Ad-hoc on Android

Bachelor - Software Technology

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DTU - IMM

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Contents

Problem

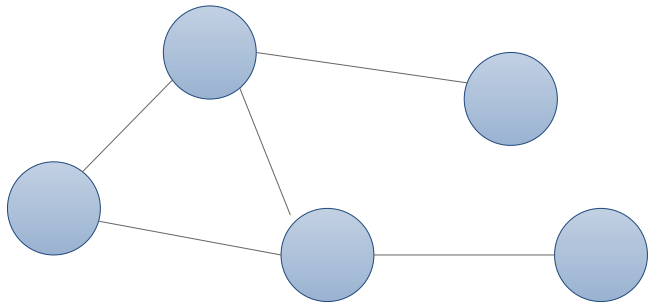
Two main project goals

To develop:

- A Java library that enables ad-hoc networks on Android devices
- An Android application that utilize an ad-hoc network as 'proof of concept'

Mobile Ad-hoc Network Characteristics

- Wireless communication
- Decentralized management
- Dynamic and scalable
- No infrastructure required



Mobile Ad-hoc Network Applications

Where are ad-hoc networks useful?

- Sensor networks
- File-sharing applications
- Text Messaging
- Multiplayer games

These applications imply that any pair of devices can communicate
$\Rightarrow$ a routing protocol is thus required

Three different routing paradigms

Proactive Routing

Finds routes to any other node in the network

$\Rightarrow$ No delay for use, but a lot of route maintenance

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On-Demand routing

Only finds route when the need arises
⇒less topology information is known but higher response time

Location based routing

Each device knows its own physical position (GPS) which is known to its neighbours
⇒little topology information is known, but require some location service

Routing in dynamic mobile networks

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- Not scalable
- Bad performance on highly dynamic networks
- High PDU overhead

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Location based routing

- Location service has to be turned on all the time
- GPS can be inaccurate in buildings
- Highly scalable

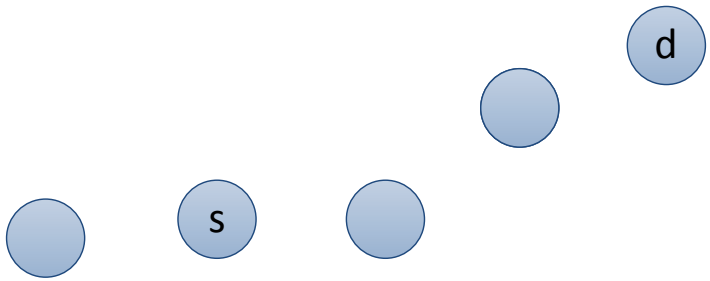
Ad-hoc On-Demand Distance-Vector

Main design features:

- Stores only used routes
- Unused routes will timeout and get discarded
- Each device knows only to its neighbours (next-hop)
- Broadcasts 'Hello' PDU periodically
- Sequence numbers ensures against routing loops

Example: AODV PDU Exchange

S want to communicate with D



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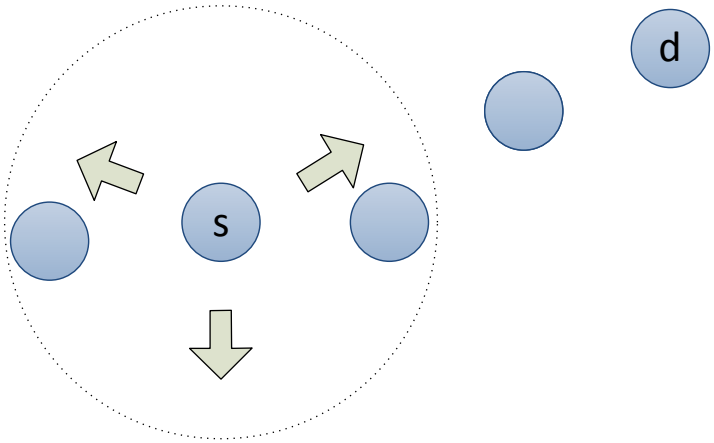
S initiates route discovery



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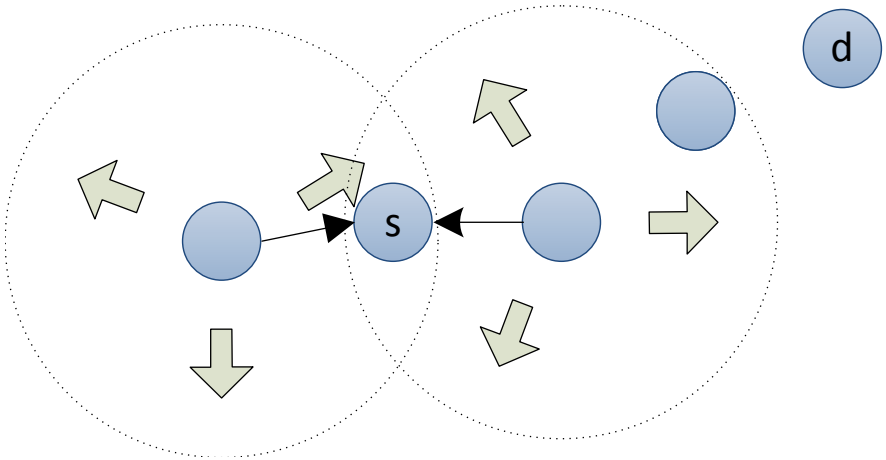
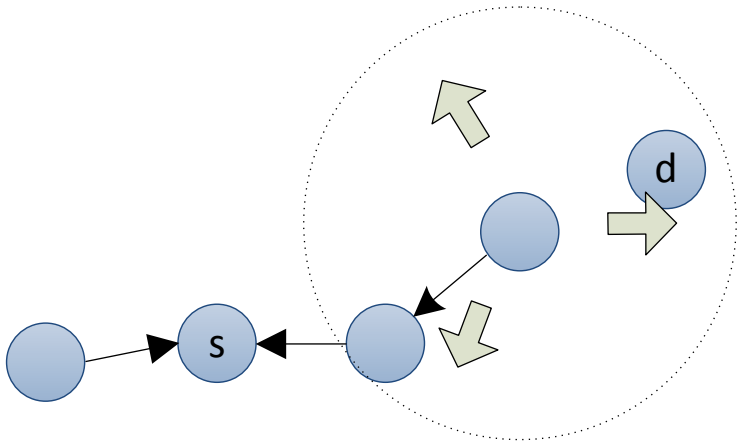
RREQ PDU flooding



Example: AODV PDU Exchange

Reverse route setup, D receives RREQ



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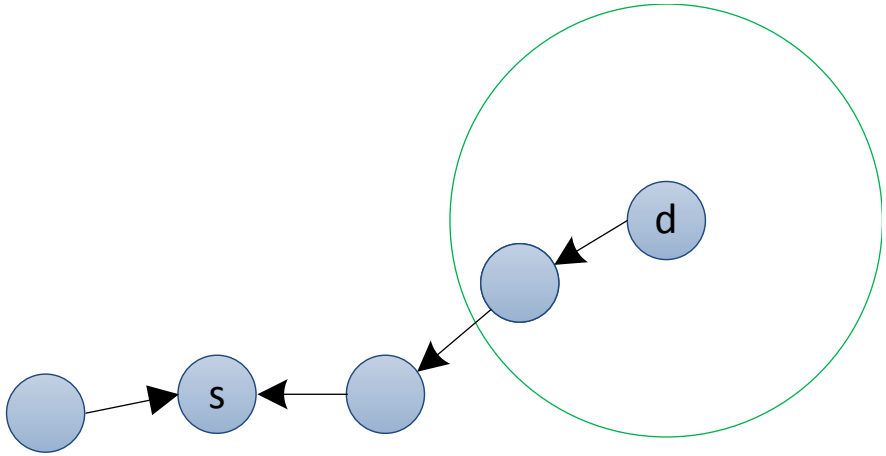
D unicast a RREP along reverse route



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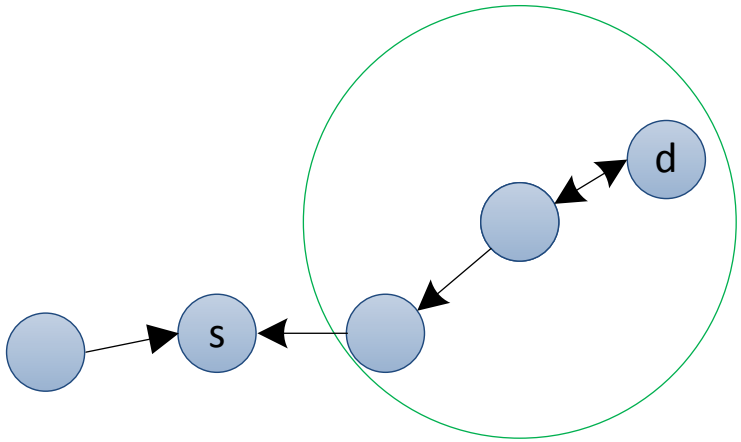
Forward route setup



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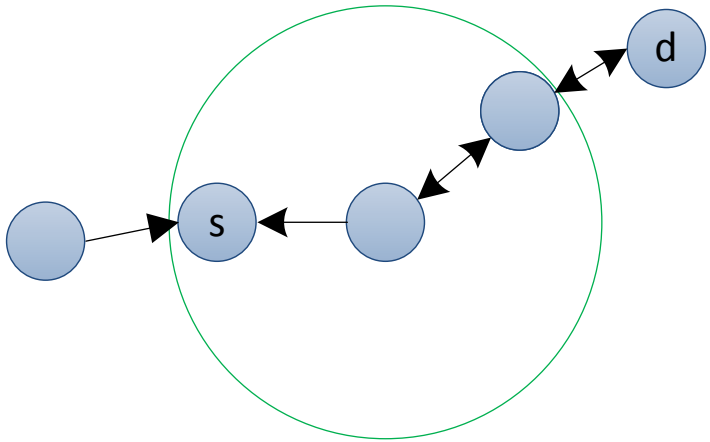
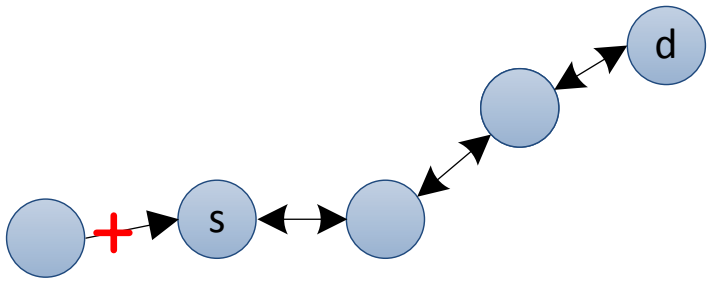


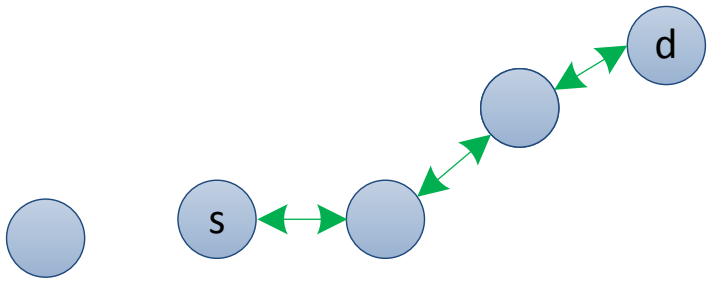
Example: AODV PDU Exchange

Unused reverse routes cleansed



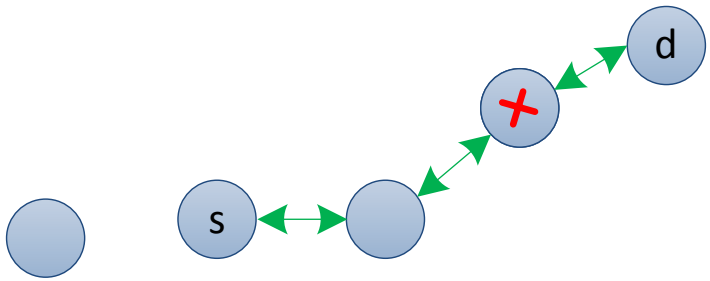
Example: AODV PDU Exchange

Symmetric link established



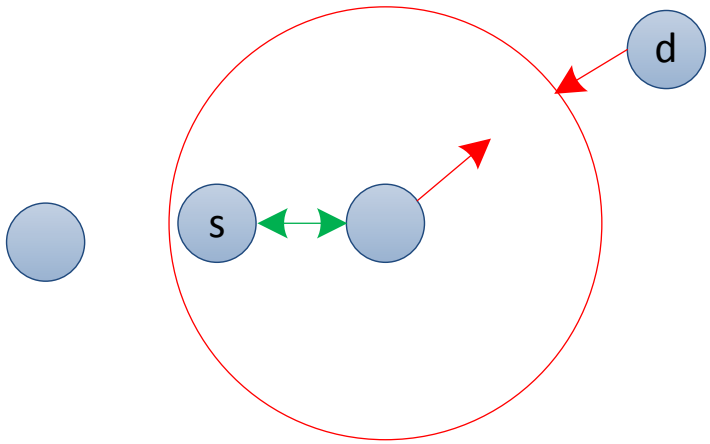
Example: AODV PDU Exchange

Topology change!



Example: AODV PDU Exchange

Break detected RERR sent along path



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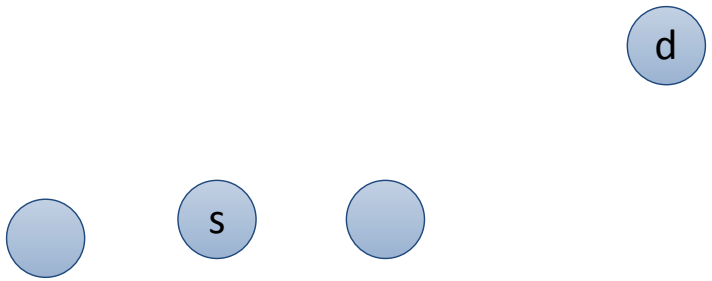

Ad-hoc Library Design

Library Abstracted in Layers

Each layer offers specific functionality:

- Single-hop communication

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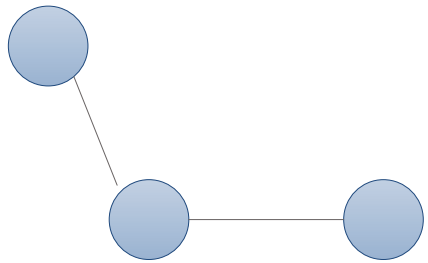

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Each layer offers specific functionality:

- Ad-hoc network on Android
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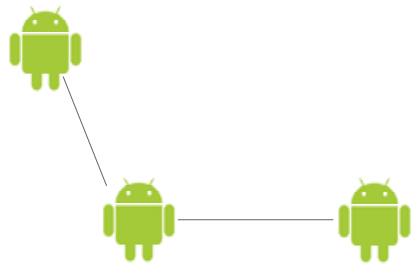
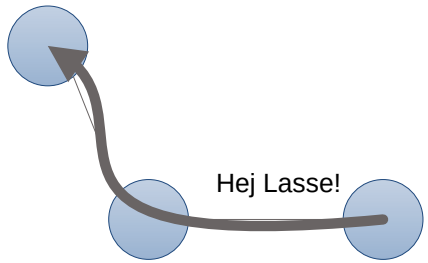
- Single-hop communication



Library Abstracted in Layers

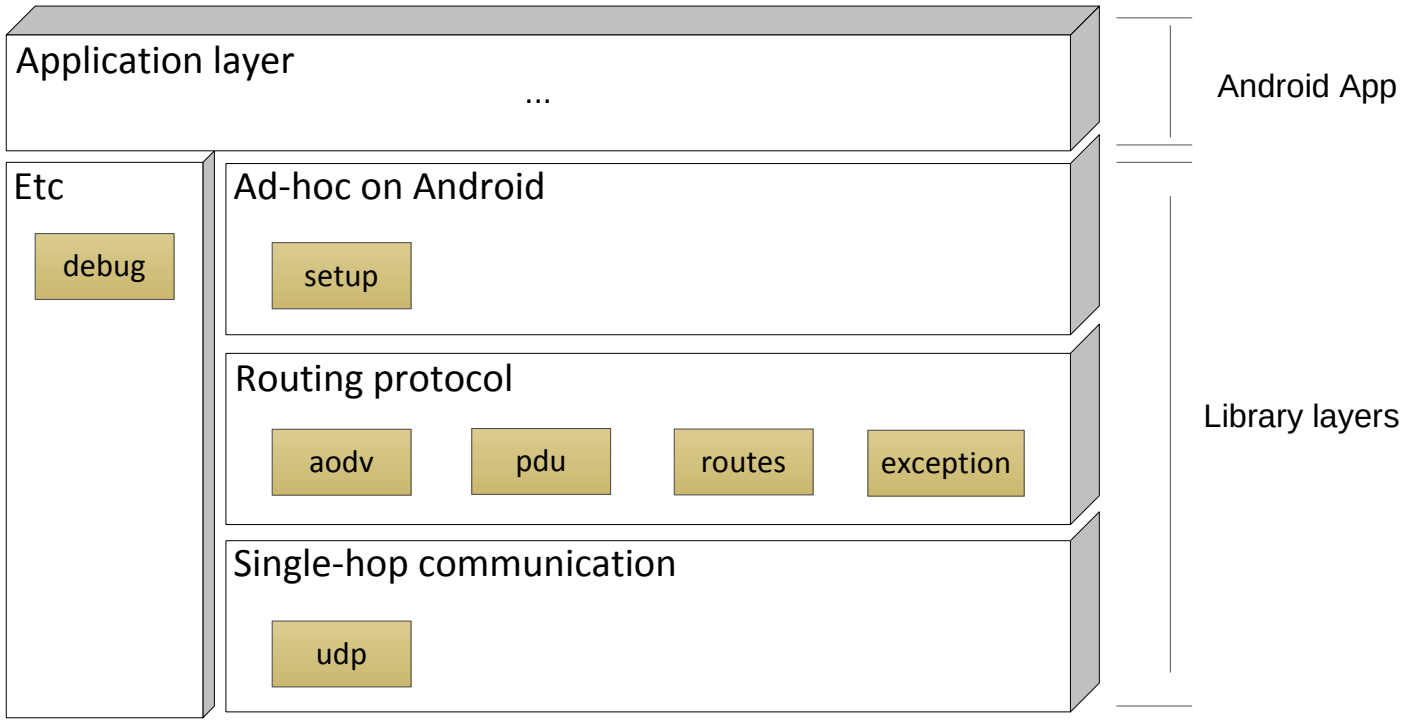
Each layer offers specific functionality:

- Text Messenger using the library
- Ad-hoc network on Android
- Routing of packets
- Single-hop communication

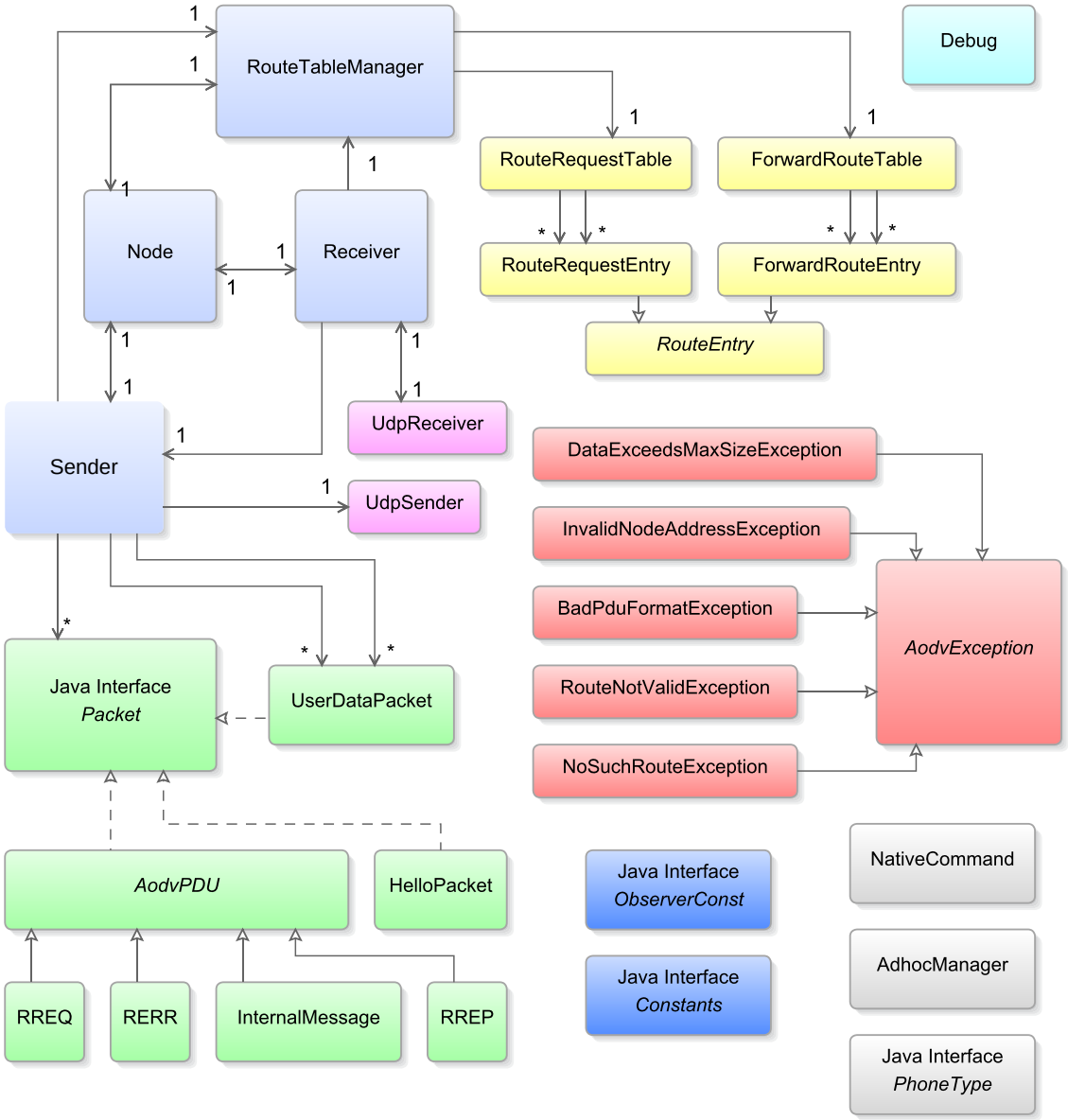


Library modules/packages

Layers consist of modules responsible for smaller part



UML Class Diagram



Ad-hoc on Android layer

- setup

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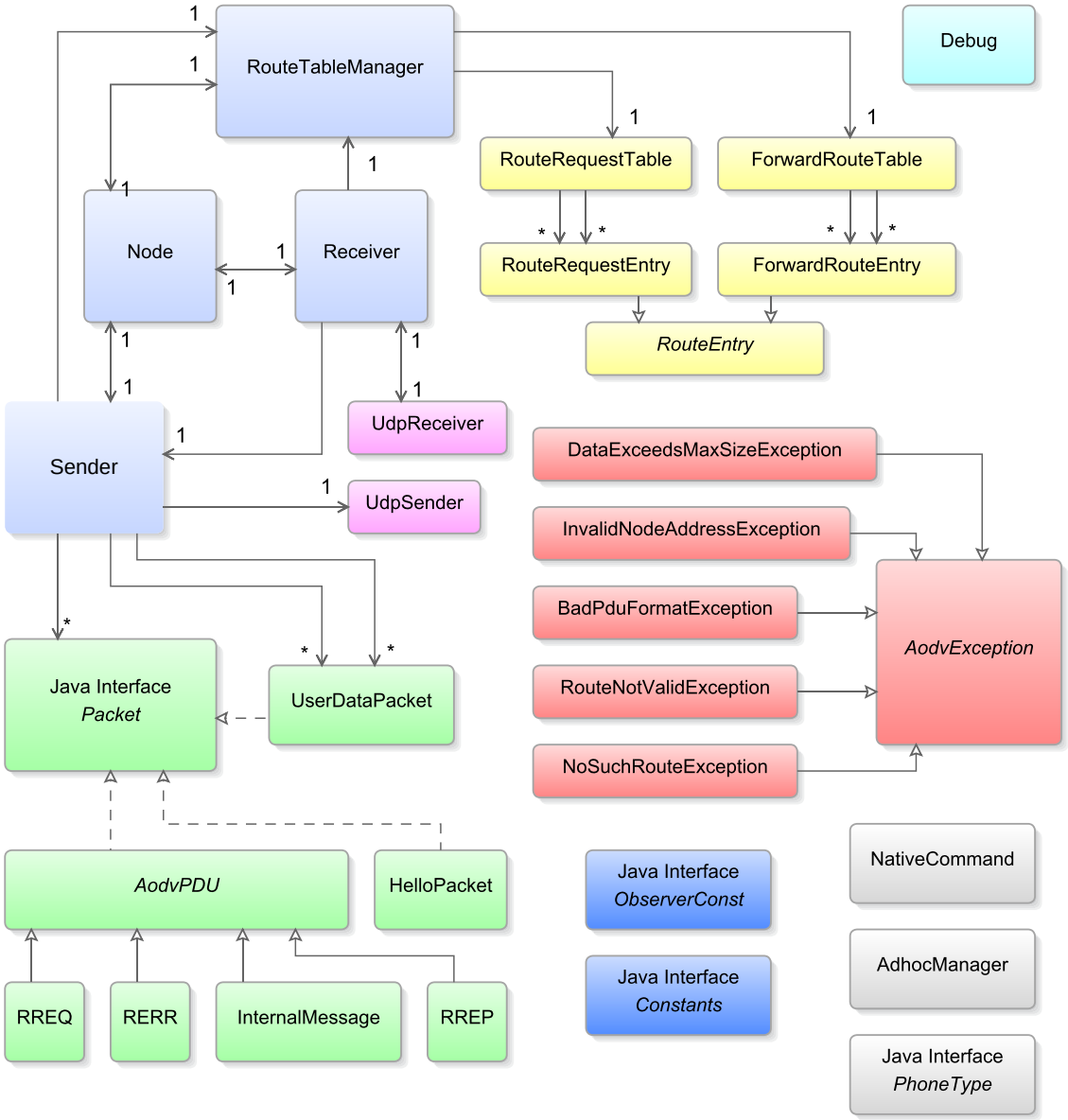

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Routing layer

- aodv
- routes
- pdu
- exception

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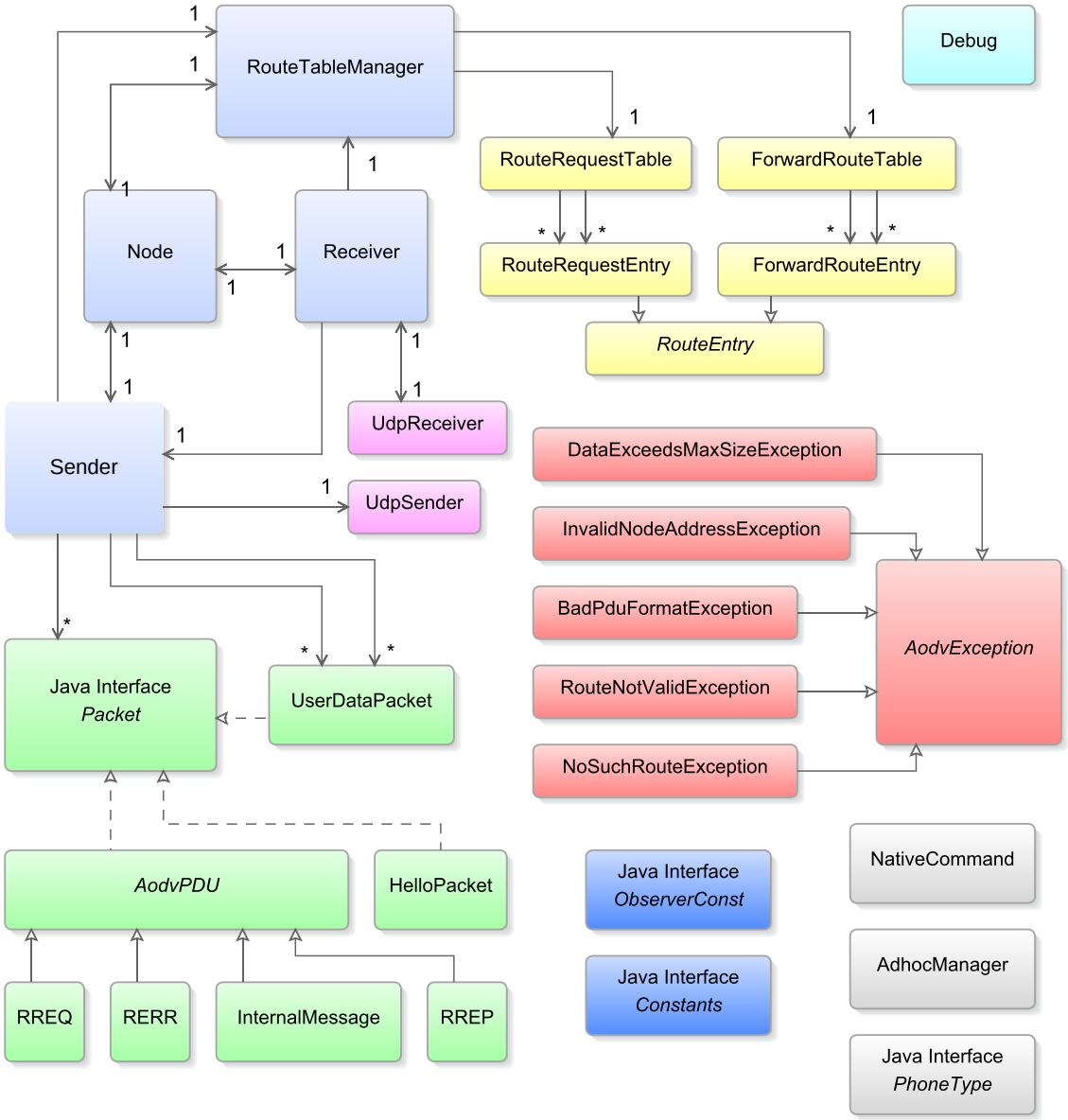

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- setup

Routing layer

- aodv
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Single-hop com.

- udp

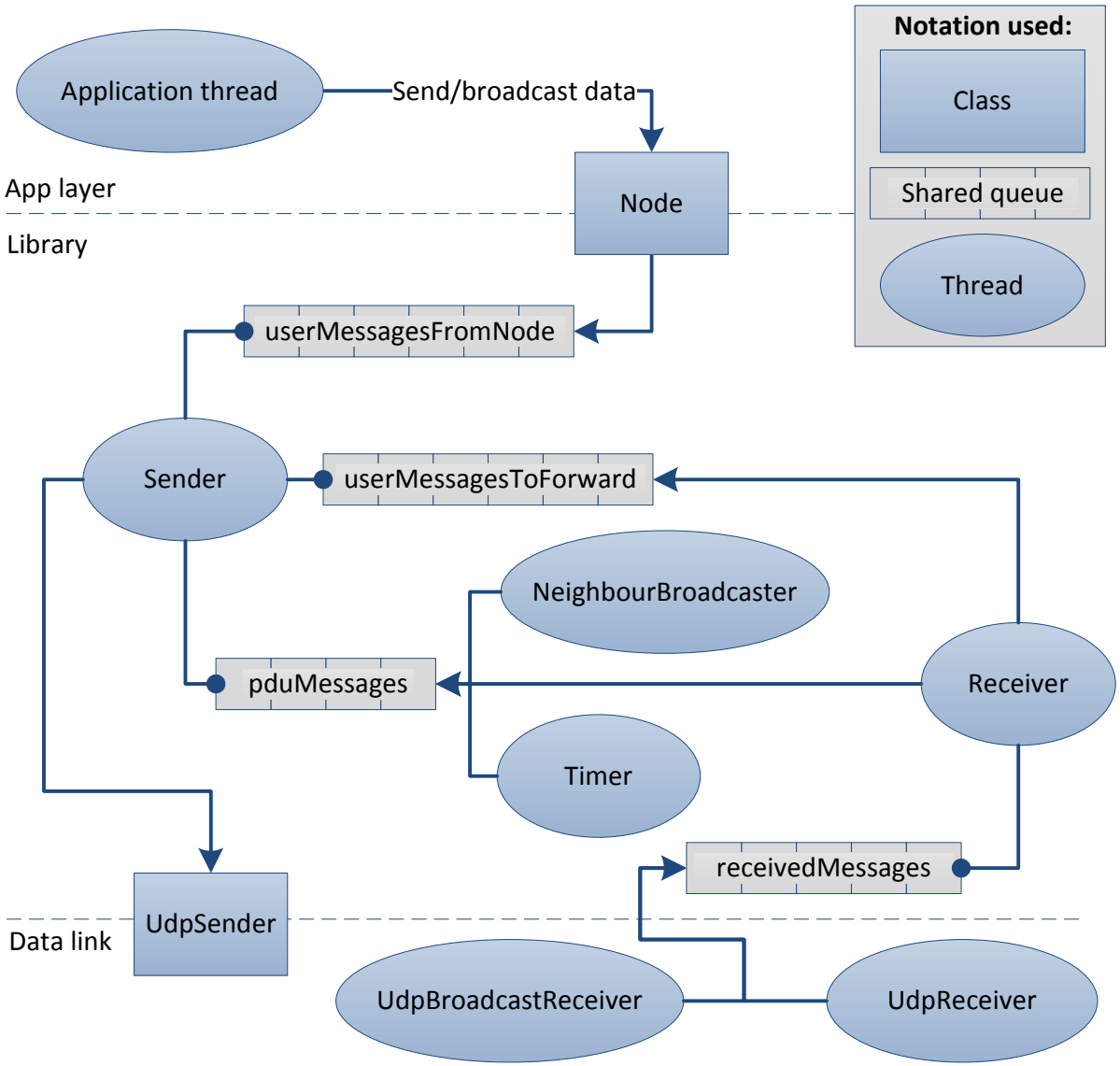
Multi-threaded Library

Library

Sender	Handles the processing of PDU that must be sent
Receiver	Handles PDUs that is received
NeighbourBroadcaster	Generate periodic 'Hello' PDUs
Timer	Maintains the route tables
UdpReceiver	Receives datagram packets
UdpBroadcastReceiver	Receives broadcast datagram packets

Interaction Between Library Threads

Message passing paradigm by shared queues

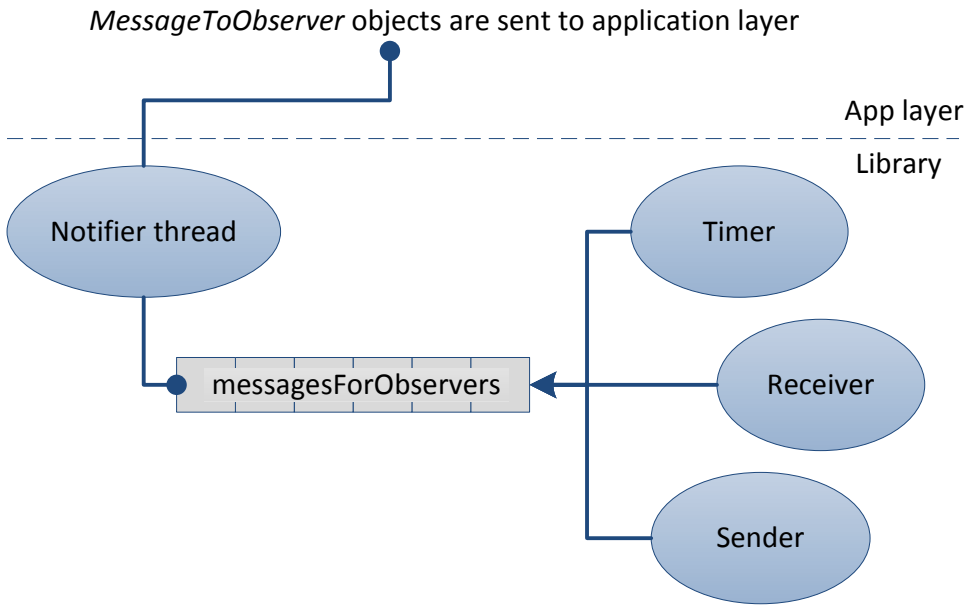


Interaction Between Library and Application Threads

Observer-pattern used for notifications

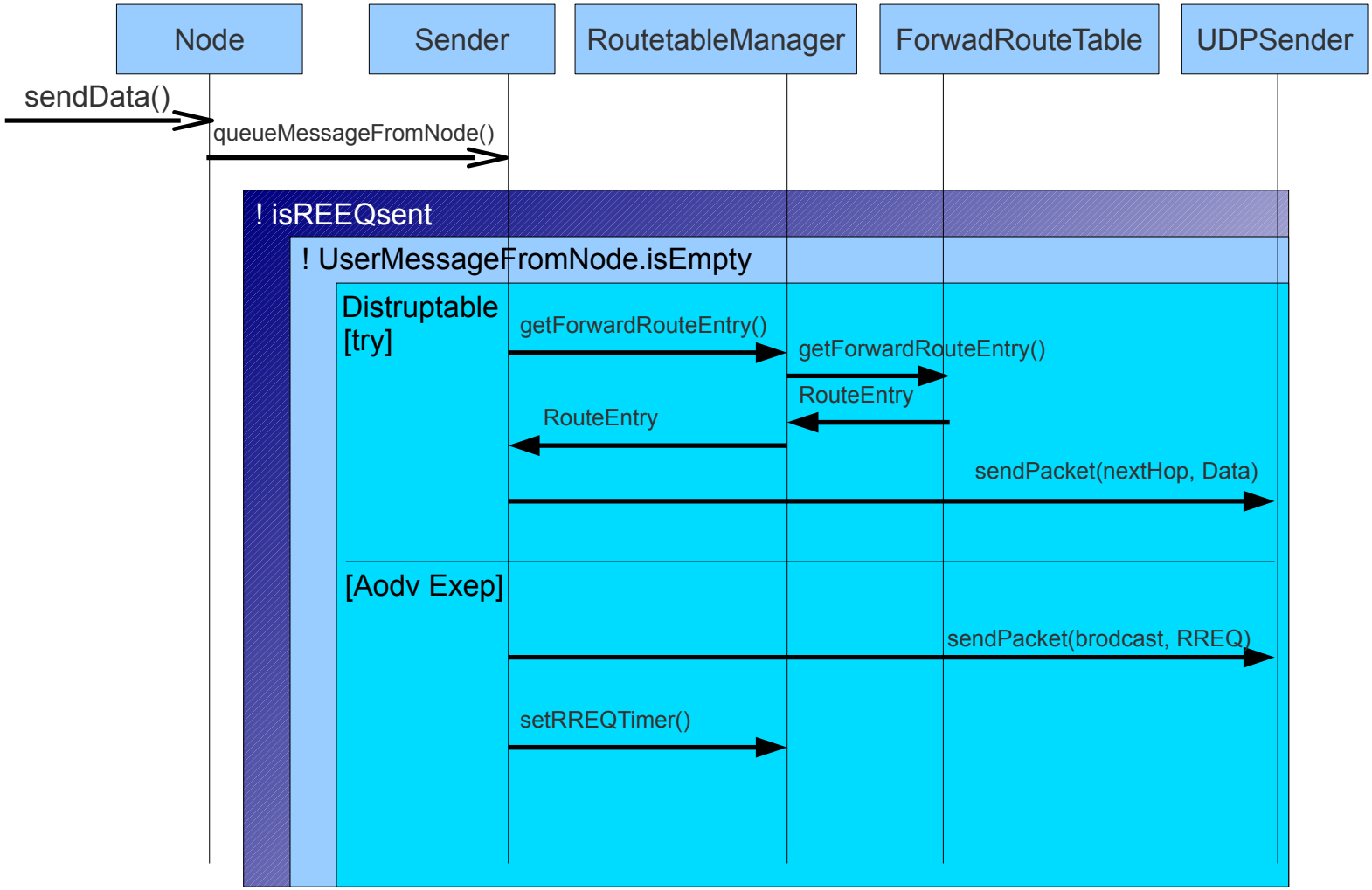
Events:

- Application data received
- Search fail
- New route available
- Data successfully sent



UML Sequence Diagram

Application request to send a data packet

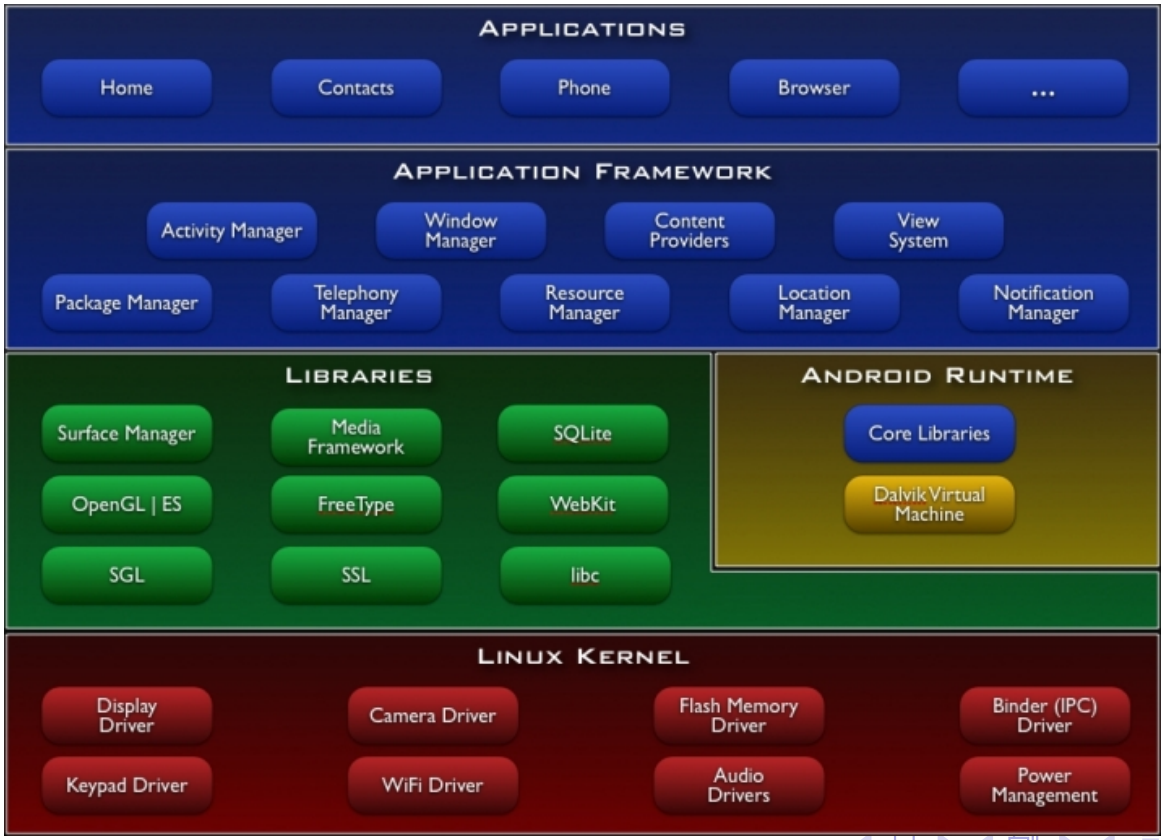


Android OS and Text Messenger Application

Android OS

- **Applications**
- Application Framework
- C/C++ Libraries and VM
- Linux Kernel

- Java - TextMessenger
- JNI - Java to C
- NDK - startstopadhoc
- Linux kernel - WiFi driver



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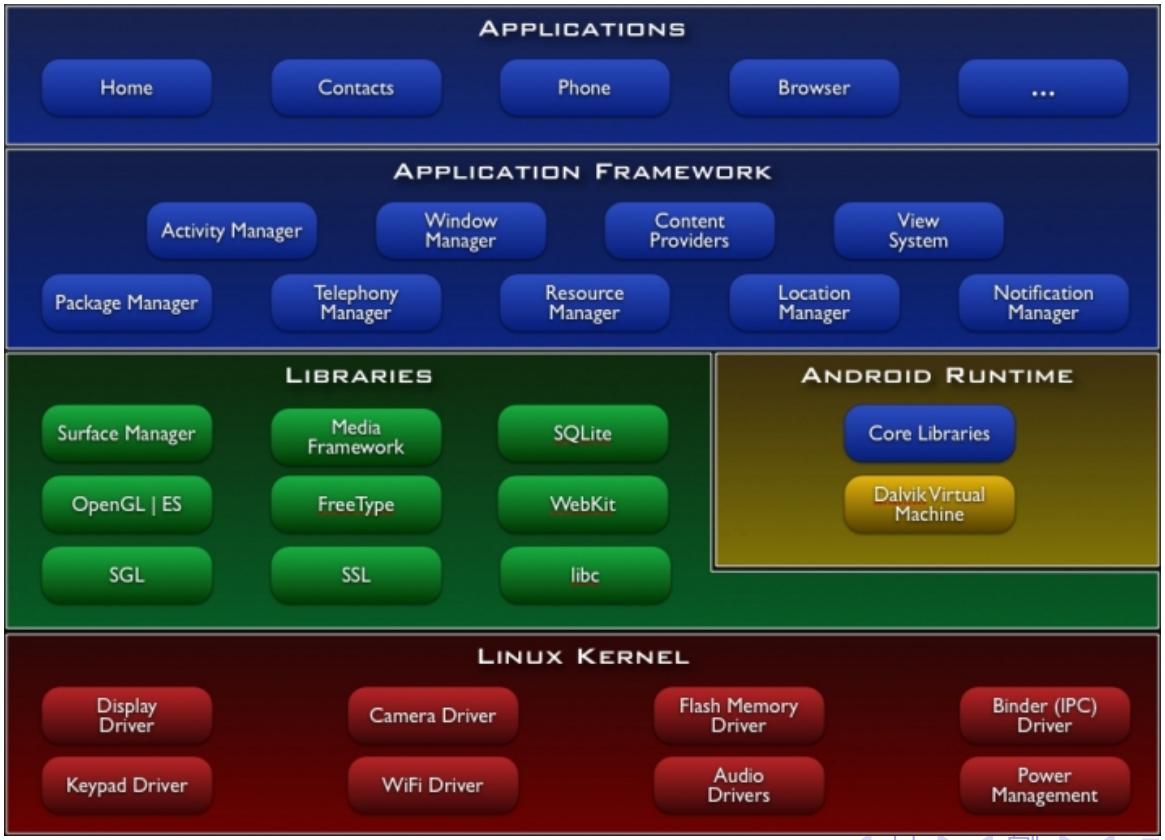

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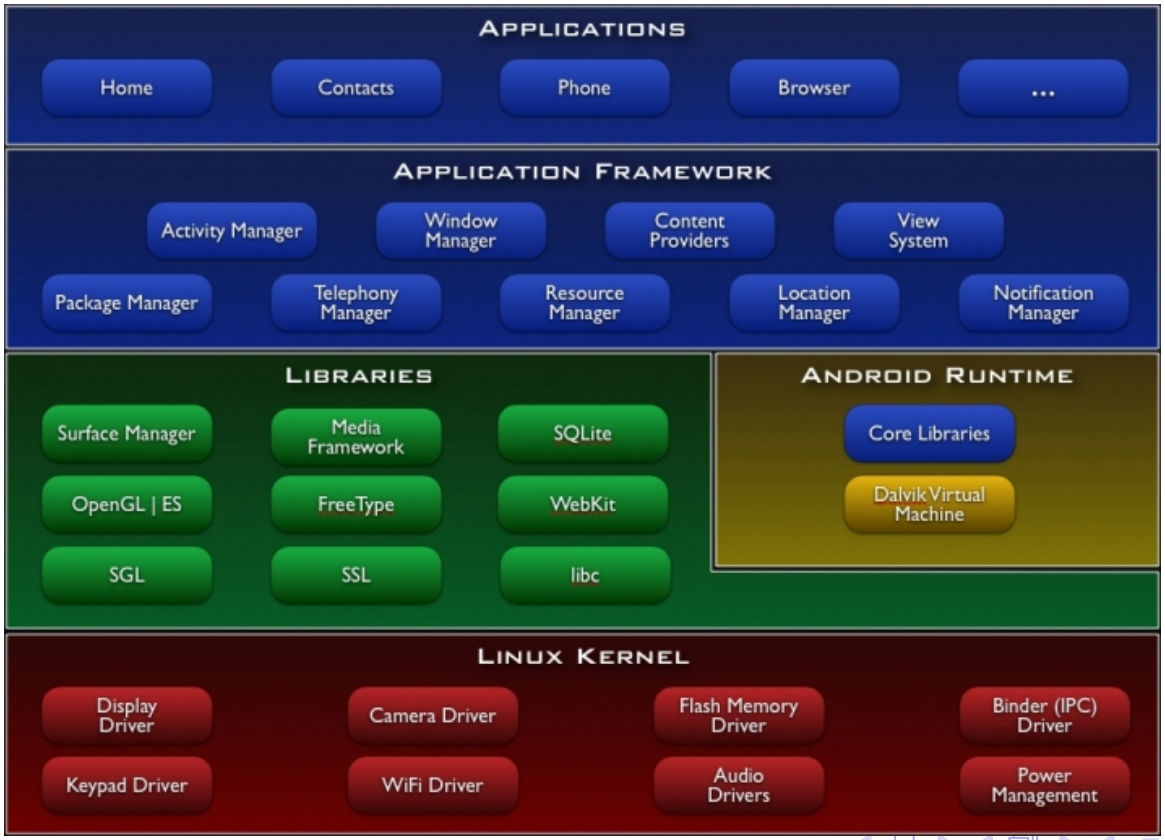

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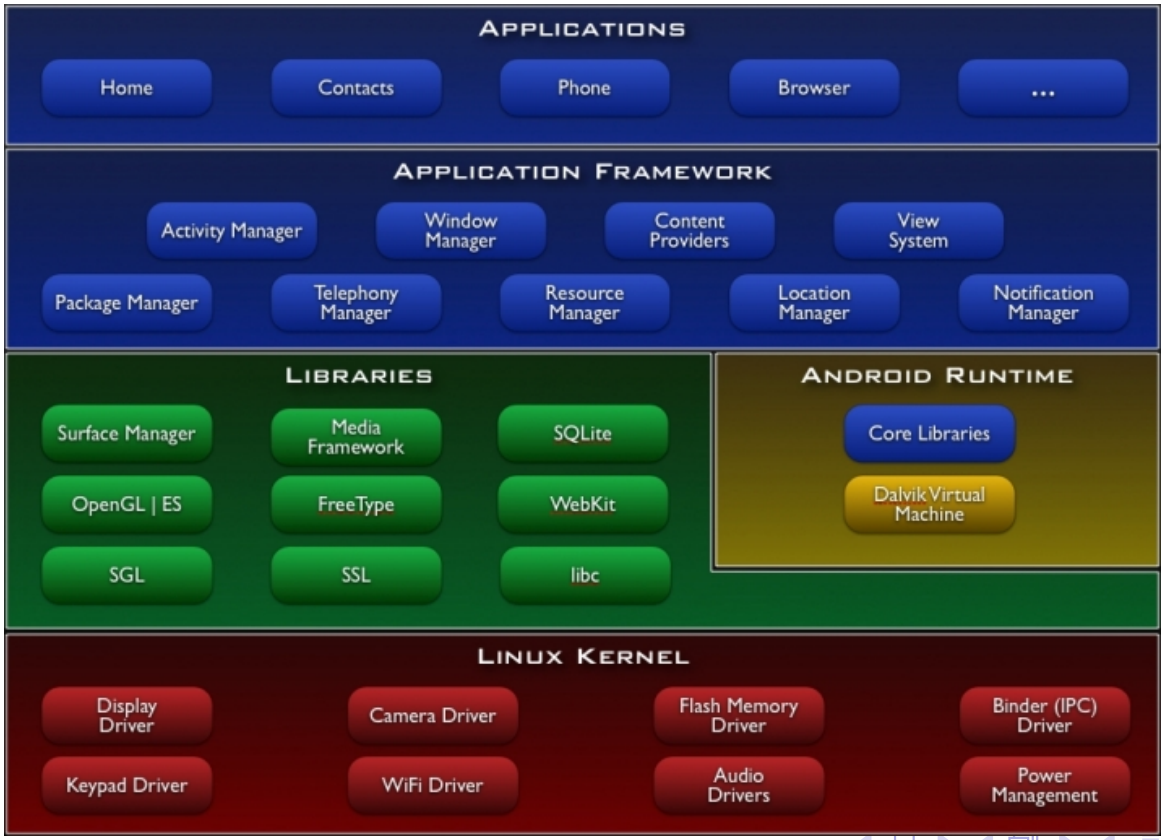

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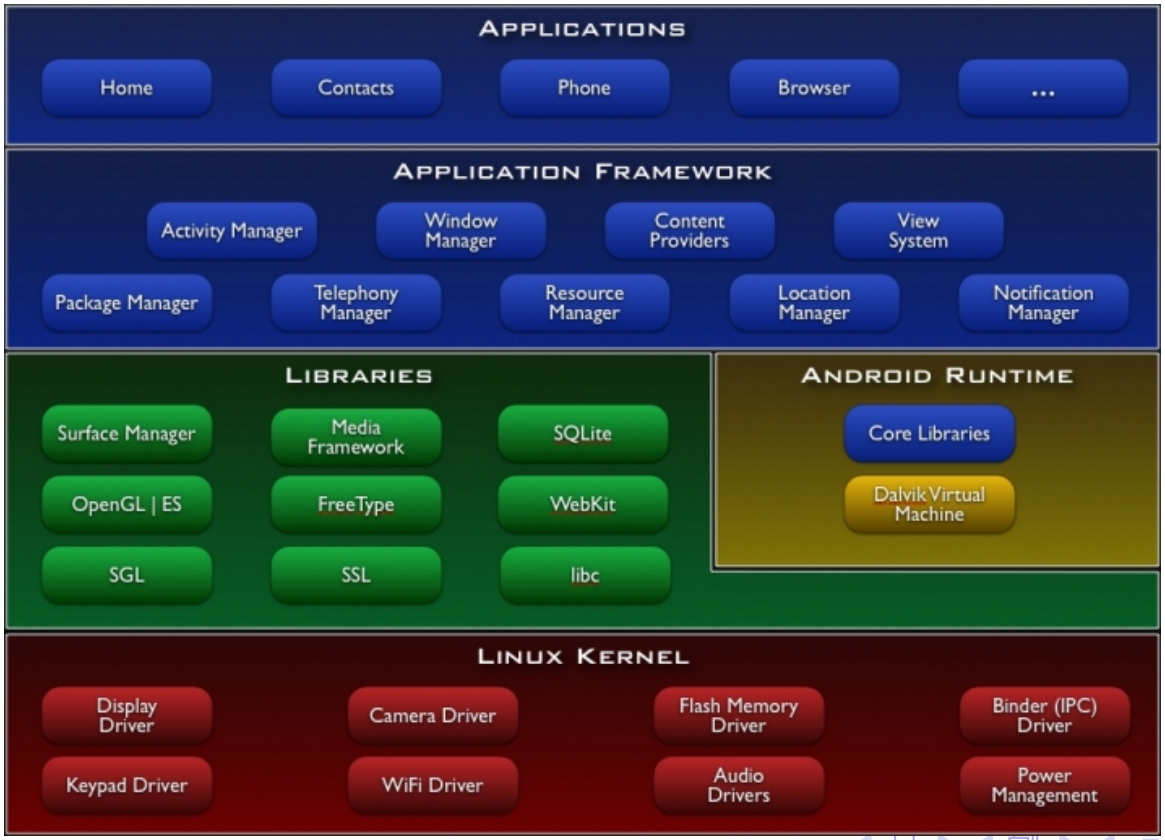

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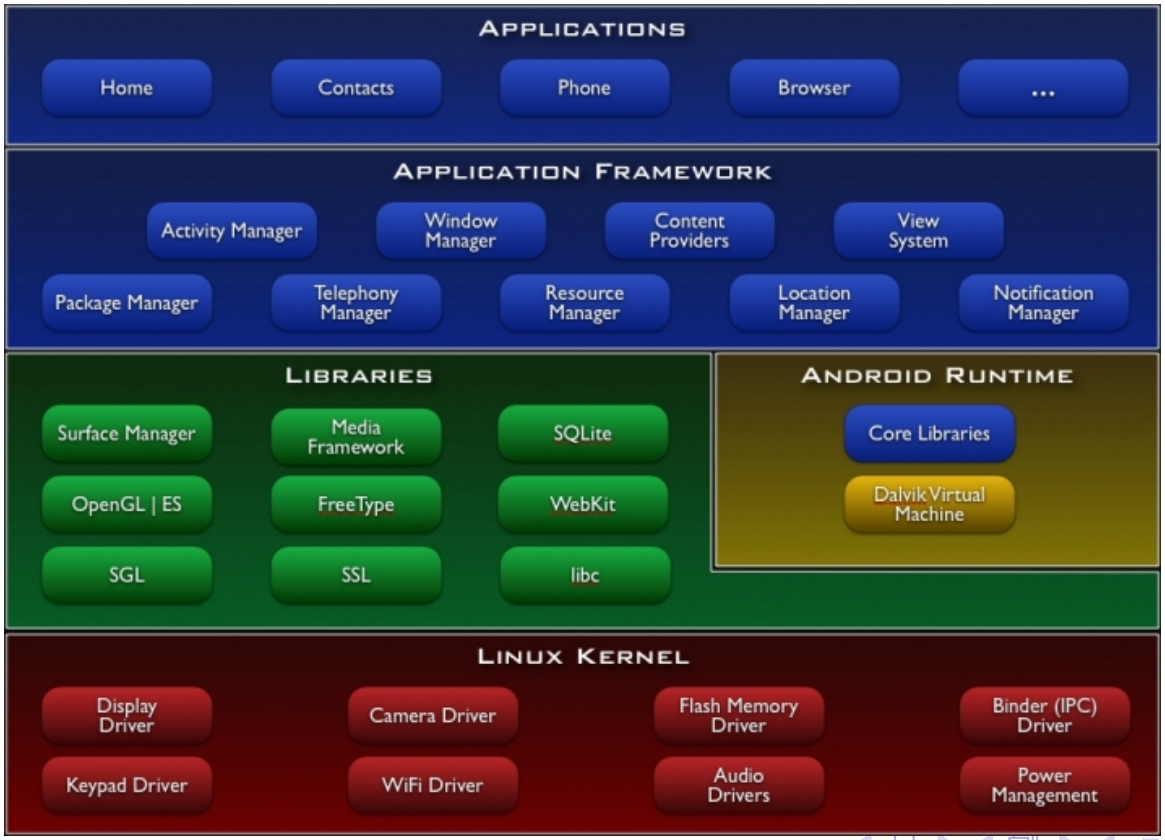

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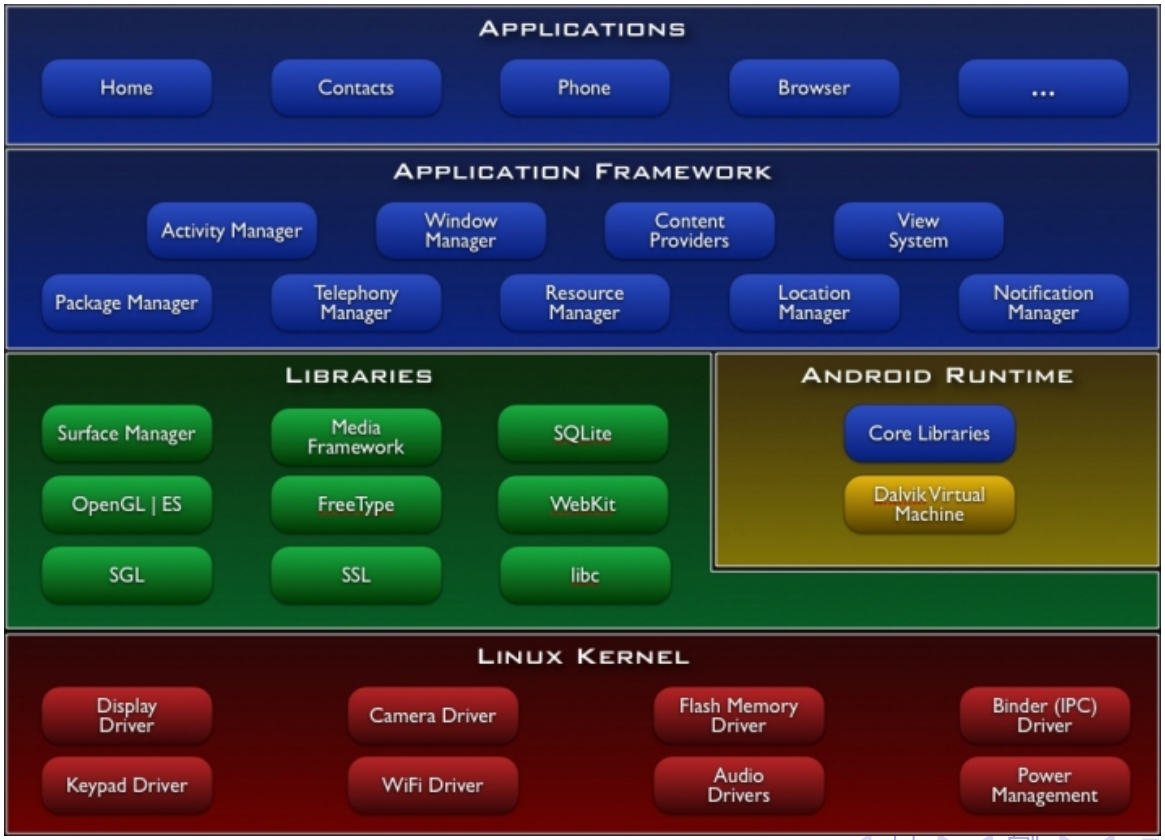

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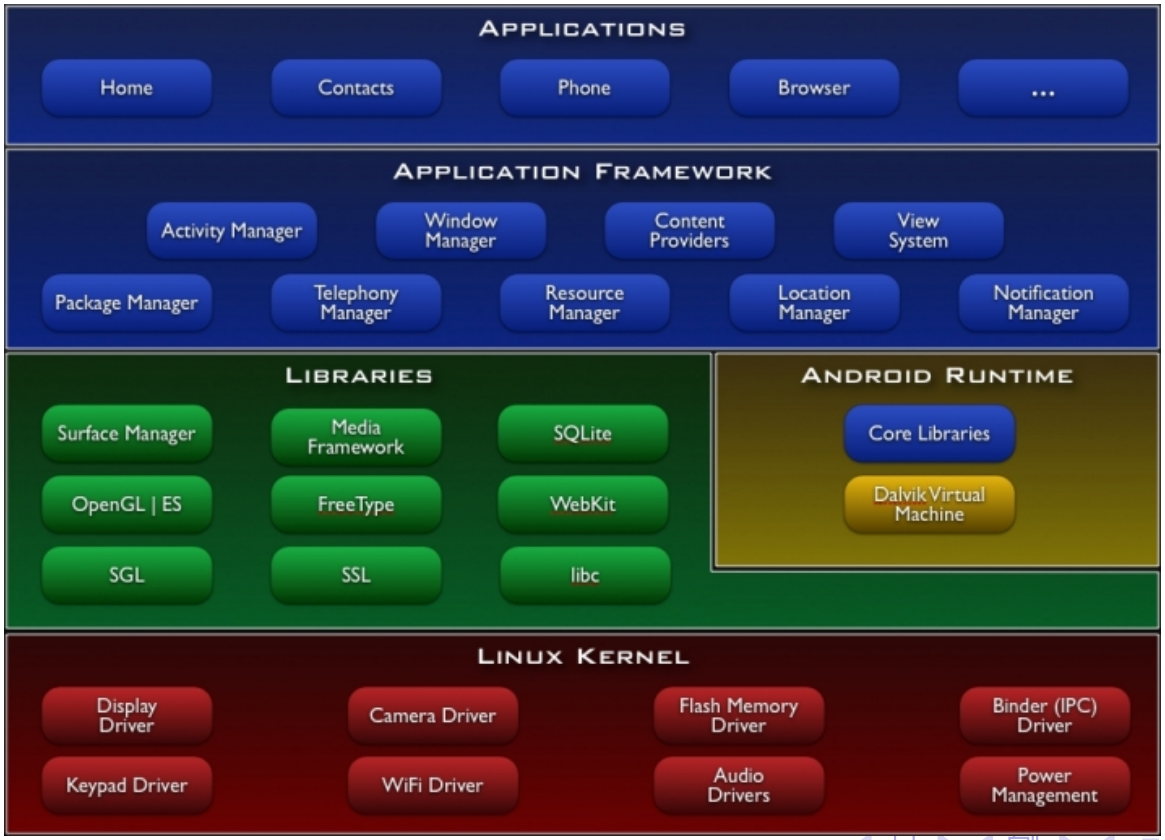
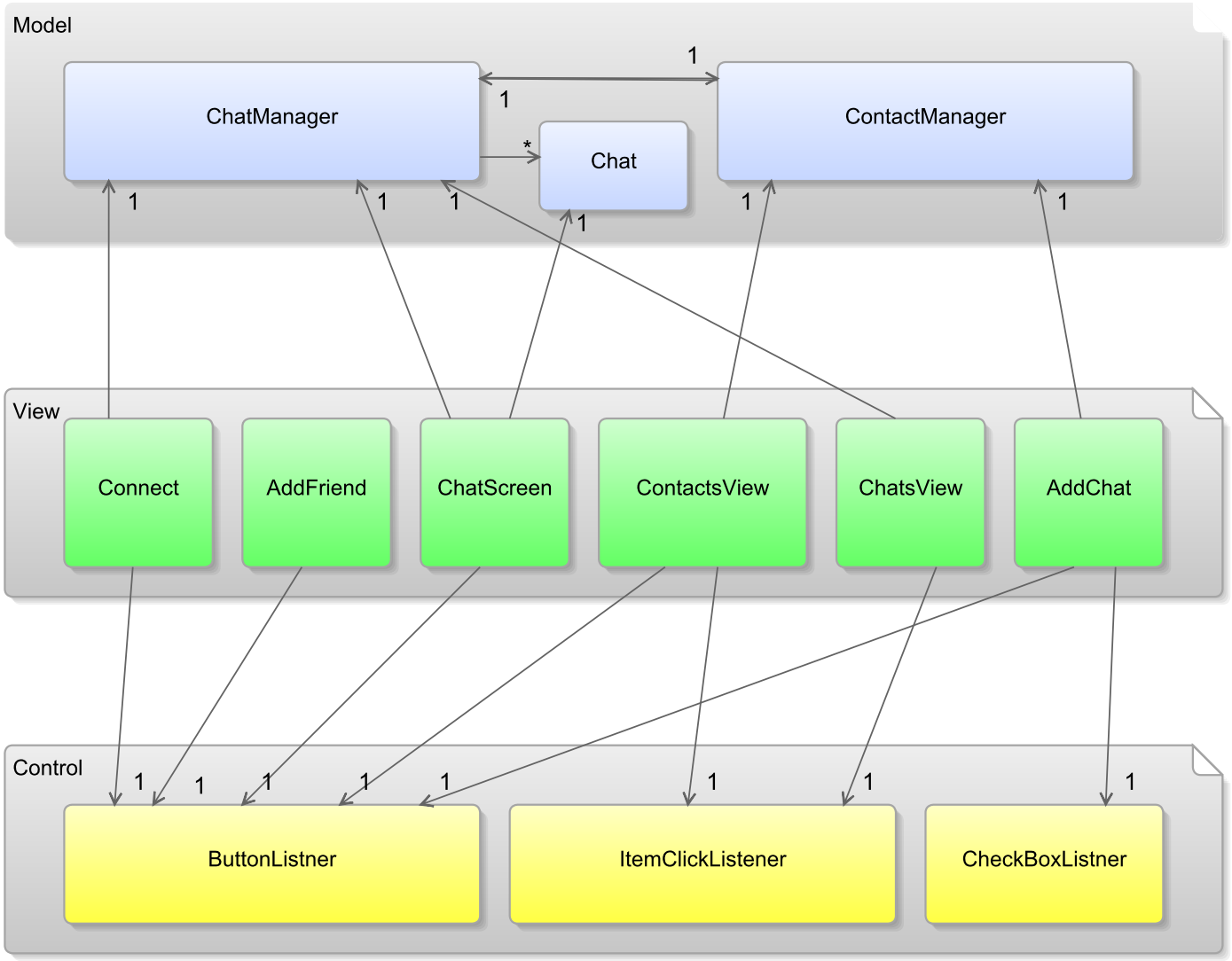


Application Design

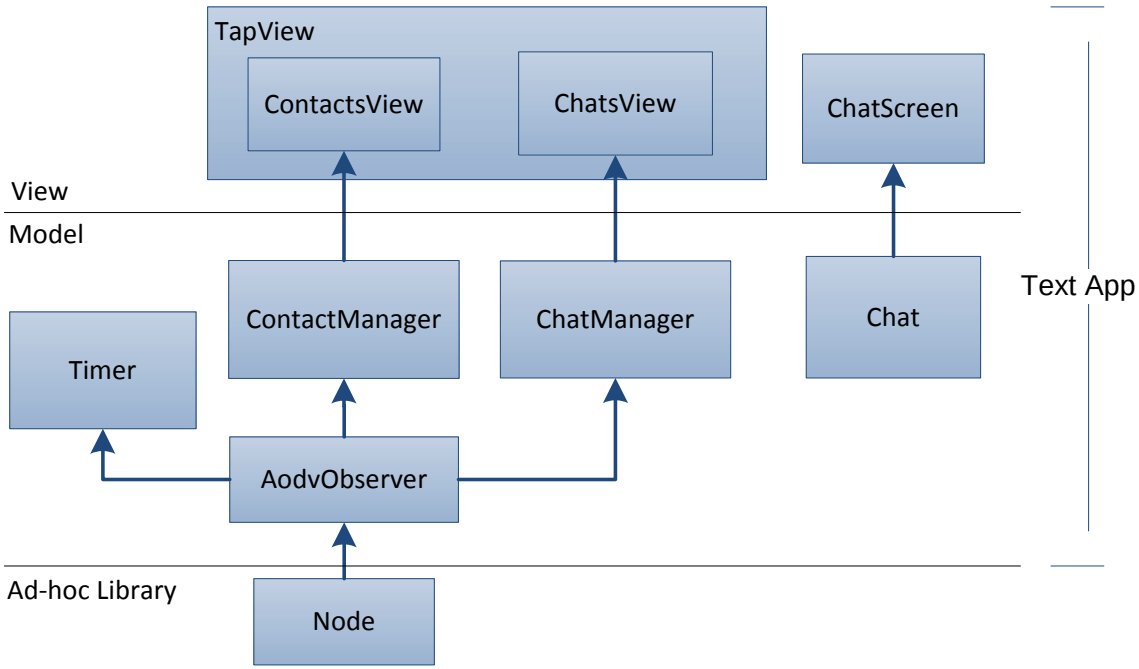
Model-View-Control (MVC)



Observer patterns

Model to View

- **New contact or chat**
- Remove contact or chat
- Contact online status change
- New text message



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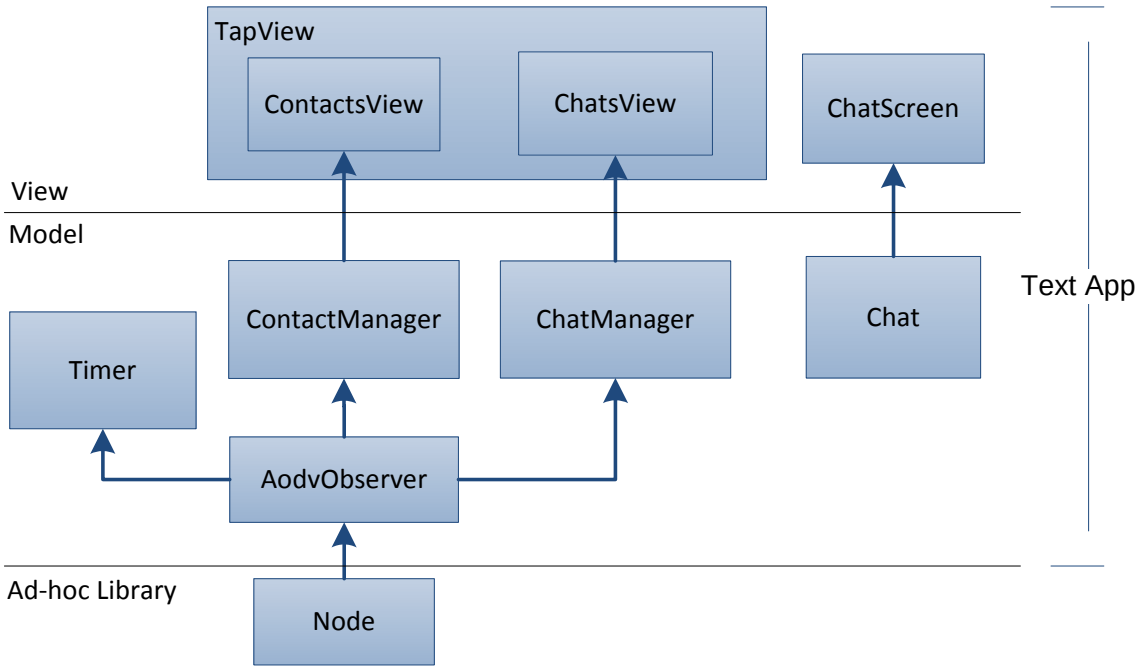

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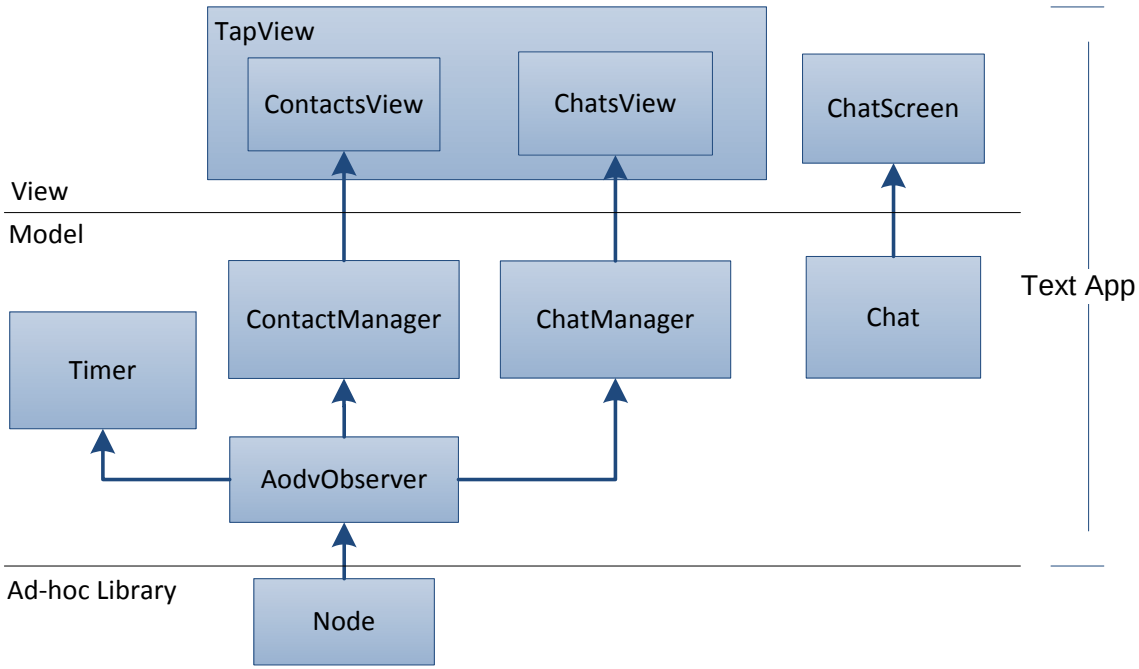

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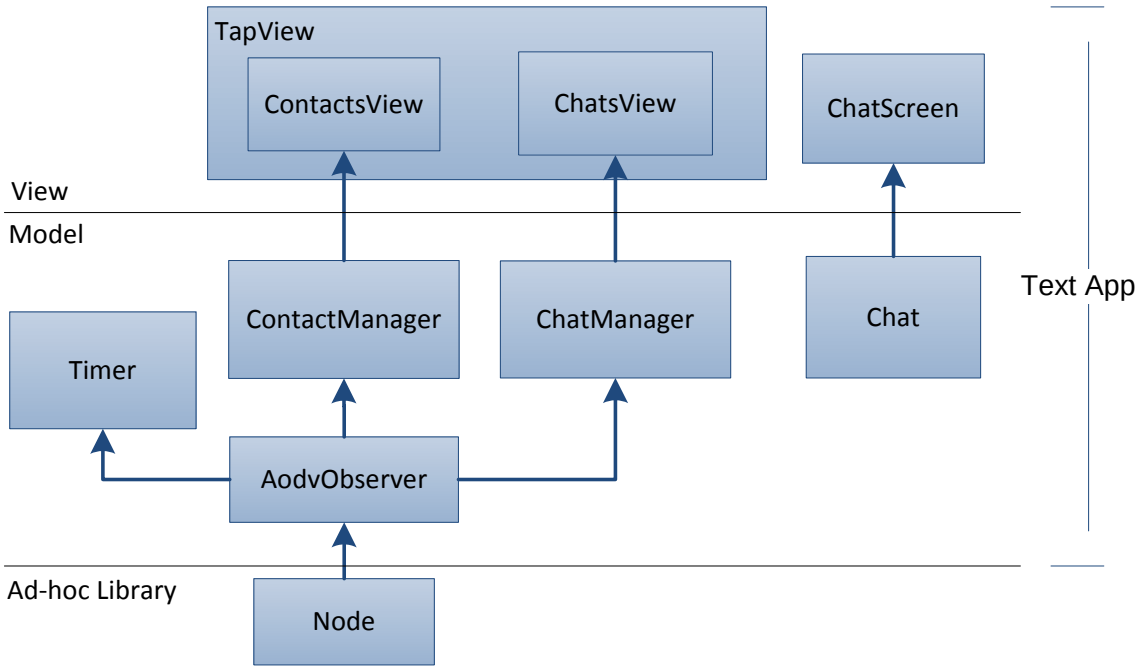
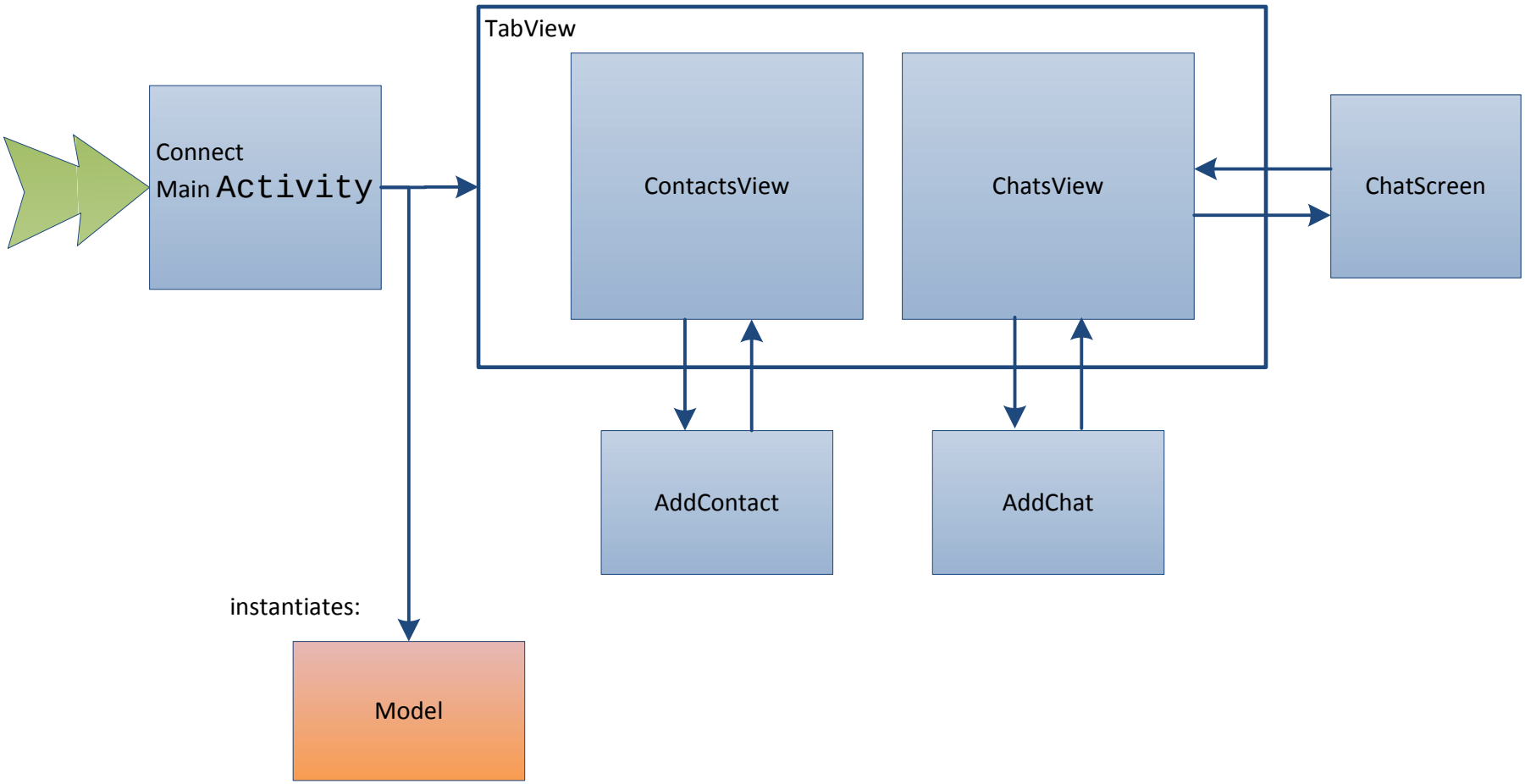


Activity Flow

Illustration of how the user may navigate between screens



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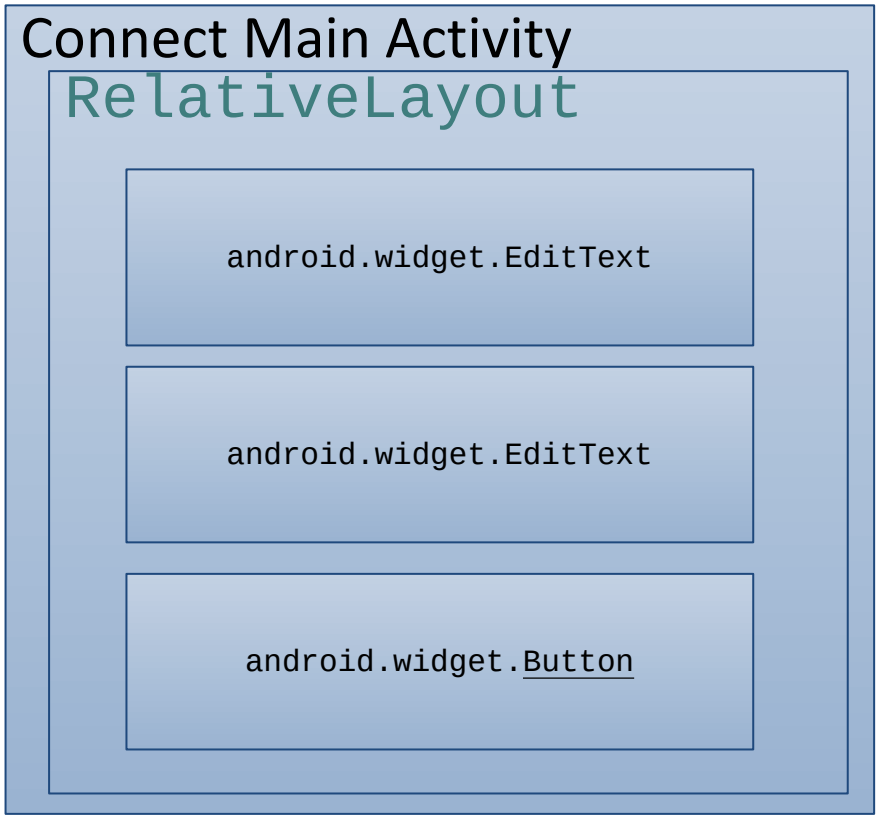

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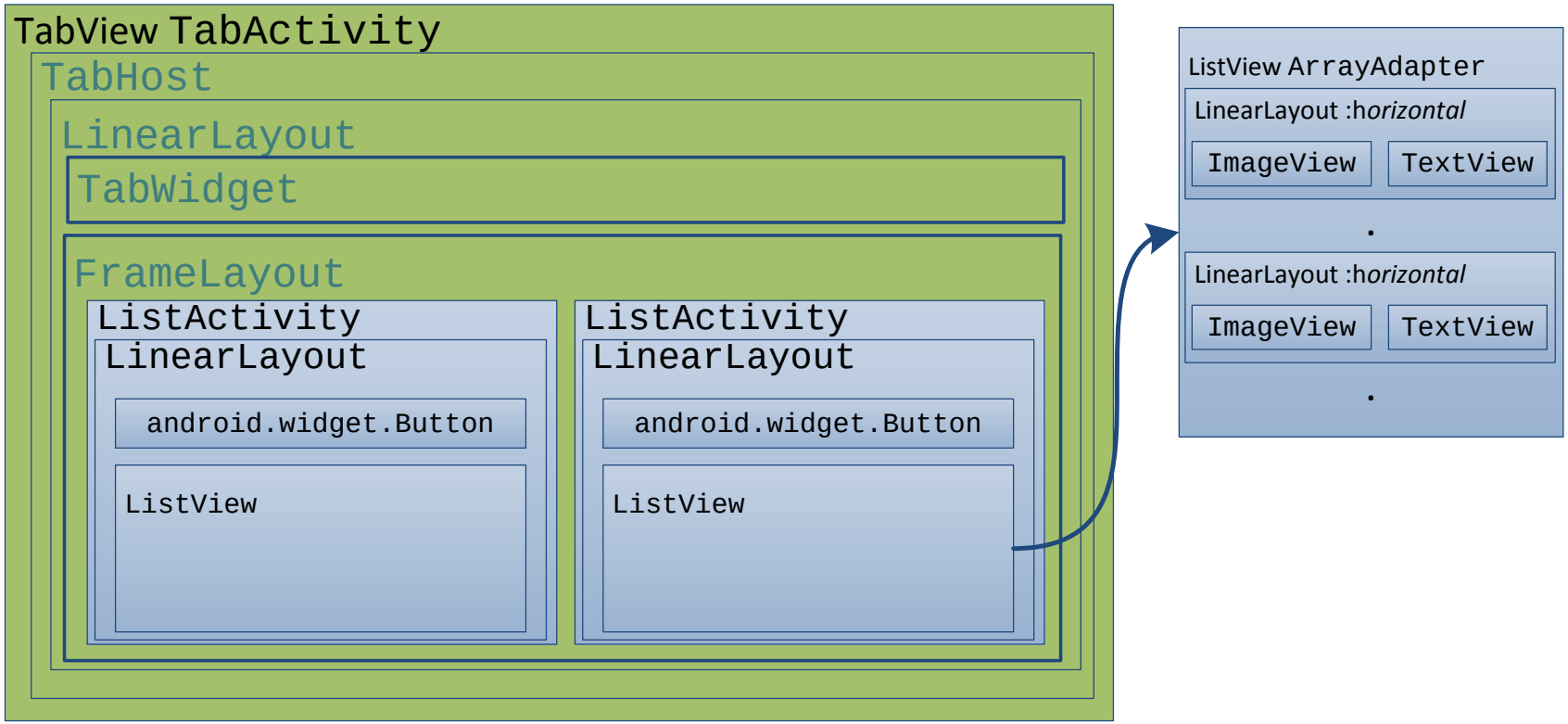
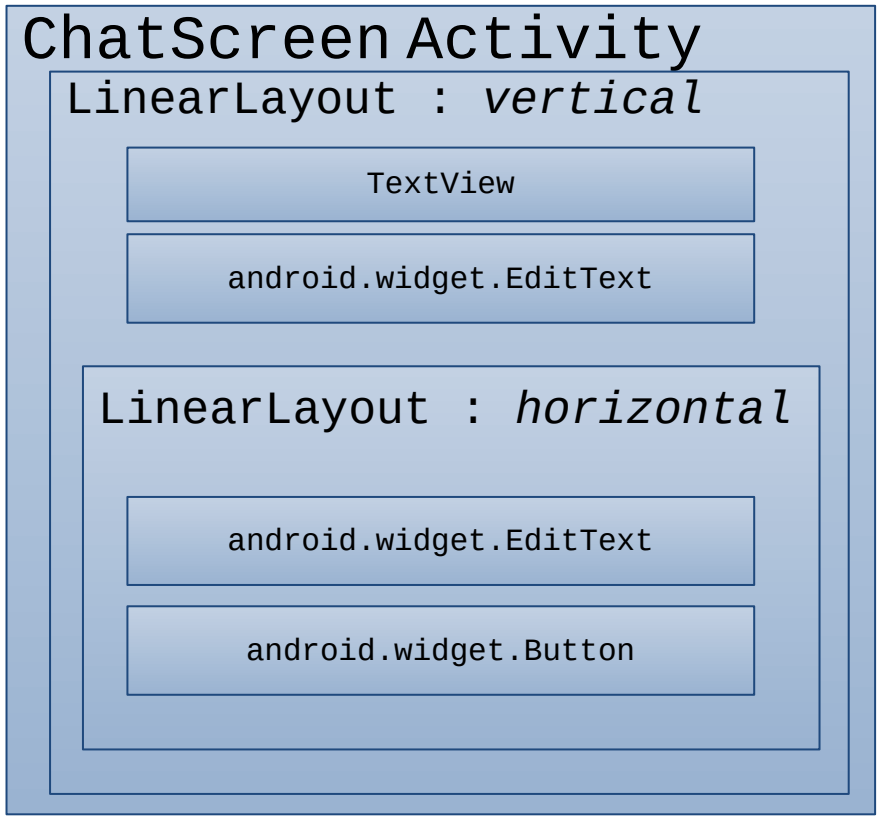


Design of the Views



PDUs of Text Messenger Application

List of all Application PDUs

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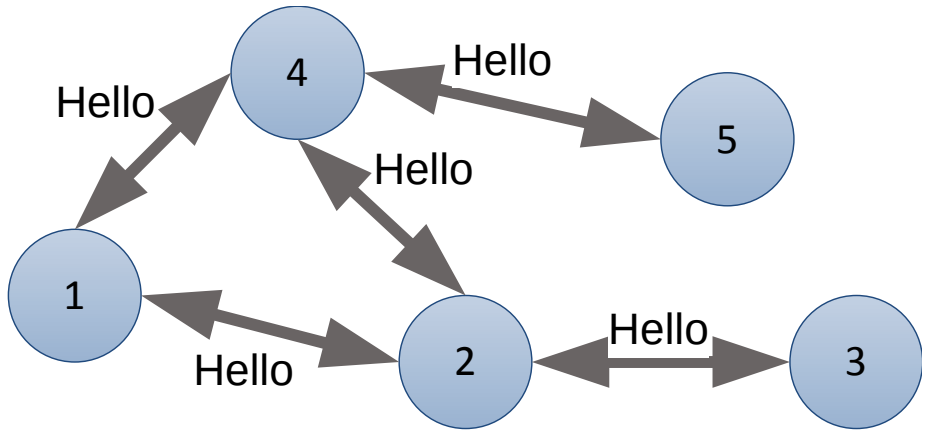

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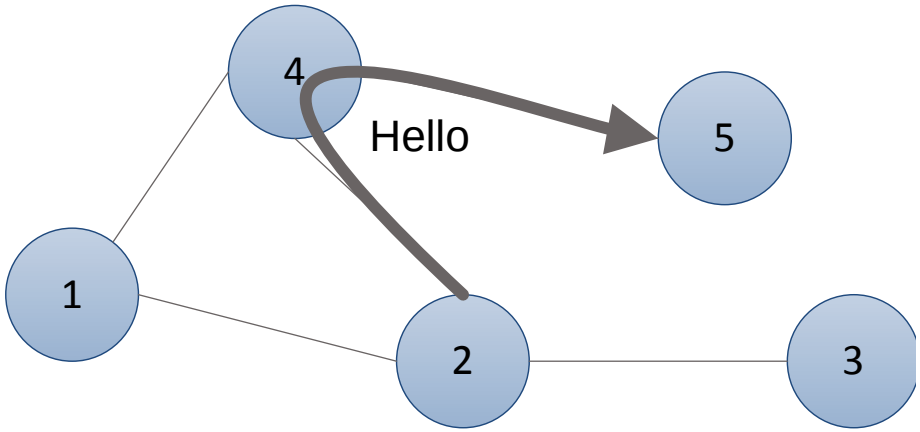

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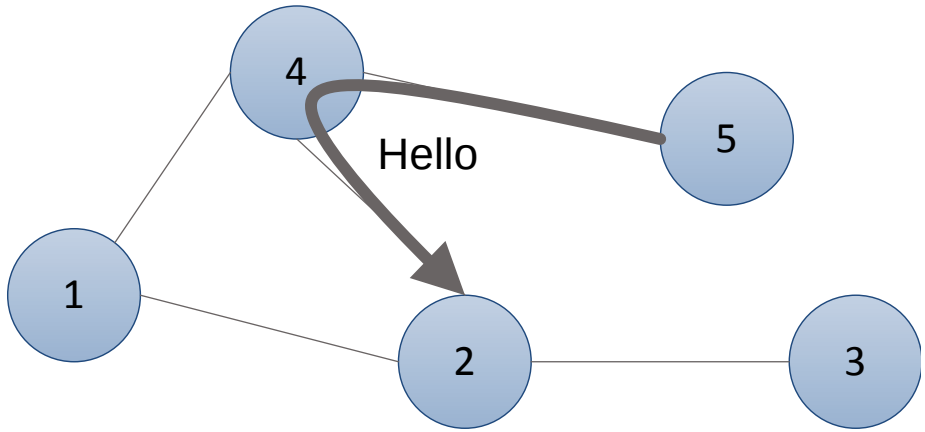

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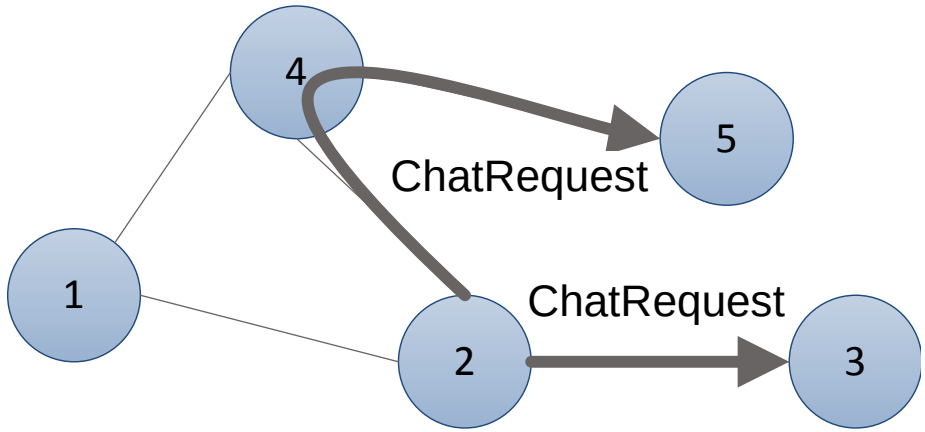

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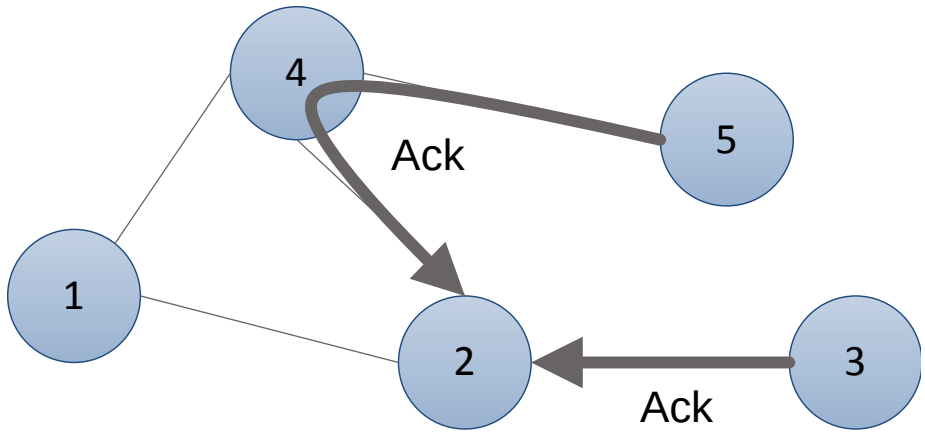
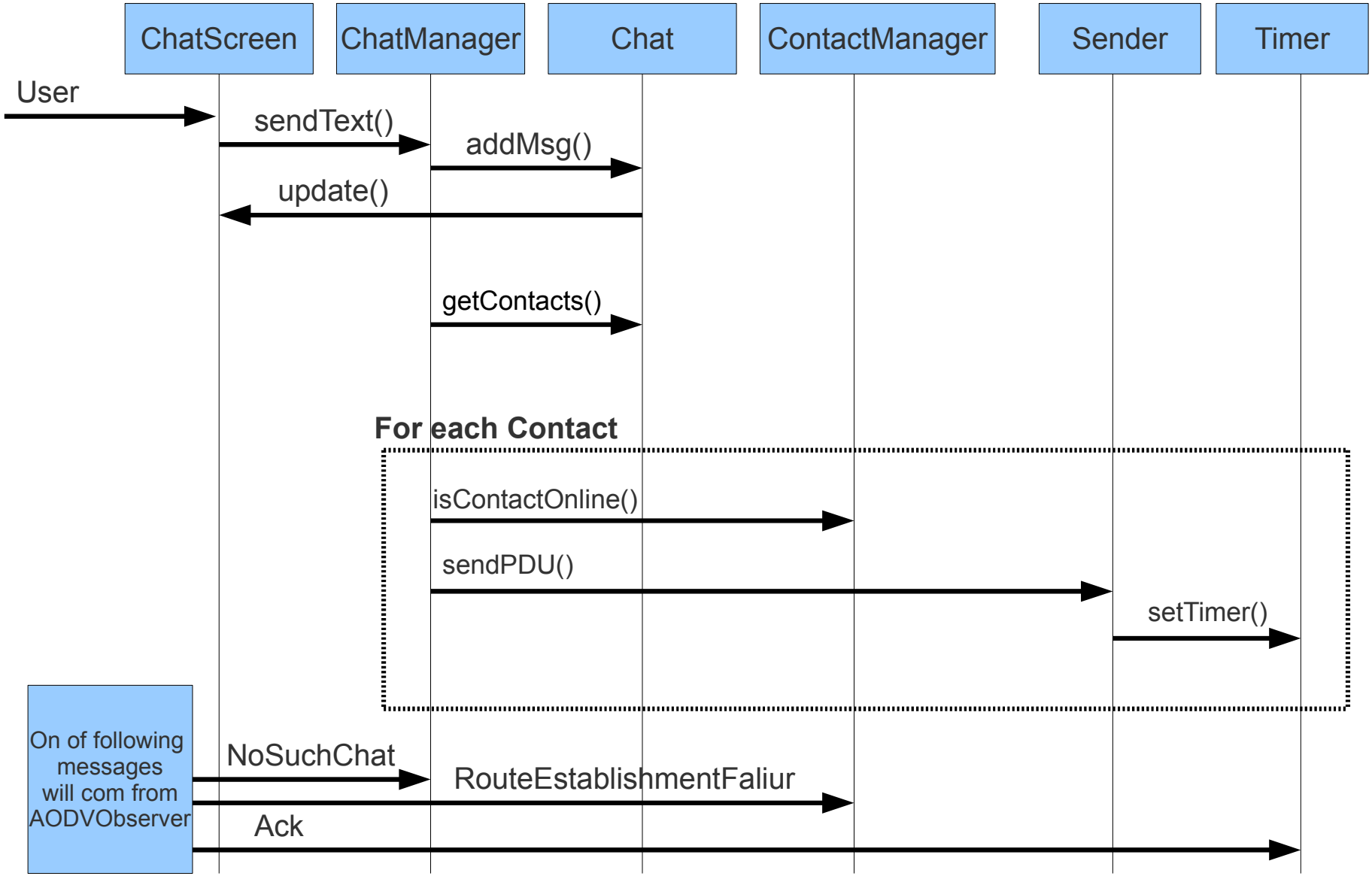


Sequence Diagram - User Sending Text Message



How is Text Messenger a Proof of Concept?

Library functionality Utilized:

- **AODV Hello PDU**
- New contacts when new routes are found
- RREQ flooding for friend search
- Multihop for Msg exchange

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Creating ad-hoc network

- **Need rooted phone**
- Configuration of the wireless adapter
  - ifconfig - native
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The Conclusion

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- Routing library is developed
  - Routing protocol is developed in Java - independent of OS
  - Tested in different scenarios
  - Not fully capable to create ad-hoc on Android itself
  - Improvements are possible - Performance and functionality
- Text Messenger application
  - Not fully tested!
  - Only a prototype version
  - Many improvements and corrections still