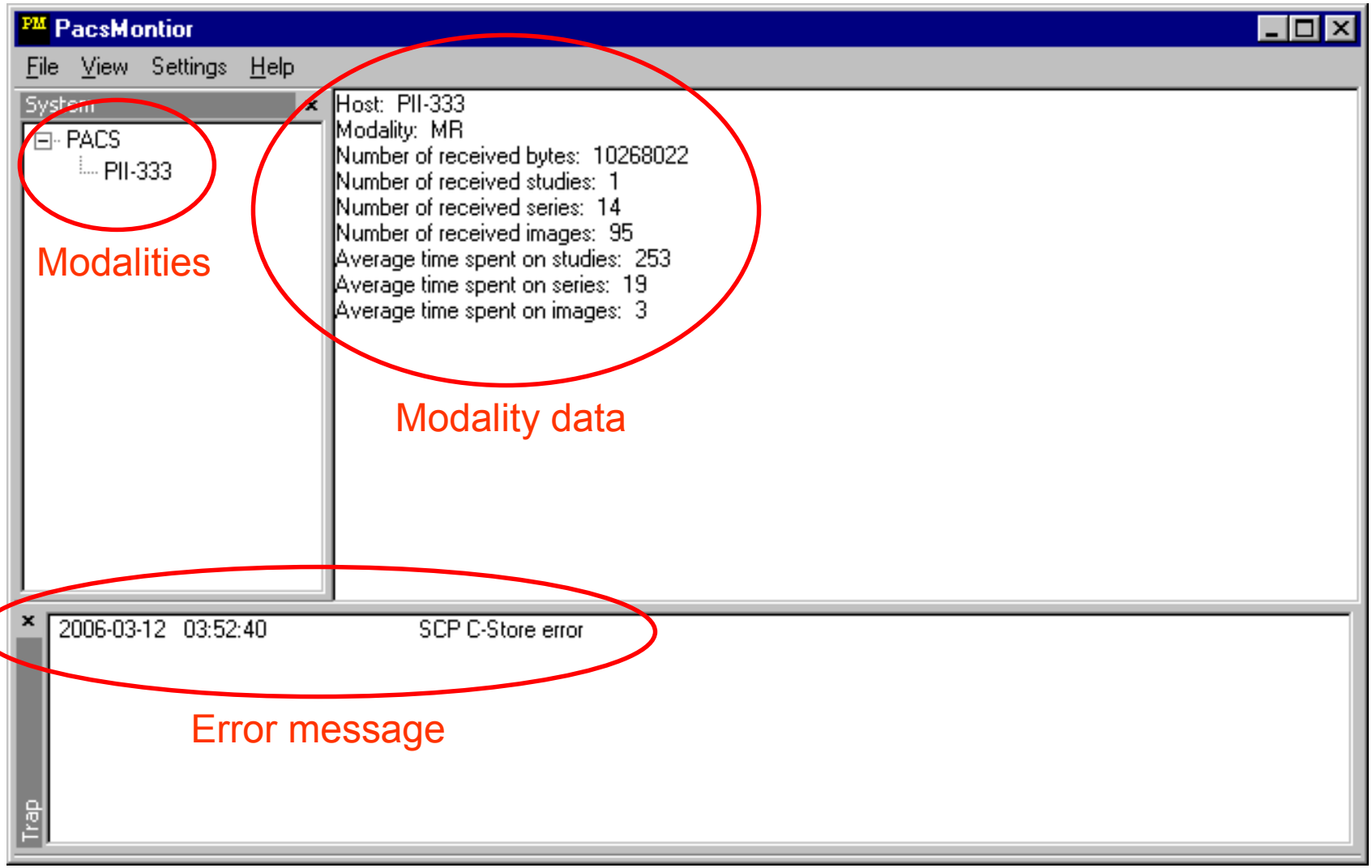


PACS SNMP Manager: trap thread

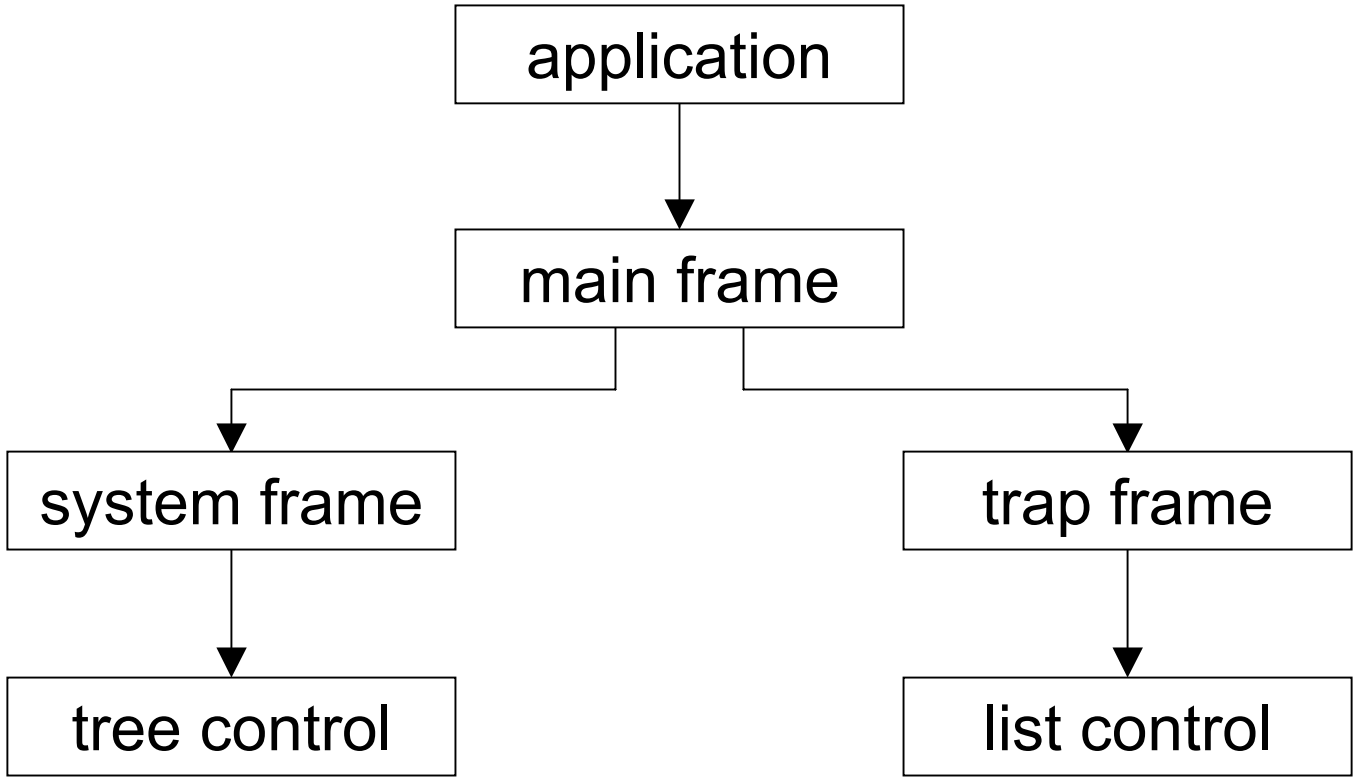
- Trap thread flowchart



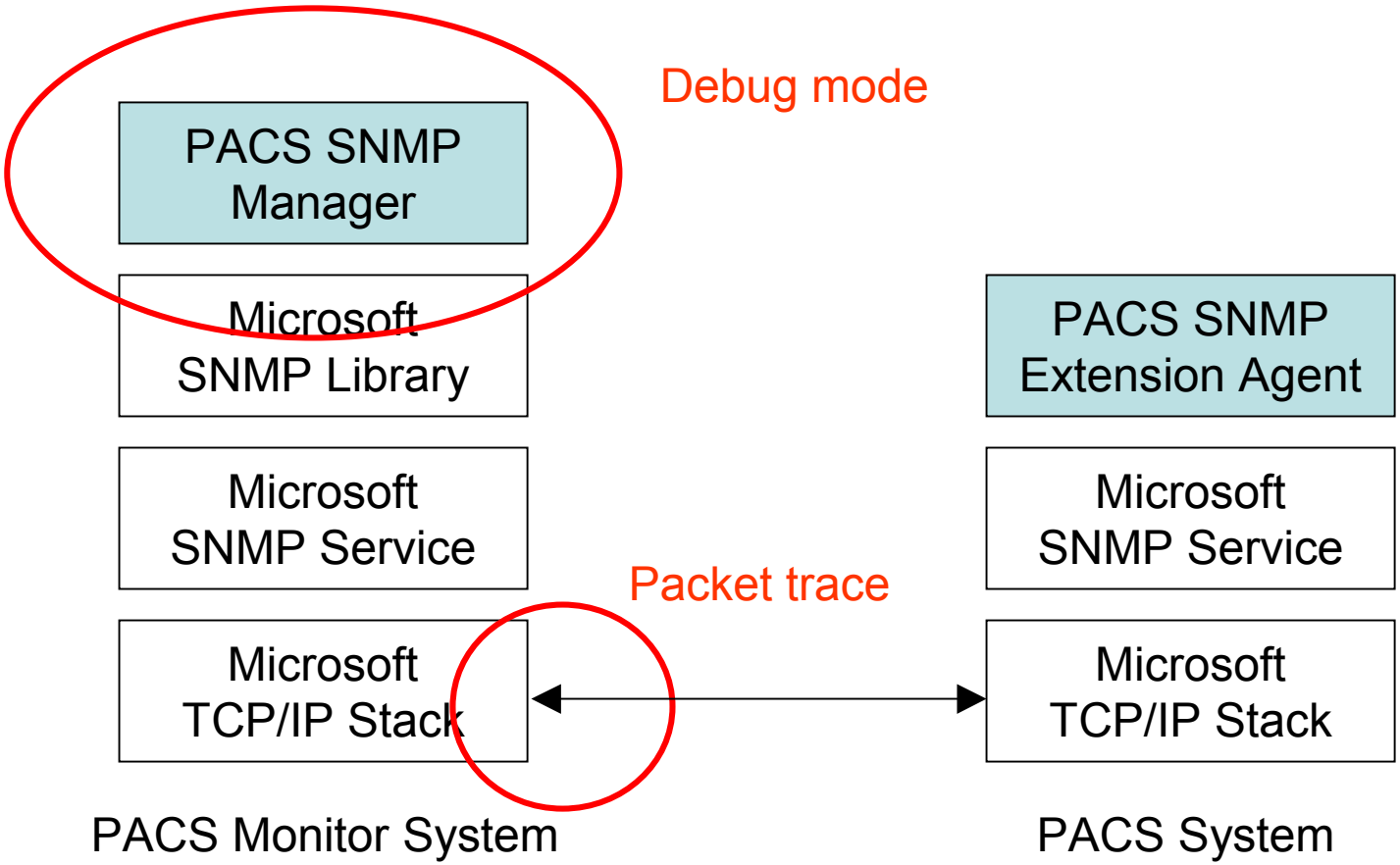
PACS Monitor GUI



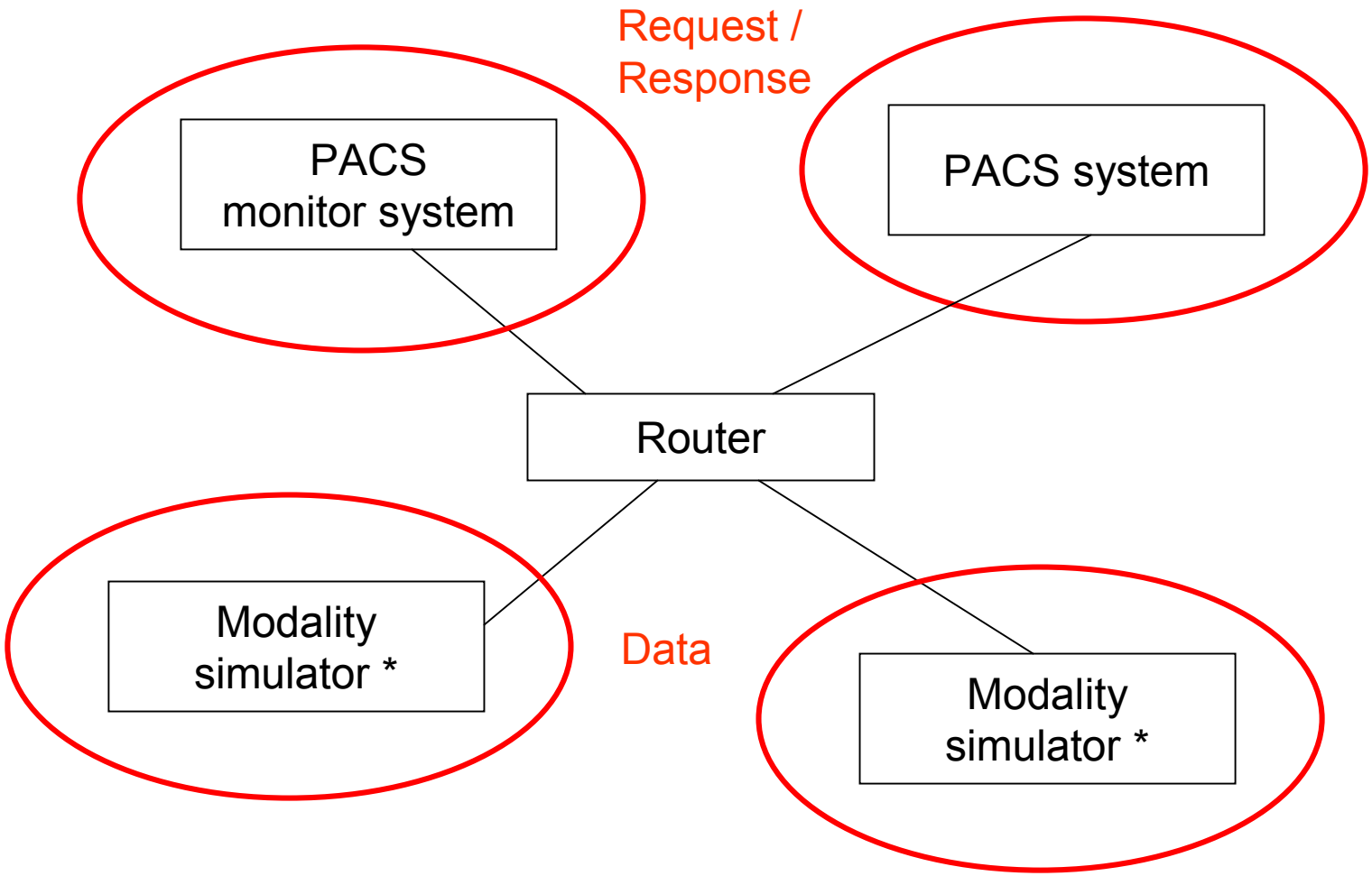
PACS Monitor GUI: classes



Channel Verification



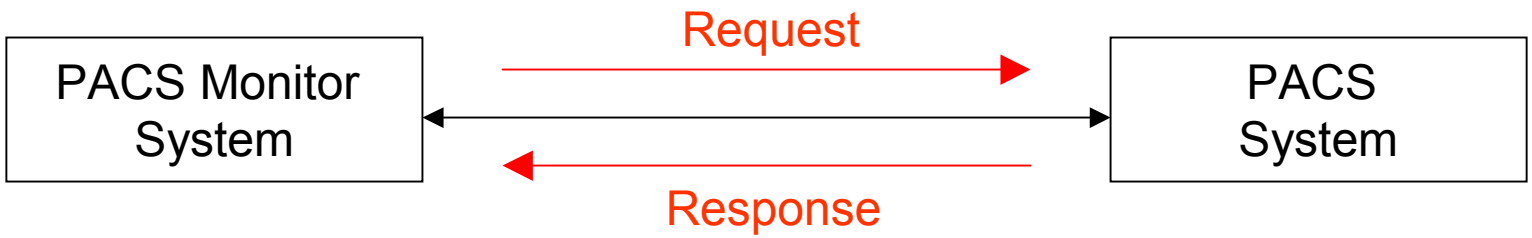
System Verification



* Modality simulator is responsible for sending pre-captured data (such as, CT images) to PACS

Operation: Get, Get-Next, Set

- Retrieve modalities using get-next
- Retrieve statistics using get
- Configure PACS using set



Operation: Trap

- Notified upon error

Conclusion

- PACS is an innovative development
- Network management of PACS is necessary
- Our development can help the PACS administrator
- Project Accomplishment:
  - define the MIB for the service operation
  - create the PACS SNMP manager
  - design the PACS monitor GUI

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Question ?