School of Technology and Health

- Is one of nine schools that constitute KTH (Kungliga Tekniska Högskolan - The Royal Institute of Technology)

- The profile of the school is technology across the borders of engineering and medicine in a broad sense, including technical research of importance to medical applications and health care in its widest meaning.

Device-to-Device Sensor Communication in Home Healthcare

Jonas Wåhslén jonas.wahslen@sth.kth.se
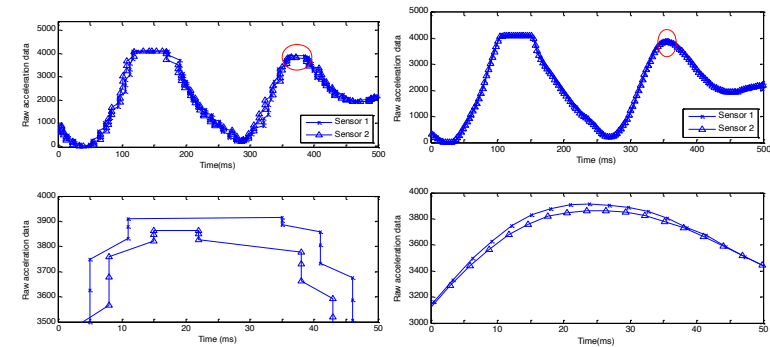
Digital Doping is Legal

Jonas Wåhslén jonas.wahslen@sth.kth.se

How synchronized is a K2?

Getty Images / Xinhua Photo / Fairfax Media

Before and after synchronization

Multi-Sensor
Data Synchronization
using Mobile Phones

Licentiate Thesis in Medical Technology, 2013
Jonas Wåhslén

eHealth

- Increased hospital costs

- It is cheaper if a caregiver visits your home 5 times a day, compared to being hospitalized

- I Sweden 900 person dies every year per 100000, with an decrease almost 20 person per year. Conclusion is that 50 years from now no one will die in Sweden.

The Global Goals for Sustainable Development

1 NO POVERTY
2 ZERO HUNGER
3 GOOD HEALTH AND WELL-BEING
4 QUALITY EDUCATION
5 GENDER EQUALITY
6 CLEAN WATER AND SANITATION
7 AFFORDABLE AND CLEAN ENERGY
8 DECENT WORK AND ECONOMIC GROWTH
9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
10 REDUCED INEQUALITIES
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
13 CLIMATE ACTION
14 LIFE BELOW WATER
15 LIFE ON LAND
16 PEACE AND JUSTICE STRONG INSTITUTIONS
17 PARTNERSHIPS FOR THE GOALS

IT IS HEALTH THAT IS REAL WEALTH AND NOT PIECES OF GOLD AND SILVER

MAHATMA GANDHI
#GlobalGoals

300-400 Billions sek are annually spent on health in Sweden

DIABETES   HIGH BLOOD PRESSURE   LUNG DISEASE   CANCER
KIDNEY DISEASE   HEART FAILURE   MENTAL HEALTH

Cost: 75% of ALL health care expenditures

Doctors aren't well trained to treat chronic disease

TY Joe Cafazzo

MD. BRIAN GOLDMAN
on Digital Health Day 2015

Super utilizers - 30% of the medical cost comes from 1% of the population

Health Coach

PREVENTABLE causes
Means blame the patient

Slide 1

TECHNOLOGY *IS* HOPE.

Tumor Necrosis Factor	Synthetic bio
Herceptin	Turning genes off
Laparoscopic surgery	Gene therapy
Genome sequenced	Targeted viruses
Pain Advances	Incision free surgery
Apps	3D printing of organs
WWW	Nerve Regeneration
Smartphone	Precision Med
Sensors	Artificial Intelligence

Robin Farmanfarmaian
on Digital Health Day 2016

TOOLS

By reaching its destination within 60 seconds it will increasing the survival rate from 8% to 80%

Flying Defibrillator Ambulance Drone

Slide 2

Tricorder

QUALCOMM TRICORDER XPRIZE®

ABOUT   NEWS   TEAMS

A $10 MILLION COMPETITION TO BRING HEALTHCARE TO THE
PALM OF YOUR HAND

Imagine a portable, wireless device in the palm of your hand that monitors and diagnoses your health conditions. That's the technology envisioned by this competition, and it will allow unprecedented access to personal health metrics. The end result: Radical innovation in healthcare that will give individuals far greater choices in when, where, and how they receive care.

The winning team will develop a Tricorder device that will accurately diagnose 13 health conditions (12 diseases and the absence of conditions) and capture five real-time health vital signs, independent of a health care worker or facility, and in a way that provides a compelling consumer experience.

CLICK HERE FOR DETAILS ON HEALTH CONDITIONS >

TEMPERATURE: 99.2°   MEDICATION ADMINISTERED 10 ML (2 TBS) ACETOMENOPHEN   PULSE 86 BPM

Slide 3
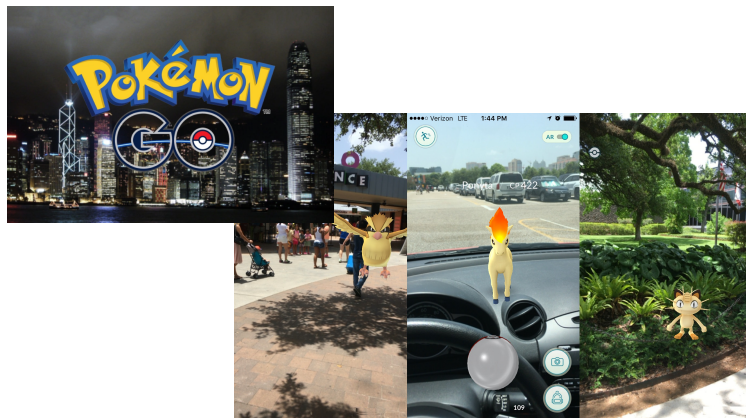
- Over 500 million downloads since June
- Player/Trainer have walked 4.6 billion kilometers
- Great example of gamification for health

Slide 4

"I tested my heart rate, and it was about 145 for about two hours after practice" – Paul Houle Jr

Wearables and RGB-D cameras in AAL

Detected Person Fallen Person

Medical sensor

- ECG
  - Electrocardiogram
  - Monitor the heart
- Pulse Oximeter
  - Pulse and the oxygen level
  - Surveillance

- Pressure measurement
  - Blood pressure
  - Lung capacity
- IMU
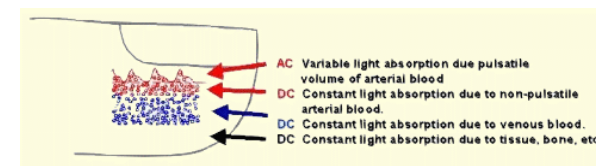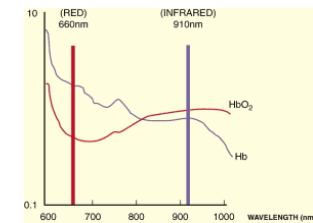 - Inertial measurement Unit (Accelerometer)
  - Stroke, alzheimers

Puls oximetry

- A non-invasive method to monitor oxygenation of patient's hemoglobin
- That is fast
  - under 90% = new red blood cells are created
  - under 70% = increase risk of heartarytmier
  - under 30% = risk for life

Puls oximetry

- How it works - Two LED with wavelength 660nm and 910nm
- Two different absorption for Hb and HbO_2
- Built on reference values

AC Variable light absorption due pulsatile volume of arterial blood
DC Constant light absorption due to non-pulsatile arterial blood.
DC Constant light absorption due to venous blood.
DC Constant light absorption due to tissue, bone, etc

Why?

- Blood pressure variations - are seen days before a stroke

- Heart rate variability - gives us a time of death

- Early warning/detection

  - Identify change in pattern

- Prevention

"Top-notch physician cure the disease before its onset"

Automatic Timed Up and Go test (TUG)
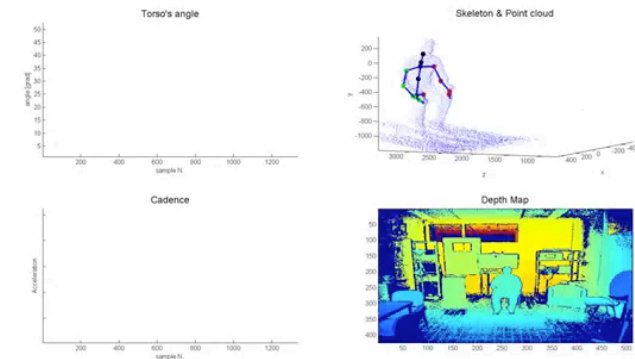
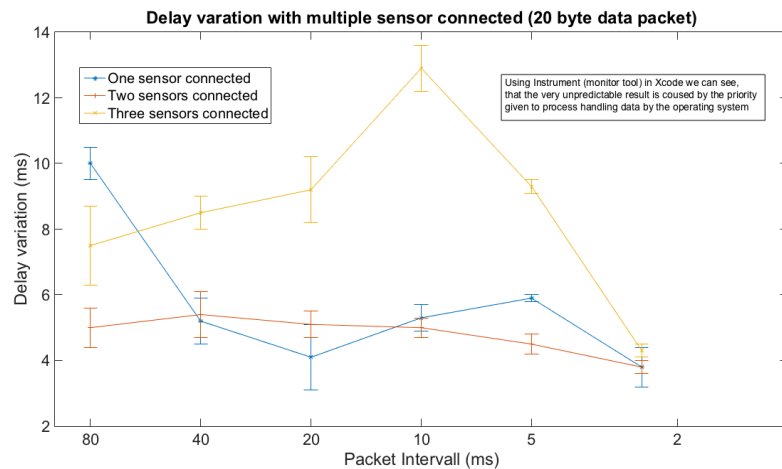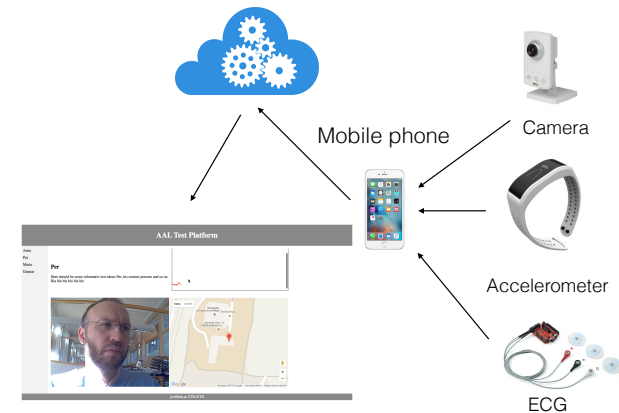Time Synchronization and Data Fusion for RGB-Depth Cameras and Inertial Sensor in AAL Applications - ICC 2015

Smart phones

- iPhone and Android - provides an easy access to application via app stores

- The platform war is about Access, Fragmentation, Java, Software patent, patent …

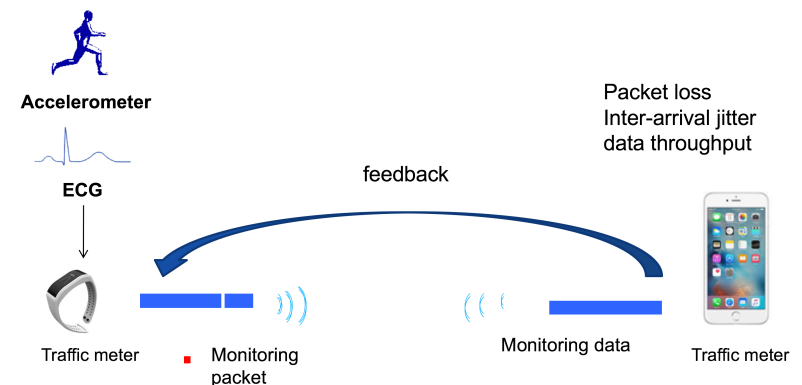- Both are using a Unix kernel

  - Java - Android

  - Swift - iOS

Different device-to-device technology in iOS and Android

	Bluetooth	Bluetooth LE	WiFi Infrastructure mode	WiFi sensor as Soft-AP	WiFi mobile as Soft-AP	Wi-Fi Direct
iOS	Not supported.	Supported. API well documented	Not supported for mobility outside the home.	Partly supported. Only one sensor connected.	Supported. Limitations to discover sensors.	Not supported.
Android	Supported. API well documented	Partly supported. API is not correctly documented	Not supported for mobility outside the home.	Partly supported. Only one sensor connected.	Supported, limitation in discovery of wireless sensors	Supported.

Smartphone-Centric Wi-Fi Device-to-Device Sensor Communication for User Mobility in AAL Services - IoTAAL 2016

Mobile phone

Camera

Accelerometer

ECG

Delay variation with multiple sensor connected (20 byte data packet)

- One sensor connected
- Two sensors connected
- Three sensors connected

Using Instrument (monitor tool) in Xcode we can see, that the very unpredictable result is coused by the priority given to process handling data by the operating system

Delay variation (ms)

Packet Intervall (ms)

Monitor and control system in wireless sensor networks

Accelerometer

ECG

feedback

Packet loss
Inter-arrival jitter
data throughput

Traffic meter

Monitoring packet

Monitoring data

Traffic meter

Bluetooth Health Device Profile (HDP)

- BT profile designed to facilitate transmission and reception of Medical Device data

- API available on iOS and Android

Bluetooth profiles

- Battery level
- Blood pressure
- Running & Cycling
- Current Time
- Find Me
- Glucose level

- Human Interface Device
- Health Thermometer
- Heart Rate
- Immediate Alert
- Link Loss
- Proximity

Serial Port Profile (SPP)

- Based on the RFCOMM protocol which provides a simple reliable data stream to the user, similar to TCP

- Emulates a serial cable to provide a simple substitute for existing RS-232

Realtime Performance Management of Assisted Living Services in Bluetooth Low Energy Sensor Communication - PAPELE 2017
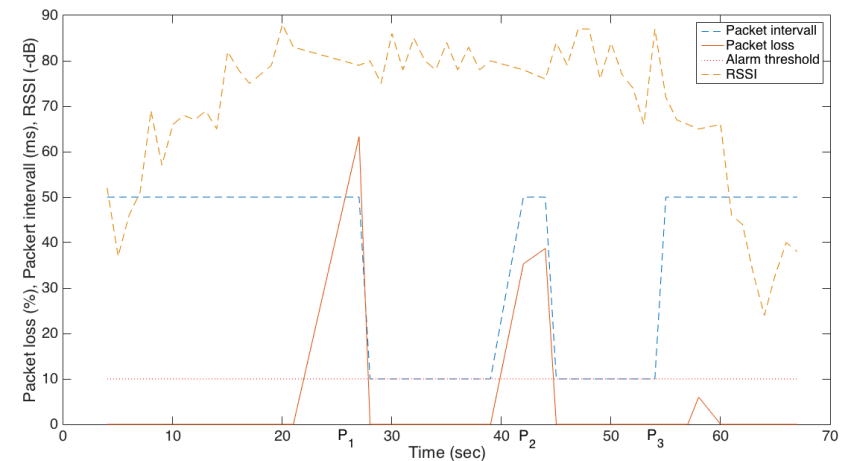
M2M vs IoT

Machine to Machine vs Internet of Things

- Telecom vs Datacom
- MQTT (MQ Telemetry Transport) - ISO standard that is a "lightweight" publish-subscribe to be used on top of TCP/IP
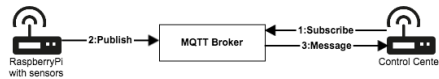

- COAP (Constrained Application Protocol) - RFC 7252
  - Make services available via URL
  - REST model (GET, PUT, PUST, DELETE)

KTH-STH professors

- "Our seniors are innovative, let them be part of the development process." - Britt Östlund

- "Focus on pervasive health care, we want to avoid hospitals" - Björn-Erik

- "IT is everywhere, every body needs to know how to program" - Hans Hebert (our Dean)

- Co-development of IT, medical and organizational systems will enable better care for vulnerable groups in society - Sebastian Mayer

- Ubiquitous monitor, a way to unleash the chronically ill - Kay Lindecrantz

- Development of easy to use mobile IT solutions are needed for the future of health care - Mats Ericson

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Questions?

Bluetooth

Master Slave

UUID

6BCF0ED3-68E3-4804-96D5-5AB8765FB9BC

The Flow channel
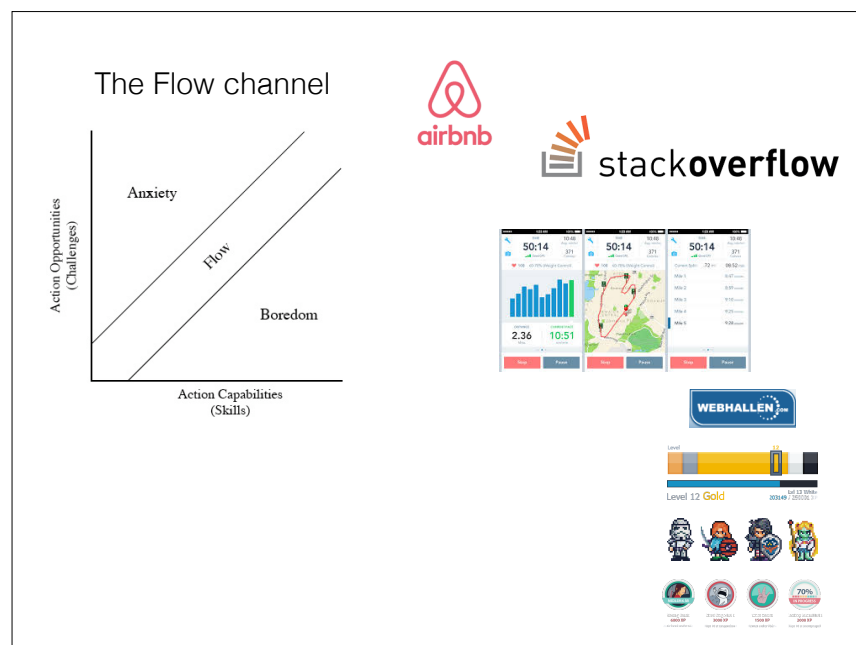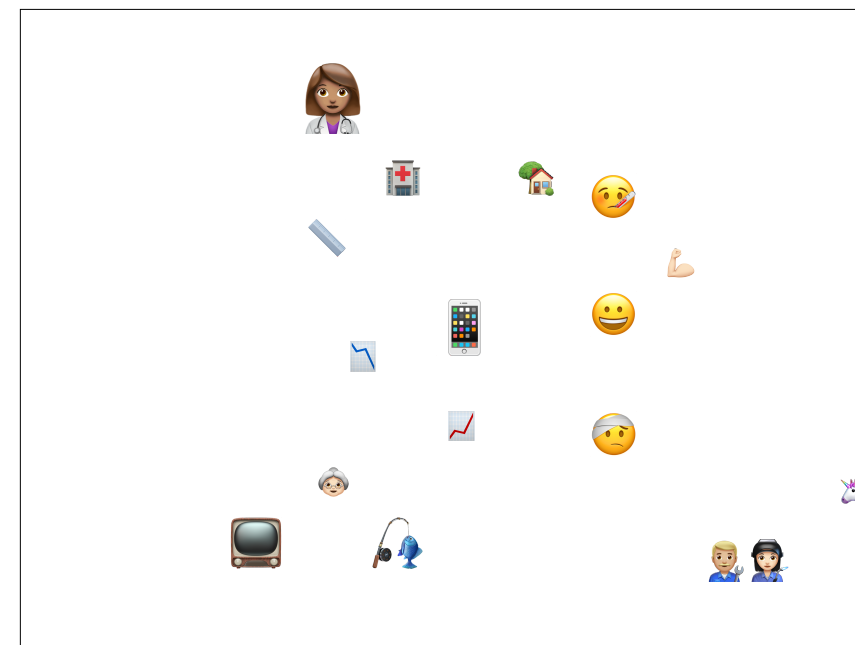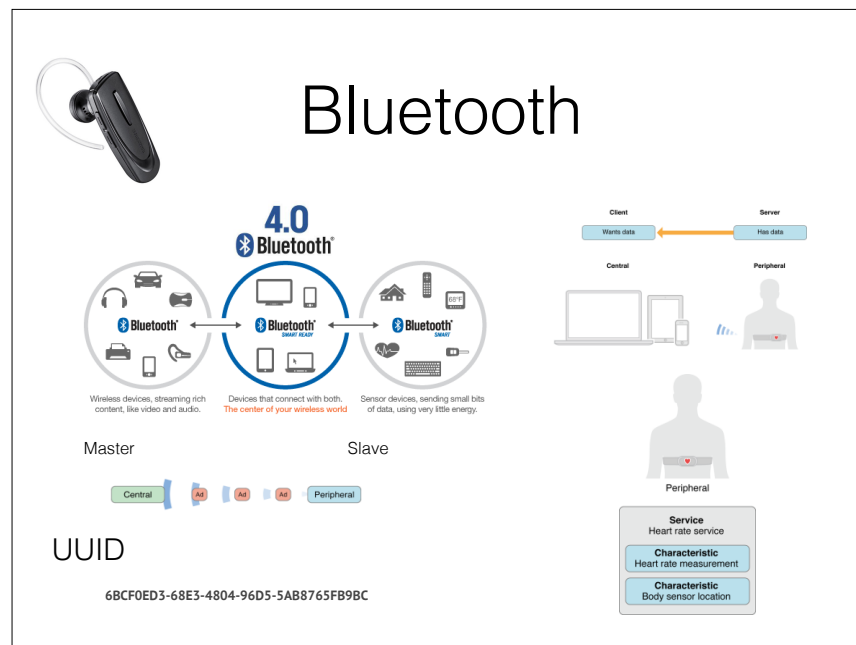
	Bluetooth	Bluetooth SMART	ANT+	ZigBee	N
Verklig hastighet (kbps)	700-2100	305	20	100-250	424
Avstånd (m)	100	50	10	100-300	0.05
Toppström (mA)	30	12-16	17	30-40	50
Latens (ms)	100	2.5	0	20-30	-
Inblandade företag	16000	16000	300	360	160

Bluetooth programming

1. Call the method "connectToSensor" (this initializes bluetoothSocket)
2. Retrieve the input and output streams from the socket
3. Write the byte sequence representing the data format to the sensor (also flush the stream)
4. Read one byte from the input stream
5. If the reply equals ACK
    6. Create a FileWriter using the provided externalPath
    7. Write a date stamp to the first line of the file While not interrupted (i.e. thread != null)
    8. Read a packet, 5 bytes
    9. Extract the byte representing the pleth measurement from the byte array Write the relevant data to the file
10. If you so wish, display the data
11. Close the Bluetooth socket and the file writer (make sure this always happens)
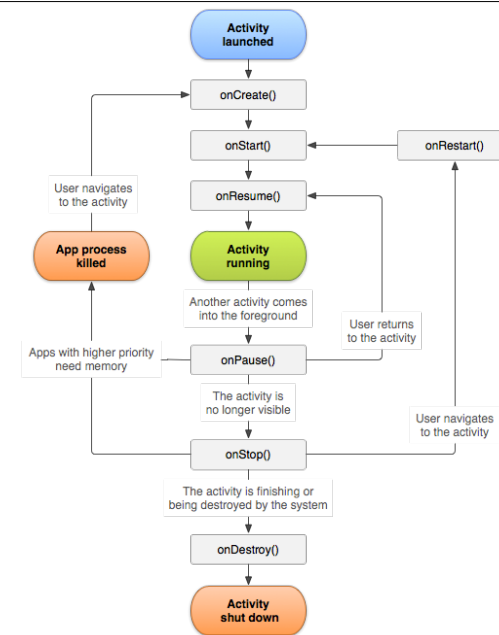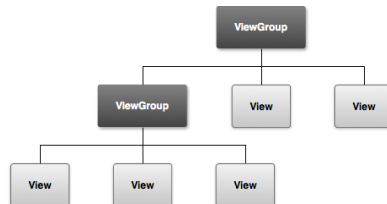

Java and Android

- We are going to use Android as it is more open for developers

- Oracle (owns SUN) suing Google

    - Java is free (except Java Micro Edition)

    - Android is using Android Runtime (ART)

        - Not using Java byte code

Activity and views

- No main method

- The system instantiate an Activity

- The Activity holds the user interface which is a View Component "activity_my.xml"

User Interface


```
res/layout/activity_my.xml
<LinearLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    android:orientation="horizontal" >
    <EditText android:id="@+id/edit_message"
        android:layout_width="1"
        android:layout_height="0dp"
        android:hint="@string/edit_message" />
    <Button
        android:layout_width="wrap_content"
        android:layout_height="wrap_content"
        android:text="@string/button_send"
        android:onClick="sendMessage"/>
</LinearLayout>
```

```
res/values/strings.xml
<?xml version="1.0" encoding="utf-8"?>
<resources>
    <string name="app_name">My First App</string>
    <string name="edit_message">Enter a message</string>
    <string name="button_send">Send</string>
    <string name="action_settings">Settings</string>
    <string name="title_activity_main">MainActivity</string>
</resources>
```

```
java/com.mycompany.myfirstapp/MyActivity.java
public void sendMessage(View view) {
  Intent intent = new Intent(this, DisplayMessageActivity.class);
}
```

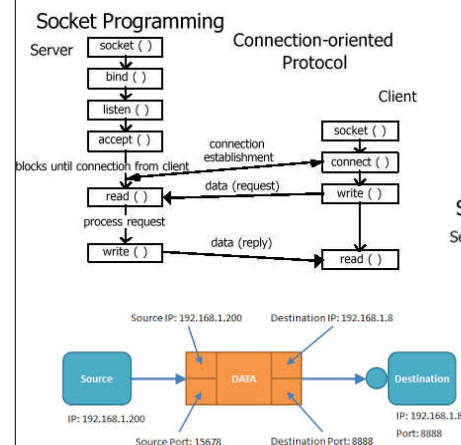# Learn more

- developer.android.com

- developer.apple.com

- Programming of Mobile Services (HI2004) 7.5p

Every thing is a file

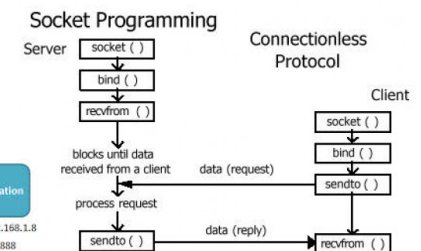/dev/sda   /proc/meminfo   /dev/mouse1   /dev/input1

- "Every this is file descriptor"

- Open-Read-Write-Close - same senario for any I/O

- Socket programming

  - RFC 791

  - Beej's Guide to Network Programming

Internet TCP/IP

TCP

UDP

Wireless Wearable

- Second to last on the IOT track of Jfokus 2017 is will present my granmother the cyborg and I will present the opportunity within ehealth and I will present and what we can do tougether for our seniors - so come and se Device-to-Device Sensor Communication in Home Healthcare

2017

iGlasses
9.7 m

You about to leave your phone!