The EDUSAFE Mobile Personal Supervision System (MPSS)

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Overview

- **General Description**
- Software (SW) Architecture & Implementation
- Hardware (HW) Architecture & Implementation
- System Performance
- System Demonstration

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General Description

So, what is it?

MPSS is a battery powered **wearable** mobile device used for the wireless transmission of **data** for **supervision** purposes.

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General Description

Wearable?

Mounted on the worker's safety helmet.

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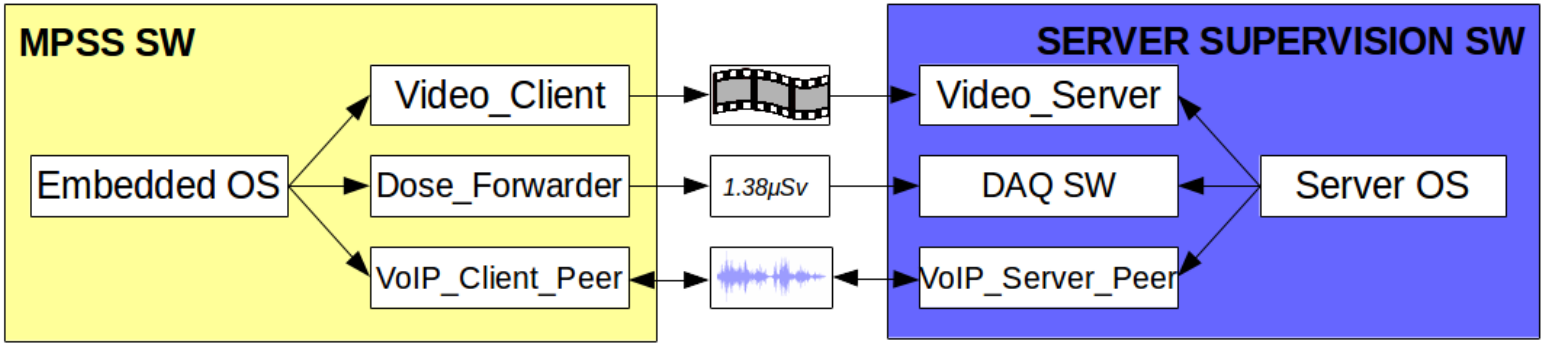
General Description

Data?

Video, Bidirectional **Audio** Communication, **Sensor Data** (e.g. Gamma Radiation Dosimeter Sensor Data).



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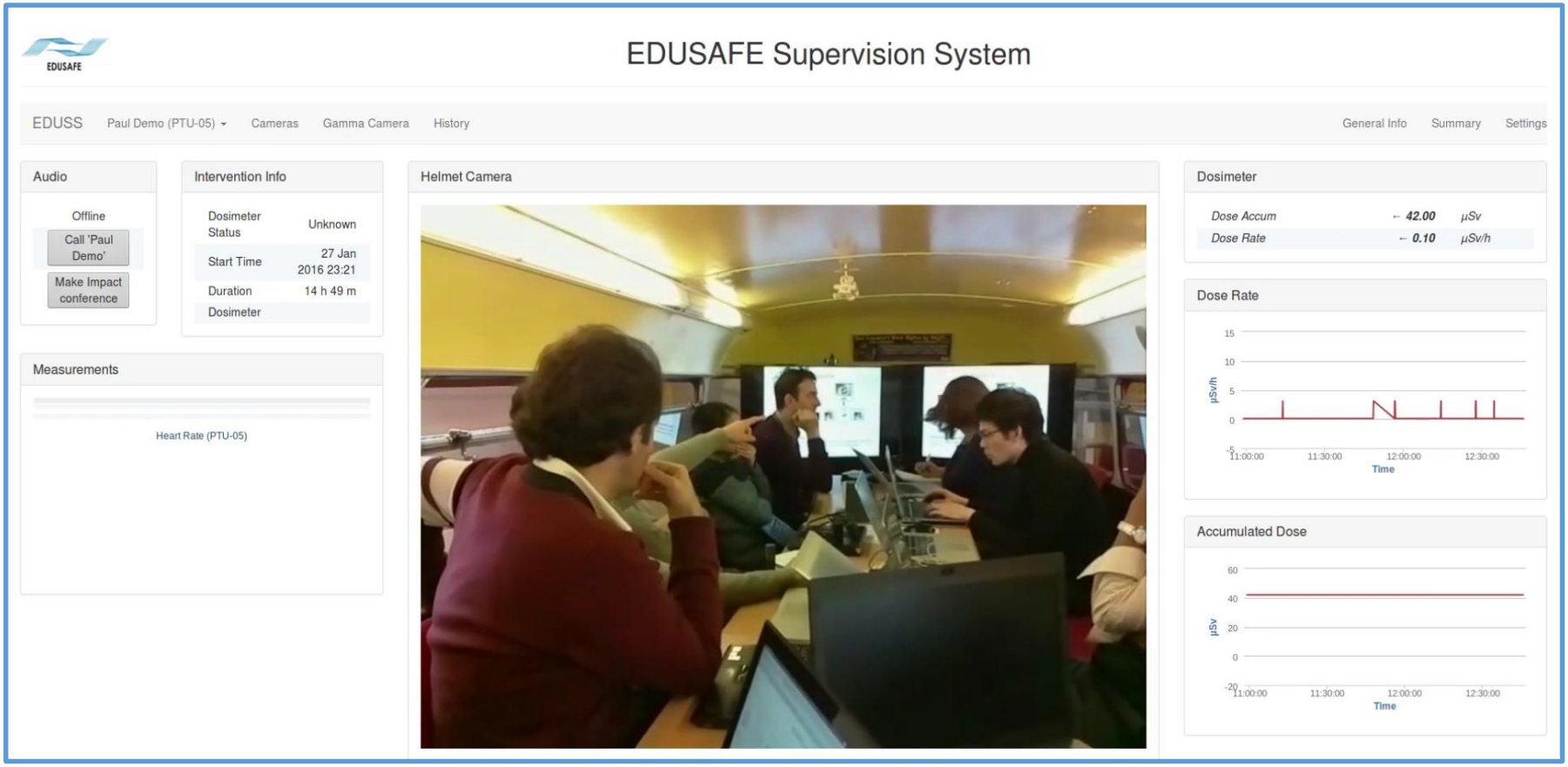
General Description

Supervision?

Supervision User Interface (UI) (thank you ESR5 ☺)



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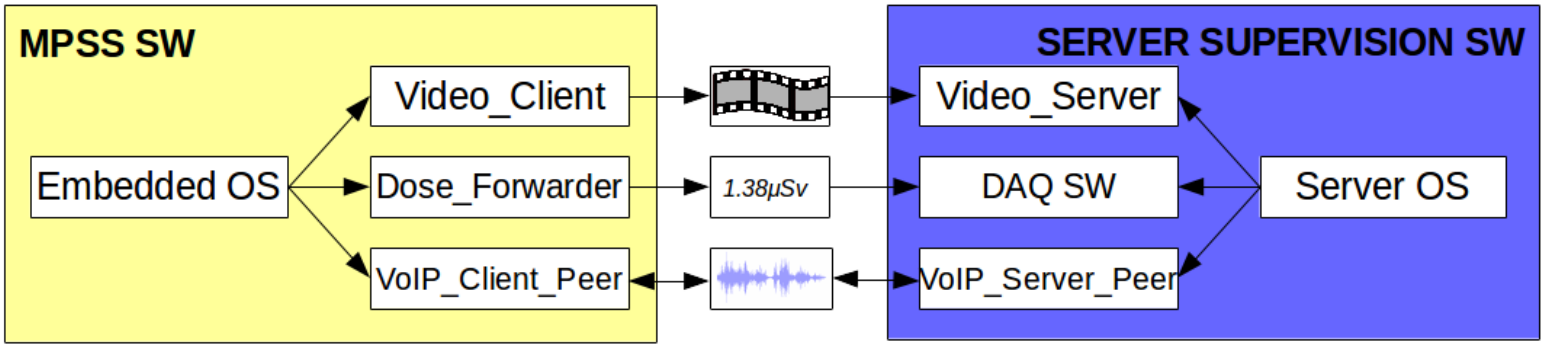
SW Architecture & Implementation

Client-Server SW Architecture:



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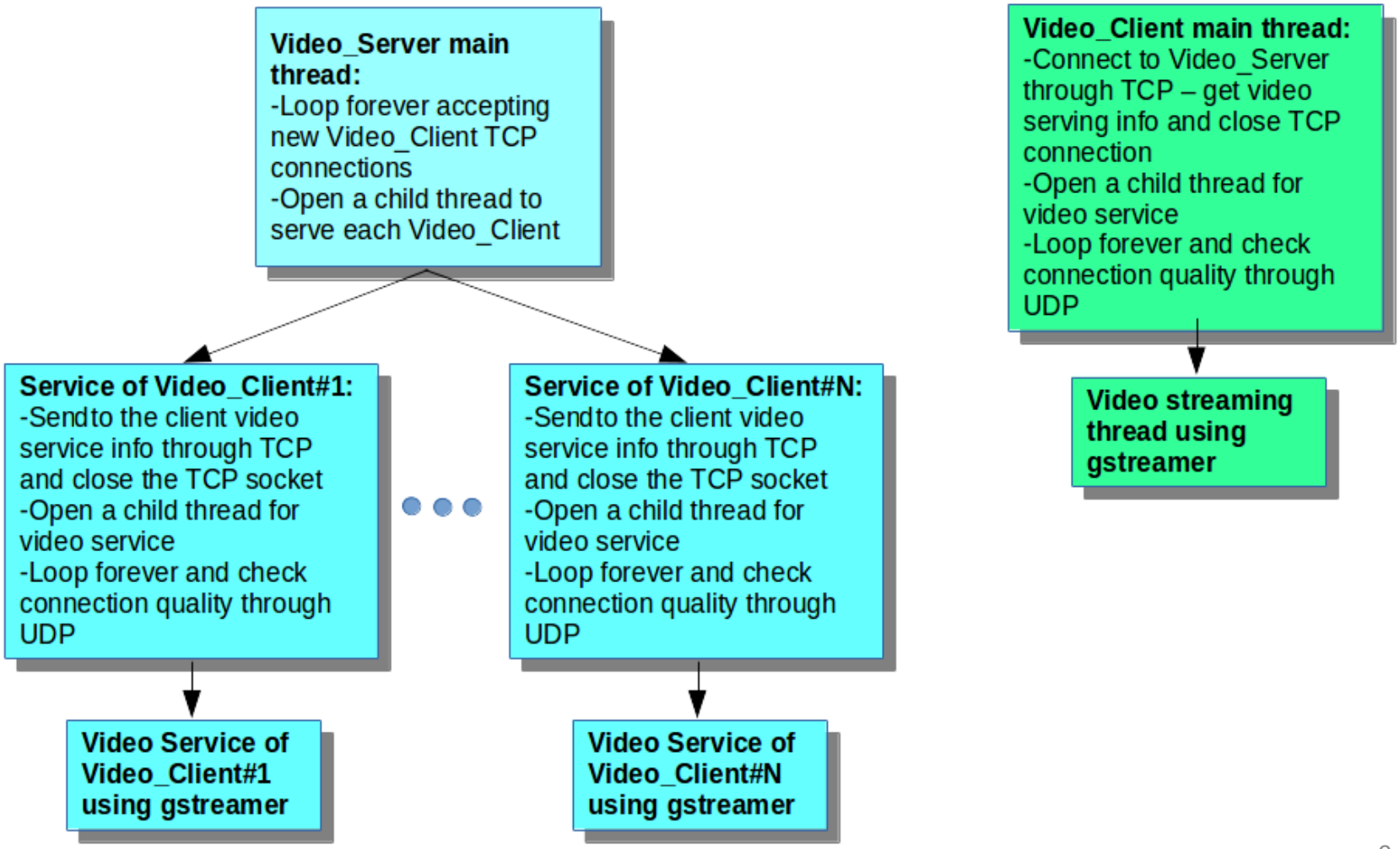
SW Architecture & Implementation

Video SW Architecture:



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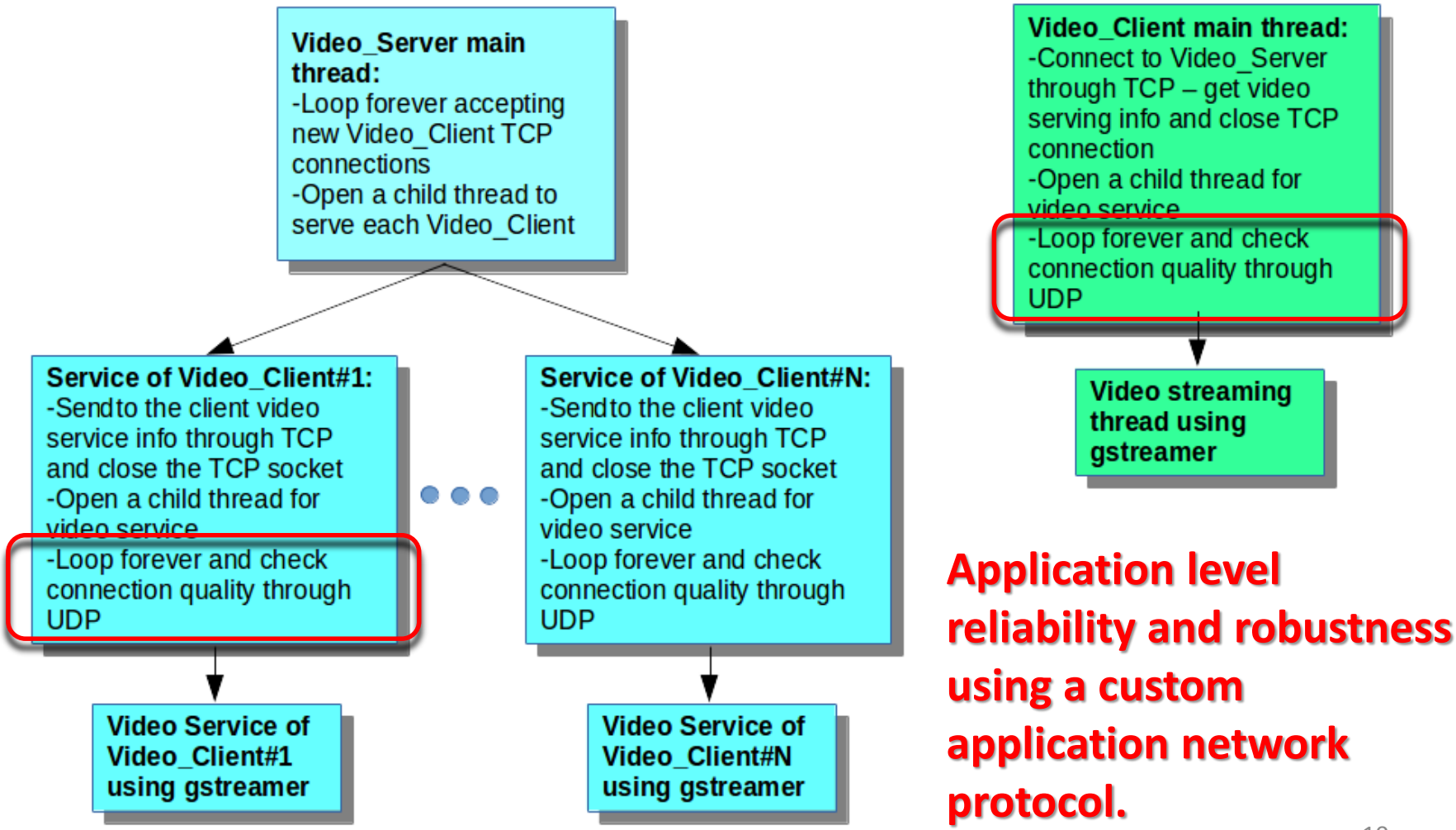
SW Architecture & Implementation

Video SW Architecture:



Application level reliability and robustness using a custom application network protocol.

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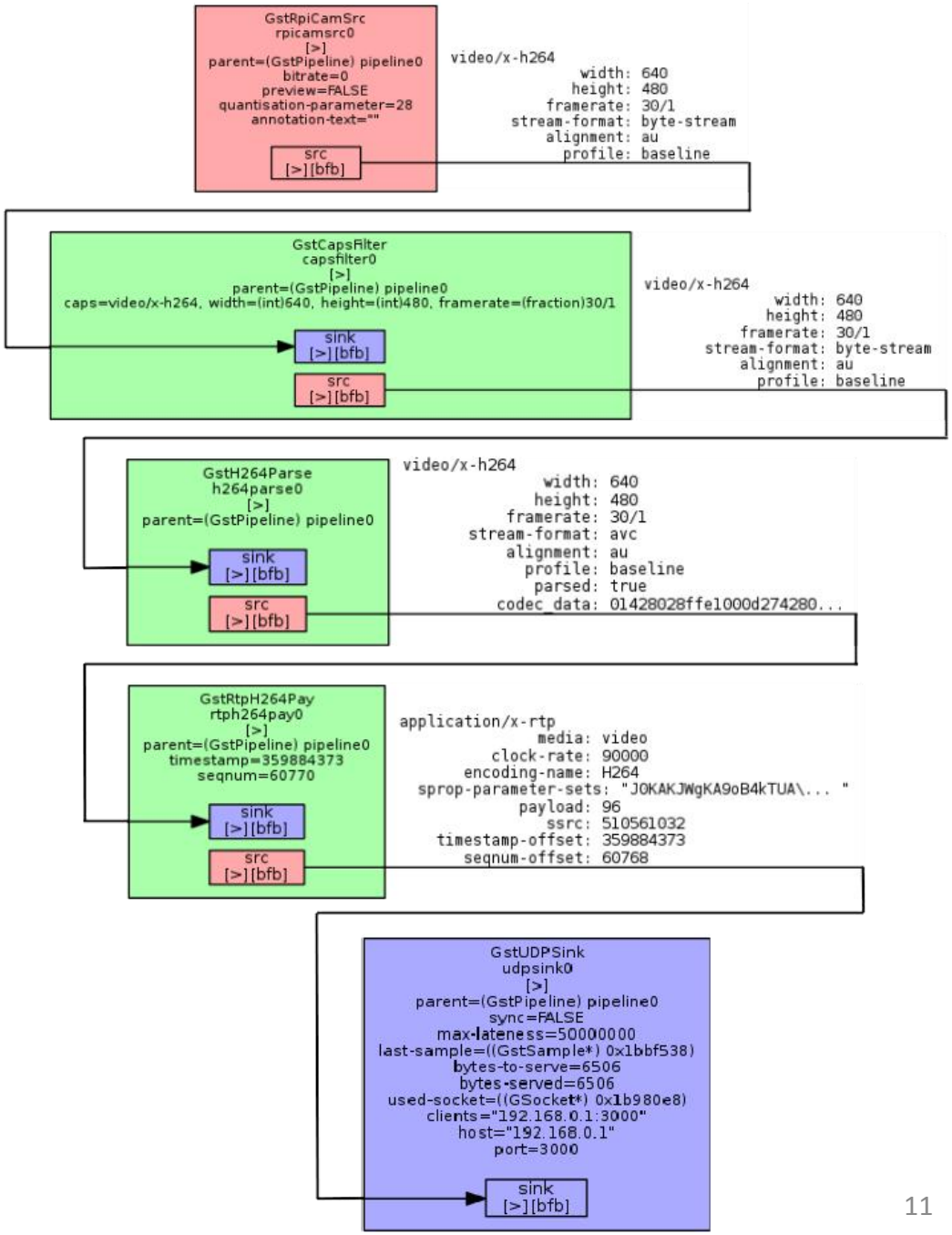
Video SW Implementation (Client video pipeline):

-C/C++
-Sockets
-GStreamer
-Pthreads



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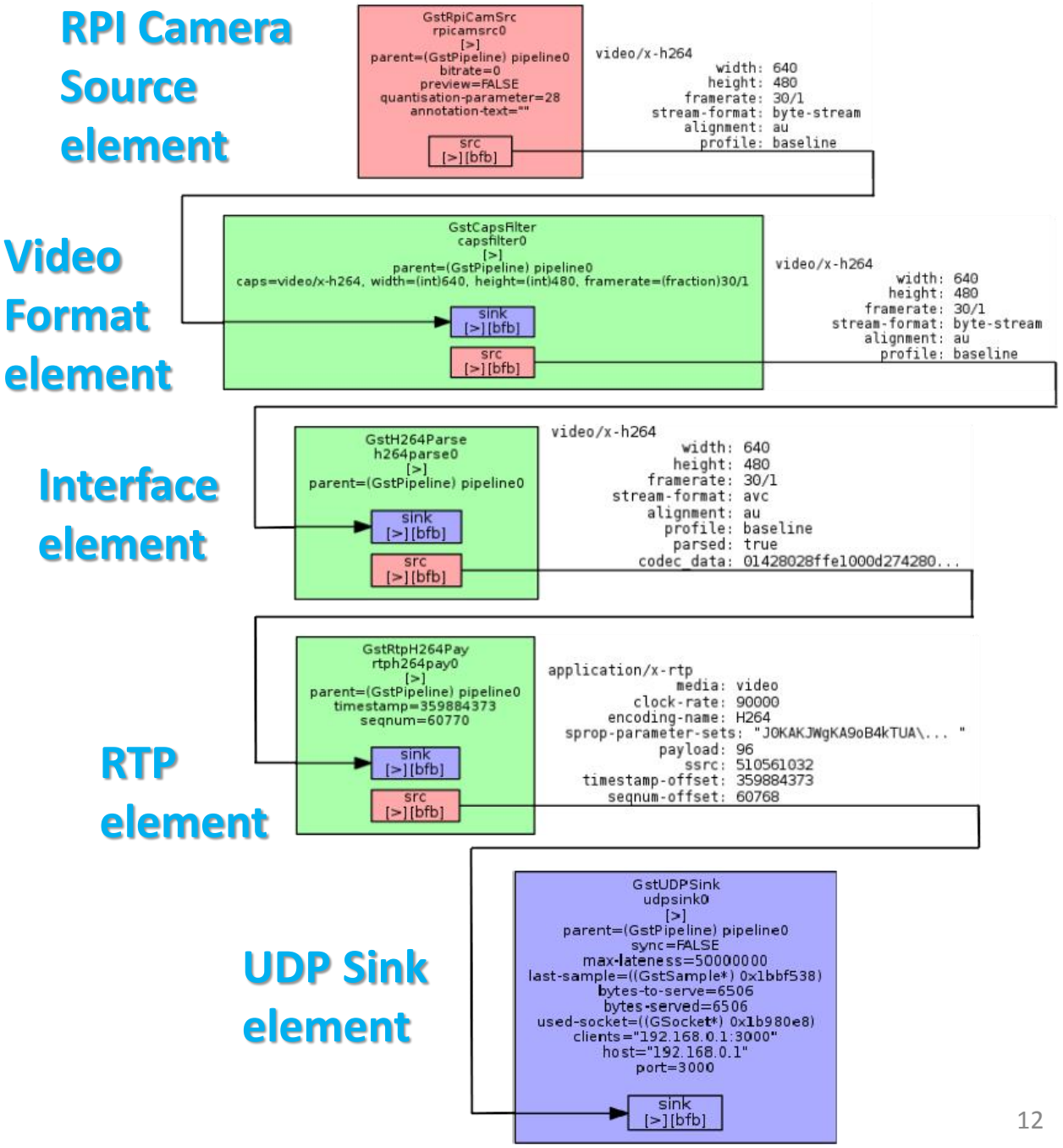
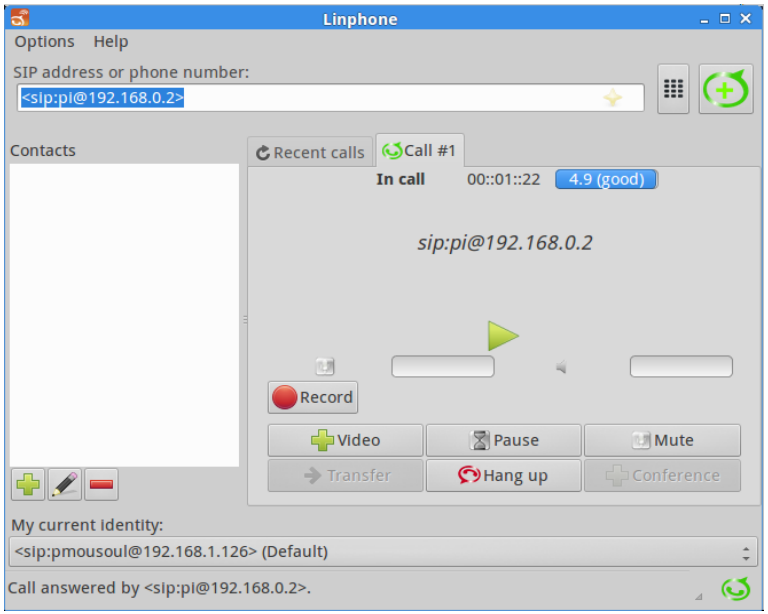


SW Architecture & Implementation

Audio – the Linphone Open Source VoIP Project is used for **portability** reasons:

"Linphone is an open source SIP Phone, available on mobile and desktop environments (iOS, Android, Windows Phone 8, GNU/Linux, Windows Desktop, MAC OSX) and on web browsers."



This solution could be replaced by a GStreamer audio pipeline using the current video SW architecture.

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SW Architecture & Implementation

Sensor data – Gamma radiation dosimeter sensor data:

The dose_forwarder program (C, Sockets, UART) reads the sensor data from the serial port (UART) of the MPSS and transmits it to the DAQ server over WiFi using TCP.

(*There is more on this in an upcoming slide*)

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SW Architecture & Implementation

Reliability and Robustness?

On the **Operating System (OS) SW Level**, a script checks constantly that:

1. *the MPSS is connected to the network*
2. *the MPSS can communicate with the server*
3. *all the SW component applications (video, audio, sensor) are running*

On the **Application SW Level**, *a custom communication protocol* has been developed for the reliable and robust transmission of video between the Client (MPSS) and the Server sides.

(*More on this during the DEMO*)

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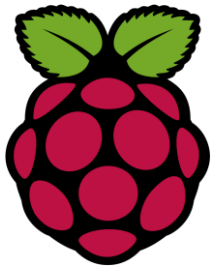
HW Architecture & Implementation

Constraints (a general view):

- Cost (cheap)
- Size/Weight (wearable)
- Power Consumption (battery powered)
- Software Development Tools (SW support)



A cheap, small-lightweight, low-power, single-board computer with mature SW development tools is required!

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HW Architecture & Implementation

Constraints (application specific view):

- Real-time, in terms of human perception, of video transmission

Raw video data size is prohibitive for wireless network transmission (more bandwidth → more latency → more power consumption).

A HW Video Encoder is required (can be included in the camera or in the single board computer HW)!

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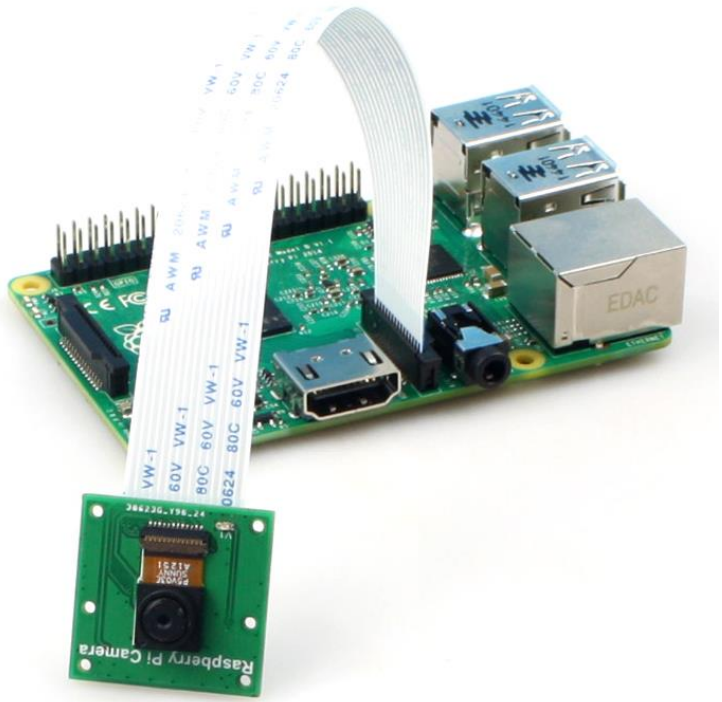
HW Architecture & Implementation

The *Raspberry Pi 2* single board computer + the dedicated *camera module* is used for the implementation of the MPSS.



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HW Architecture & Implementation

Why choose RPi 2 + dedicated camera module?

- ***Sufficiently powerful***
  - 900 MHz quad-core ARM Cortex-A7
  - 1GB RAM (GPU shared)
- ***Small size/weight***
  - RPI 2 board: 85.60mm × 56.5mm, 45grams
  - Camera: around 25 × 20 × 9mm, 3grams
- ***Low power consumption***
  - max 9Watts
- ***Low cost***
  - RPI 2 board: US$35
  - Camera: US$25
- ***Camera provides data in accelerated H.264 video format***

Additionally..

- Supports many I/O interfaces (sensors)
- Provides mature SW and a very big user community
- GStreamer camera module support
- C/C++ library for using the camera module for CV purposes (future work)
- Component interconnection schematics are available providing the flexibility to redesign the board to adapt to specific needs

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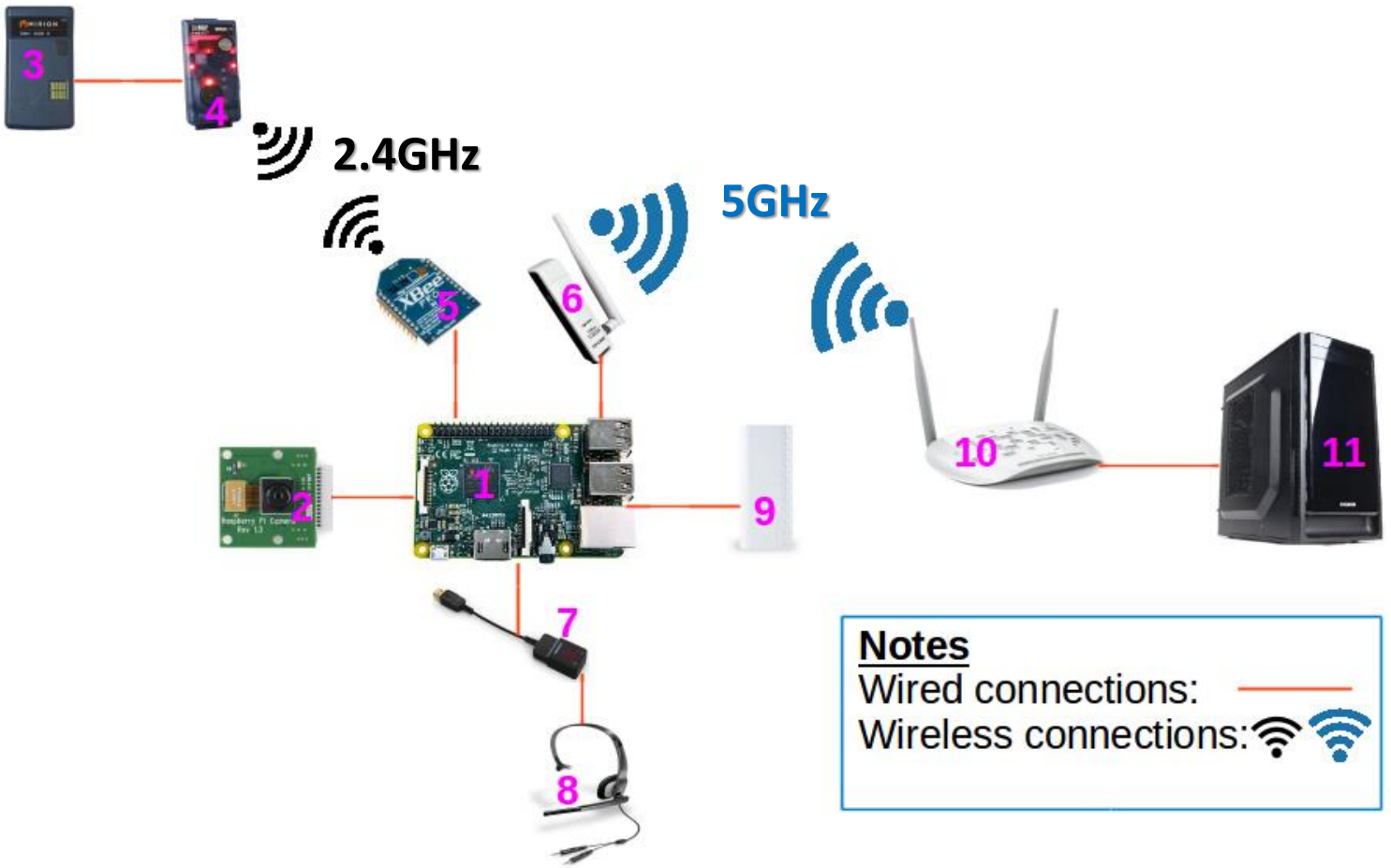
HW Architecture & Implementation

MPSS consists of the off the shelf HW components numbered from 1 to 9:



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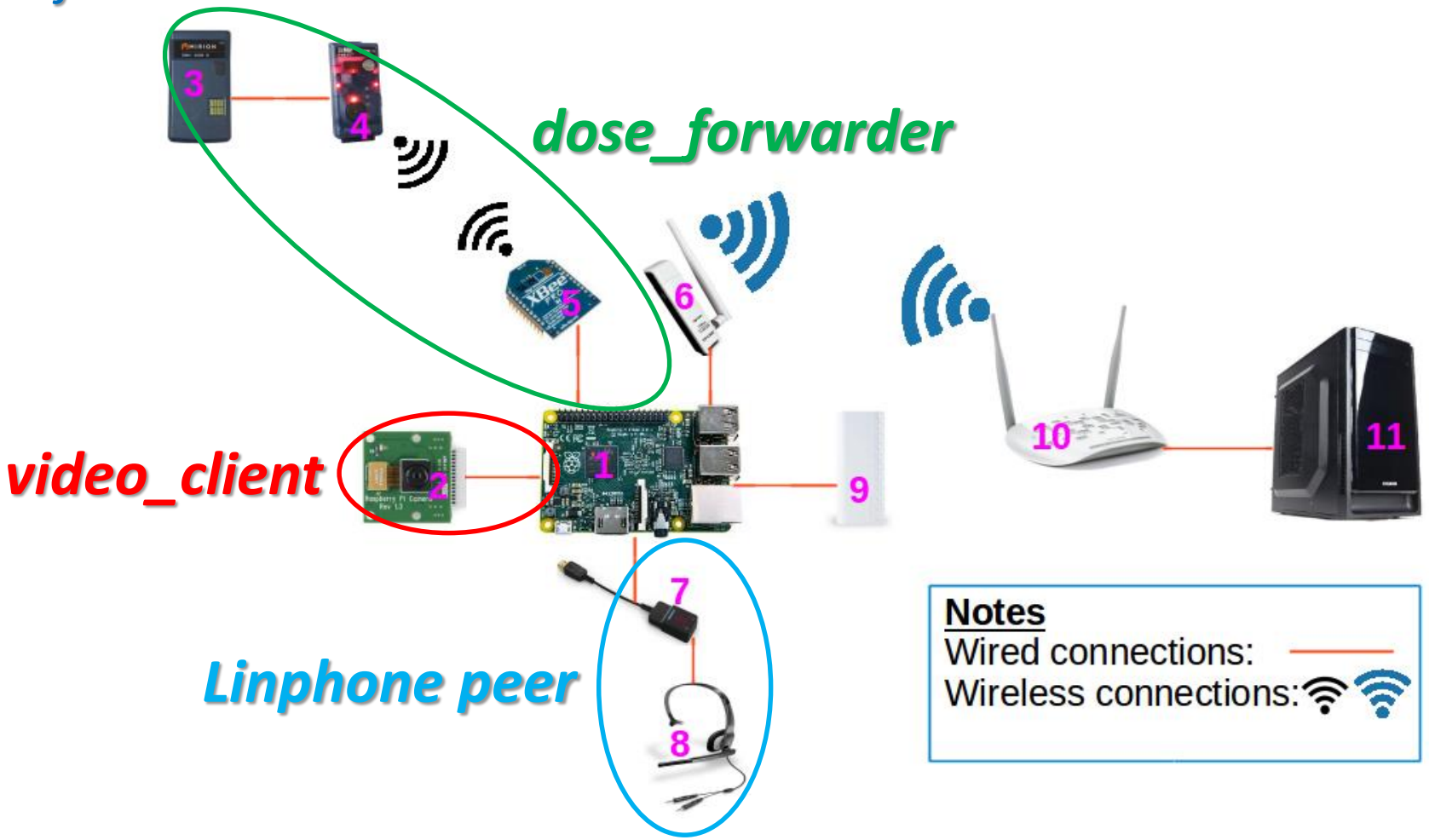

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HW Architecture & Implementation

The HW components numbered in the previous slide are:

1. The **Raspberry Pi 2** single-board computer
2. The Raspberry Pi **Camera module**
3. The **DMC 2000S gamma radiation dosimeter sensor**
4. The **iPAM-TX wireless gamma radiation dose data transmitter** module (uses the IEEE 802.15.4 standard)
5. The **XBee S1 Pro, a 2.4GHz wireless transceiver module** (uses the IEEE 802.15.4 standard)
6. A 2.4GHz and 5GHz **WiFi module (the 5GHz band is used)**
7. A **(USB) sound card**
8. An **audio headset**
9. A **battery**
10. A wireless data transceiver module (**Access Point**)
11. The **DAQ server**

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System Performance

MPSS Performance Characteristics	
Weight	503grams
Video transmission latency	Under 214ms
Frames per second (fps) transmitted	30fps of 640x480 pixels resolution
Network bandwidth usage	270-405KiB/s for transmission 12-15KiB/s for data reception
CPU and RAM usage (percentage)	Video SW : 2.2% CPU, 1.1% RAM Audio SW : 1.6% CPU, 1.7% RAM Sensor SW : 0.1% CPU, 0.2% RAM

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System Performance

MPSS Power Consumption Characteristics	
HW+SW Unit	**Power**
TEST CASE 1: Main Processing Unit running only the Operating System (No any other SW running)	
Camera module	0.255A x 5V
Camera module + USB WiFi module	0.331-0.4A x 5V
Camera module + USB sound card	0.373A x 5V
ALL HW (Camera module + USB WiFi module + USB sound card)	0.449-0.523A x 5V
TEST CASE 2: ALL HW + ALL SW (OS+Video+Audio+Sensor SW) running	
ALL HW + ALL SW running	0.632A x 5V
ALL HW + ALL SW running for 30min	1.592Wh (2547.2mAh for 4hours)

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Thank you very much for your attention! ☺
Questions?

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