Peer to Peer Networks on Android
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Agenda

- Motivation
- Constraints
- Tools and Barriers
- Architecture
- Demonstration
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Motivation

- Communication Critical in Disasters
- Infrastructure Networks likely damaged
- However, end users likely still have battery powered wireless devices
- Quickly deploy internet enabled devices in new areas
  - Only the edge needs an uplink
Existing Solutions

- Peer to Peer network
- However, theoretical P2P already exists
  - Let's operate with unmodified end-user devices
- SMesh
  - Uses a system of mobile devices and fixed routers to create a mesh network
  - Requires rooting the phones
  - Overlays (via Spines) running on Android
Existing Solutions

http://www.smesh.org/
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Constraints

Cannot:

- Root
- Require other OS
- Require different radio
- Require any modification beyond installation of an application
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Technology

- Android
  - Can have long-lasting outbound connections
  - Use the VPN interface to capture packets
  - Java

- WiFi Direct
  - Use 802.11-like protocols without an access point
Android Apps

- Activity
  - One screen of an application
  - Control interface
- Service
  - Long lasting background worker
  - Networking
- Communicate using message passing
- The app *has* to be multithreaded
  - No network on the GUI thread
Android

- iOS does not have the flexibility we need
  - Can't have the persistent outgoing connections
  - Can't capture packets via VPN
- Apple implements the client as part of the operating system
WiFi Direct

- Point-to-Point connectivity
- Targeted at:
  - Printers
  - Projectors
  - Transferring photos
  - Multiplayer Gaming?
There's no network name, so let's make one!

- Group owner acts as an access point

Pairing with another device means joining a group.

Communication goes through the owner

Everyone is told the address of the owner
Barriers

- Android programming is conceptually challenging
- WiFi Direct functions poorly
Android Problems

- Everything is asynchronous and through callbacks
  - Requesting information about the current WiFi group
  - Spaghetti code
  - Maybe we're just not good enough at coding
- Some things can only happen on certain threads
  - Toast notifications, GUI access, Network
Java is Not the Right Tool

- No unsigned types
  - Have to compute checksums

Diagram:

- Channel
  - SelectableChannel
    - DatagramChannel
      - read()
    - SocketChannel
      - read()
    - FileChannel
      - VPN exposes one of these
WiFi Direct Authors would fail
600.437
WiFi Direct Authors would fail
600.437

I/wpa_supplicant( 3714): p2p0: P2P-INVITATION-RECEIVED sa=12:68:3f:87:3a:c2 persistent=1
E/WifiP2pService(  510): Unhandled message { what=147487 when=0 obj=network: null
E/WifiP2pService(  510):  isGO: false
E/WifiP2pService(  510):  GO: Device:
E/WifiP2pService(  510):  deviceAddress: 12:68:3f:87:3a:c2
E/WifiP2pService(  510):  primary type: null
E/WifiP2pService(  510):  secondary type: null
E/WifiP2pService(  510):  wps: 0
E/WifiP2pService(  510):  grpcapab: 0
E/WifiP2pService(  510):  devcapab: 0
E/WifiP2pService(  510):  status: 4
E/WifiP2pService(  510):  wfdInfo: null
E/WifiP2pService(  510):  Client: Device:
E/WifiP2pService(  510):  deviceAddress: 12:68:3f:87:3a:c2
E/WifiP2pService(  510):  primary type: null
E/WifiP2pService(  510):  secondary type: null
E/WifiP2pService(  510):  wps: 0
E/WifiP2pService(  510):  grpcapab: 0
E/WifiP2pService(  510):  devcapab: 0
E/WifiP2pService(  510):  status: 4
E/WifiP2pService(  510):  wfdInfo: null
E/WifiP2pService(  510):  interface: null
E/WifiP2pService(  510):  networkId: 1 }
Things to Never See from a JVM...

```
2pnet System.err at edu.jhu.cnos.packets.TCPWrapper.handlePacket(TCPWrapper.java:44)
2pnet System.err at edu.jhu.cnos.packets.IPv4Wrapper.handlePacket(IPv4Wrapper.java:98)
2pnet System.err at edu.jhu.cnos.wifip2pnet.NATLink.send(NATLink.java:125)
2pnet System.err at edu.jhu.cnos.wifip2pnet.NATLink.send(NATLink.java:97)
2pnet System.err at edu.jhu.cnos.wifip2pnet.PointToPointRouter.send(PointToPointRouter.java:8)
2pnet System.err at edu.jhu.cnos.wifip2pnet.VPNLink.handleMessageFromVPN(VPNLink.java:76)
2pnet System.err at edu.jhu.cnos.wifip2pnet.VPNCapture.run(VPNCapture.java:259)
2pnet System.err at edu.jhu.cnos.wifip2pnet.VPNLink.run(VPNLink.java:55)
2pnet System.err at java.lang.Thread.run(Thread.java:856)
2pnet System.err Caused by: libcore.io.ErrnoException: sendto failed: EPIPE (Broken pipe)
2pnet System.err at libcore.io.Posix.sendtoBytes(Native Method)
2pnet System.err at libcore.io.Posix.sendto(Posix.java:141)
2pnet System.err at libcore.io.BlockGuardOs.sendto(BlockGuardOs.java:169)
2pnet System.err at libcore.io.InBridge.sendTo(InBridge.java:27)
2pnet System.err ... 12 more
2pnet libc Fatal signal 11 (SIGSEGV) at 0x000006c68 (code=1), thread 1574 (Thread-153)
```
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Architecture
Links

Router

VPNLink

Local Phone

WiFi Direct Link

TCP

Other Phones

NAT Link

Internet
NAT

NAT Link

UDP / TCP

Internet

Internal IPv6
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Demonstration

- Very Slow Browser
- Text Messaging
Questions?