



# A Platform for Testing of Real-Time Decision-Support Algorithms

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**BIC**

*opinions, interpretations, conclusions, and recommendations are those of the authors  
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# Goal

Develop the capabilities to **collect** vital-sign data during the transport of trauma patients and **prospectively test** decision-support algorithms in real time.



# Technology Comparison

## Before

- Record vital-sign data from Propaq to PDA
- Upload data from PDA to PC for analysis
- Allowed us to develop a classifier model



## Now

- Record and **analyze vital-signs in real-time** during transport
- Concurrent comparison of multiple algorithms
- Upload data and analysis results to PC for review
- Replay any previously recorded session exactly as it happened
- Allows for **hypothesis testing**

# APPRAISE Platform

- Automated Processing of Physiologic Registry for Assessment of Injury Severity
- Design Goals
  - Attach a ruggedized PC to the Propaq
  - Provide sufficient processing power and memory to run analysis in real time
  - Allow quick updates of algorithms and extraction of data



# Benefits

- **Gain experience** collecting and analyzing vitals in real-world, pre-hospital setting.
- **Assess performance** prior to military field deployment.
- **Perform automated diagnosis** of trauma victims in real time.

# Key Challenges

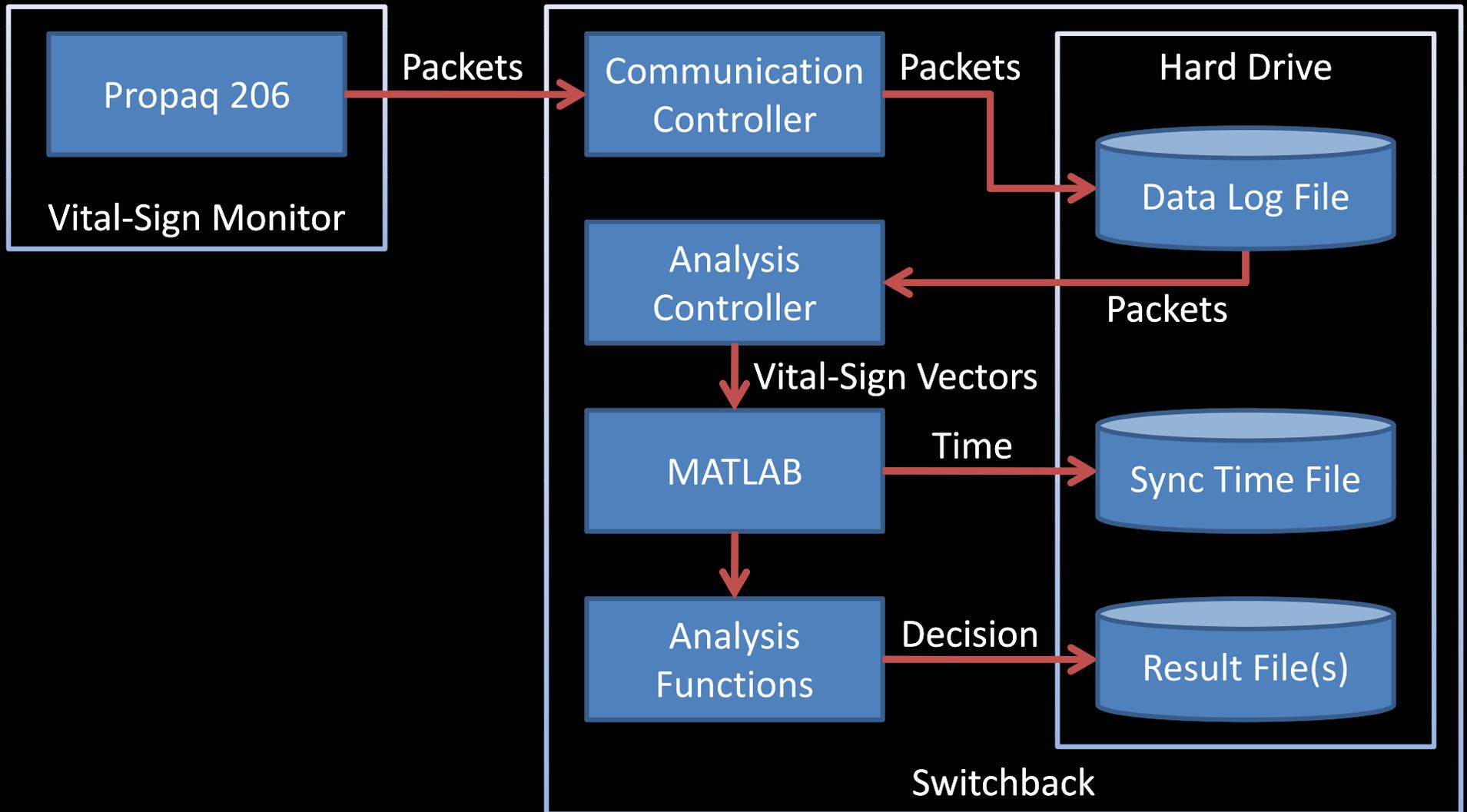
- Hardware restrictions (size, weight, environment hazards)
- Communication with vital-sign monitor
- Detection of patients (new sessions)
- Reliable real-time data acquisition and storage
- Quick update of decision-support algorithms

# Hardware

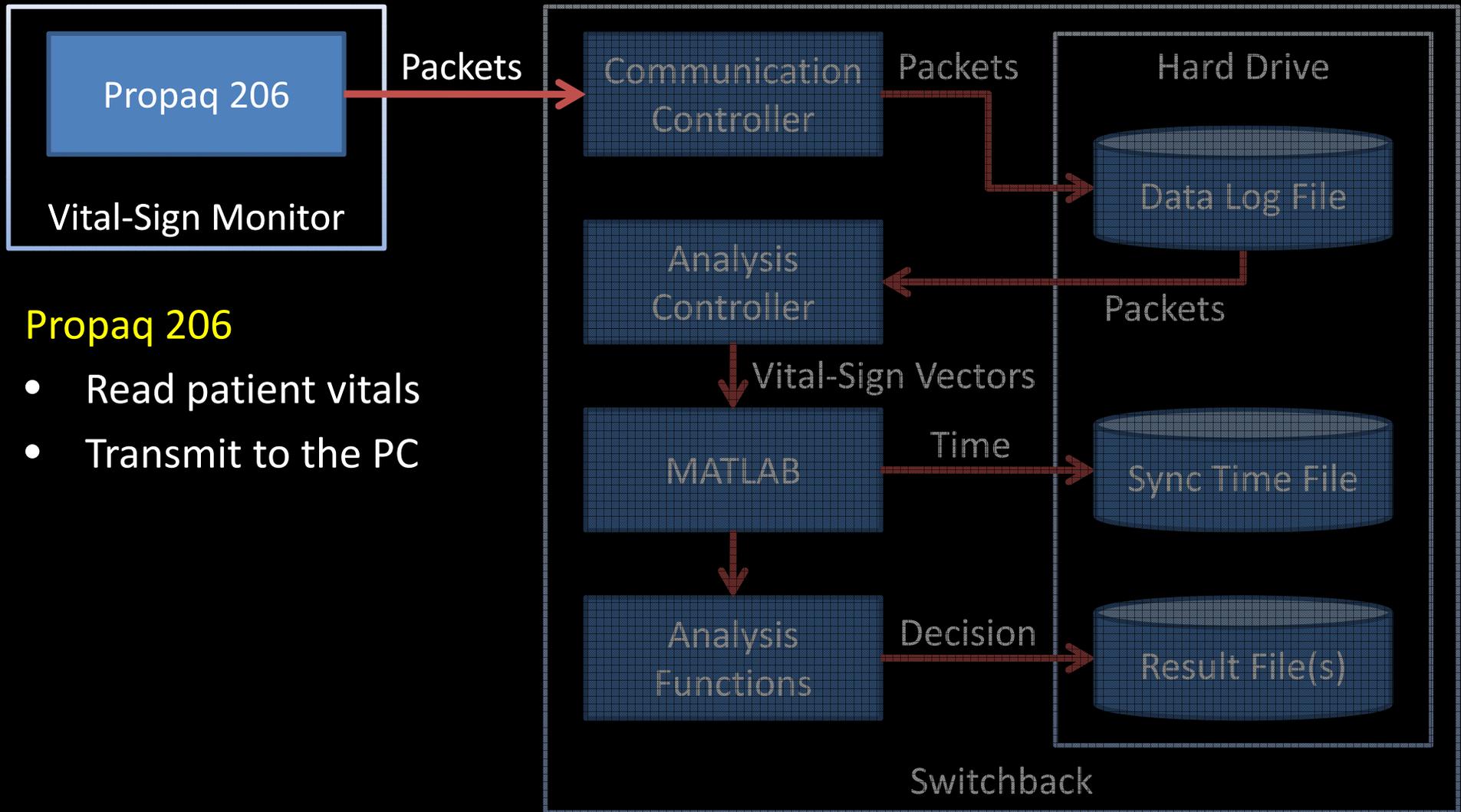
- Propaq Encore 206-EL
- Switchback ruggedized PC
  - 1 GHz CPU
  - 2 GB RAM
  - 32 GB SSD
- Serial connection
- USB flash drive for data extraction



# Software Components



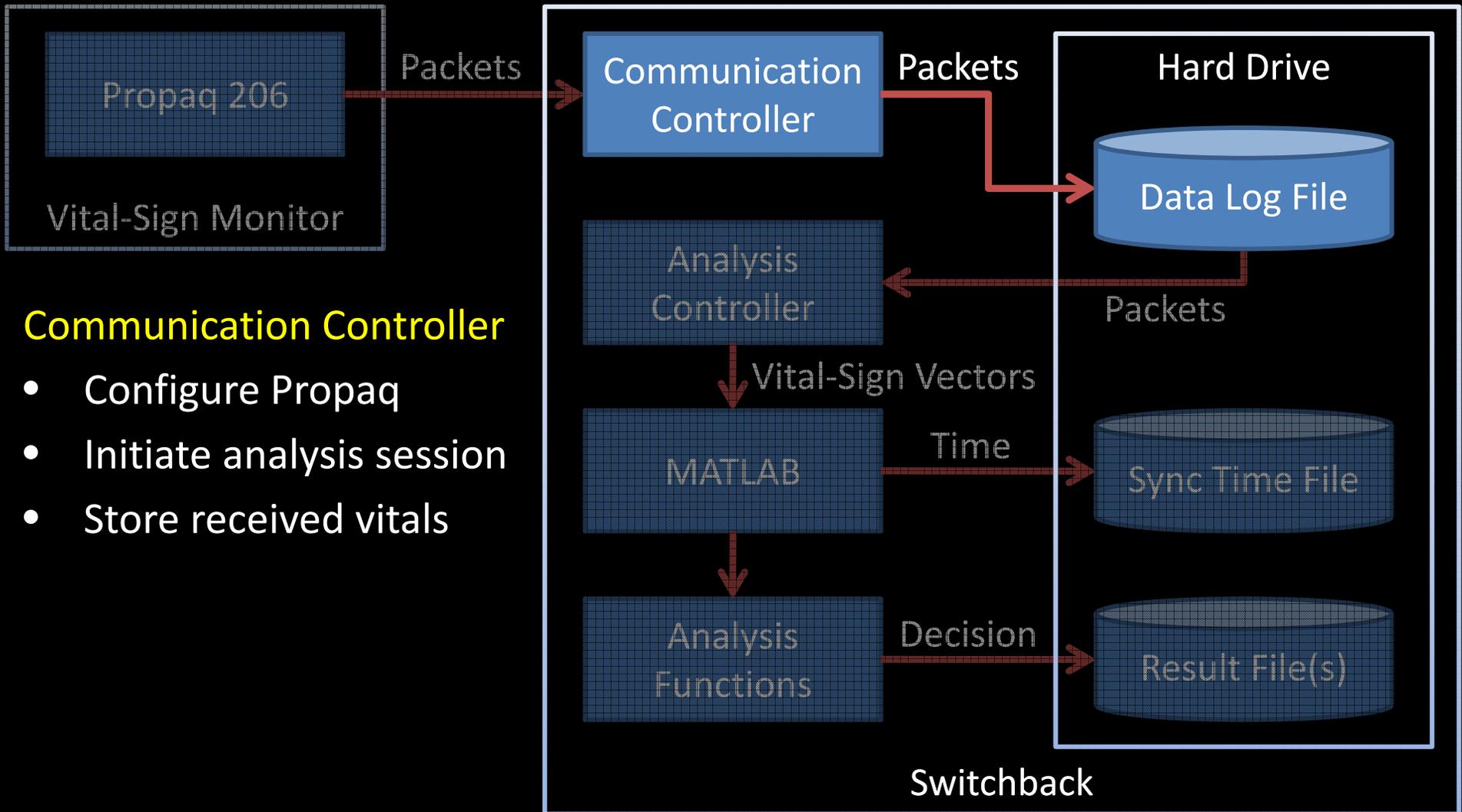
# Software Components



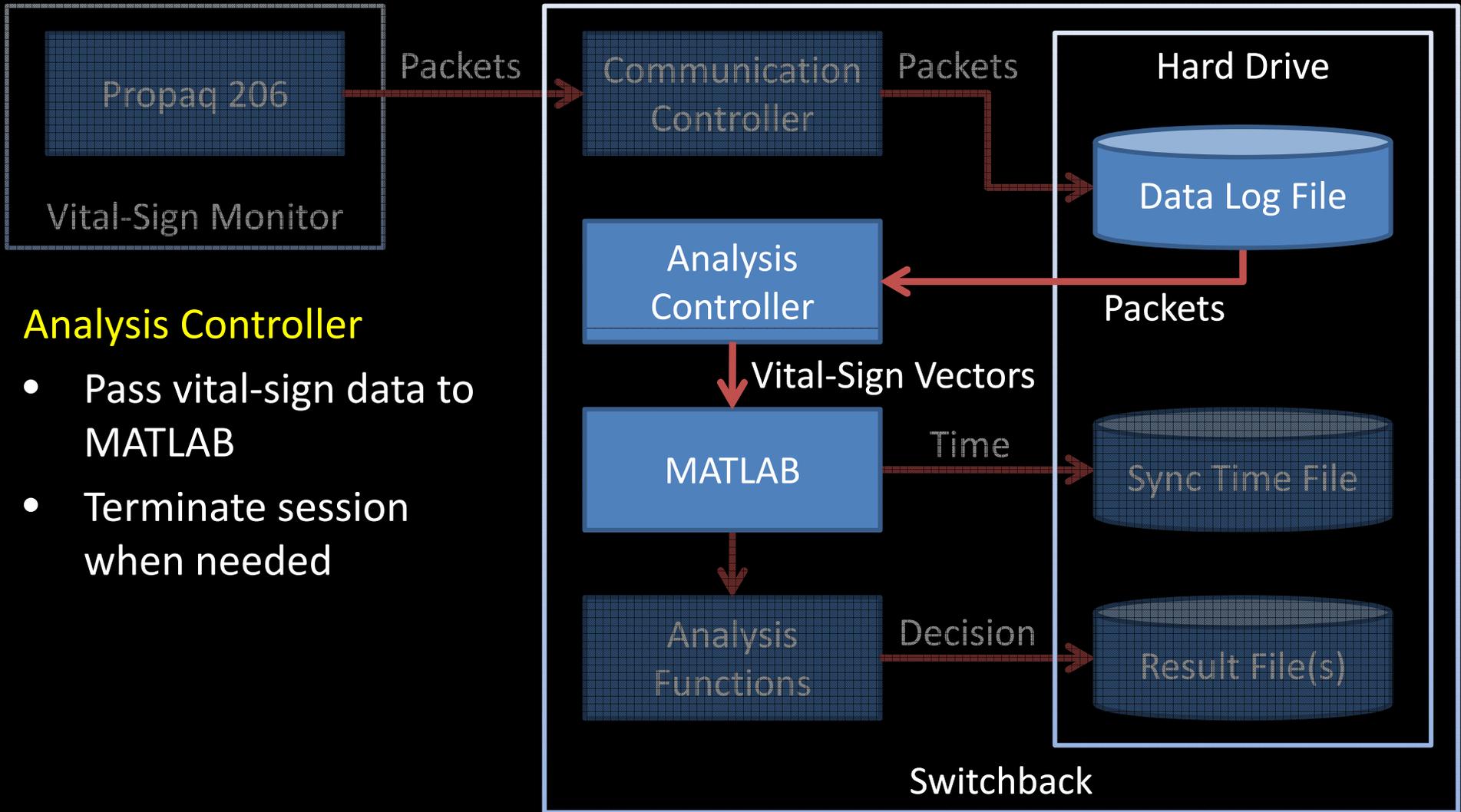
## Propaq 206

- Read patient vitals
- Transmit to the PC

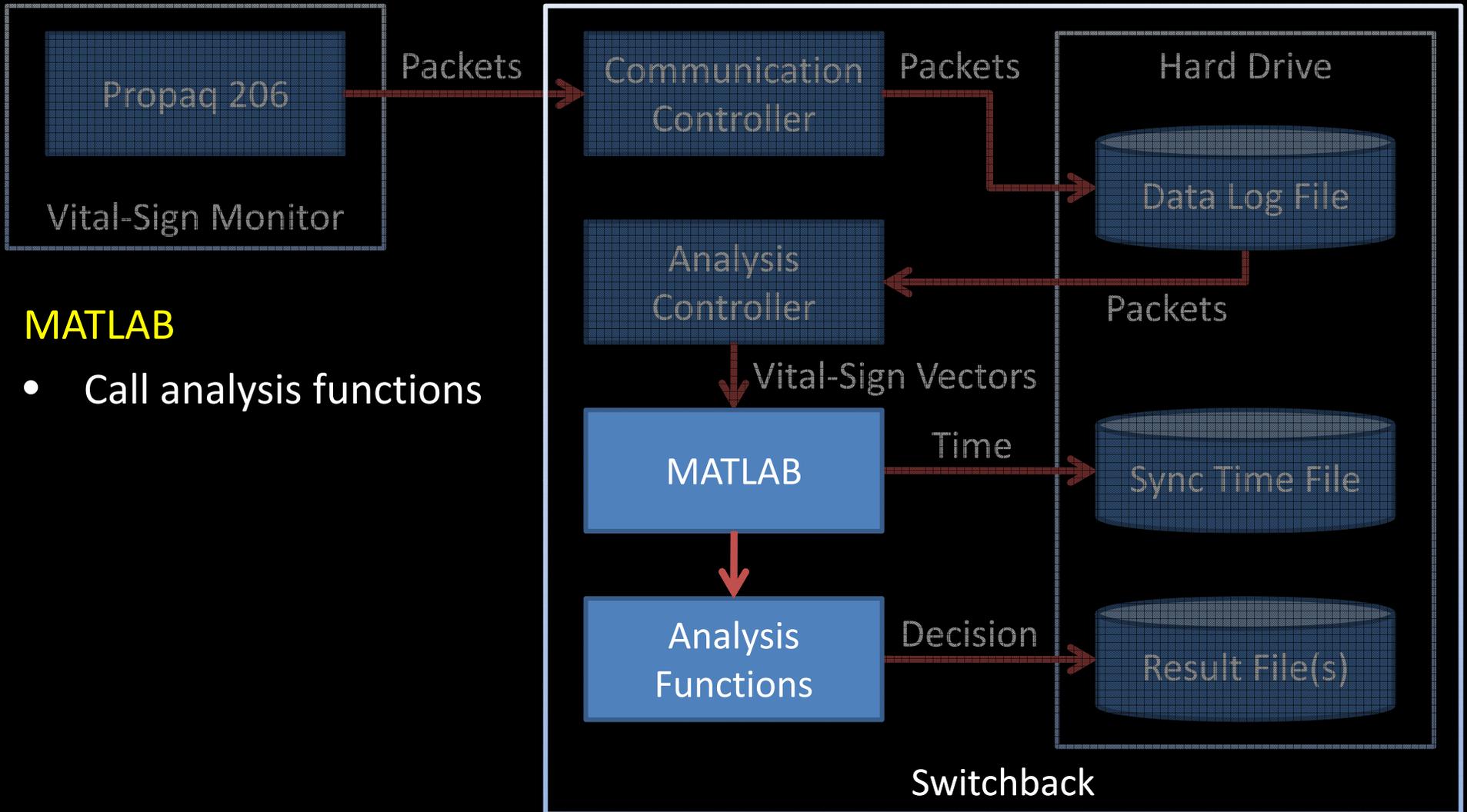
# Software Components



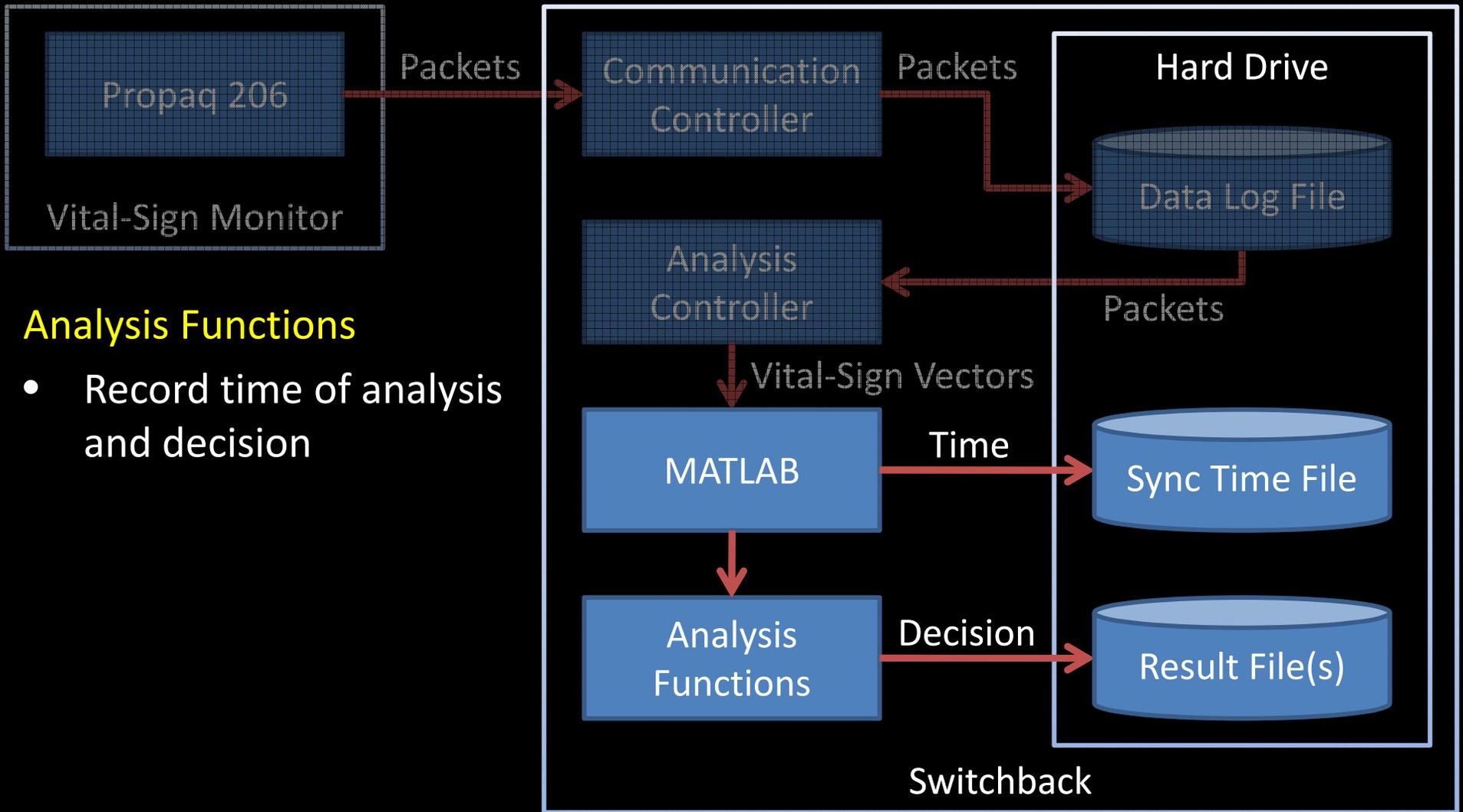
# Software Components



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# Software Components



# Platform Life Cycle

Lab

Update analysis algorithms

Send system to the field

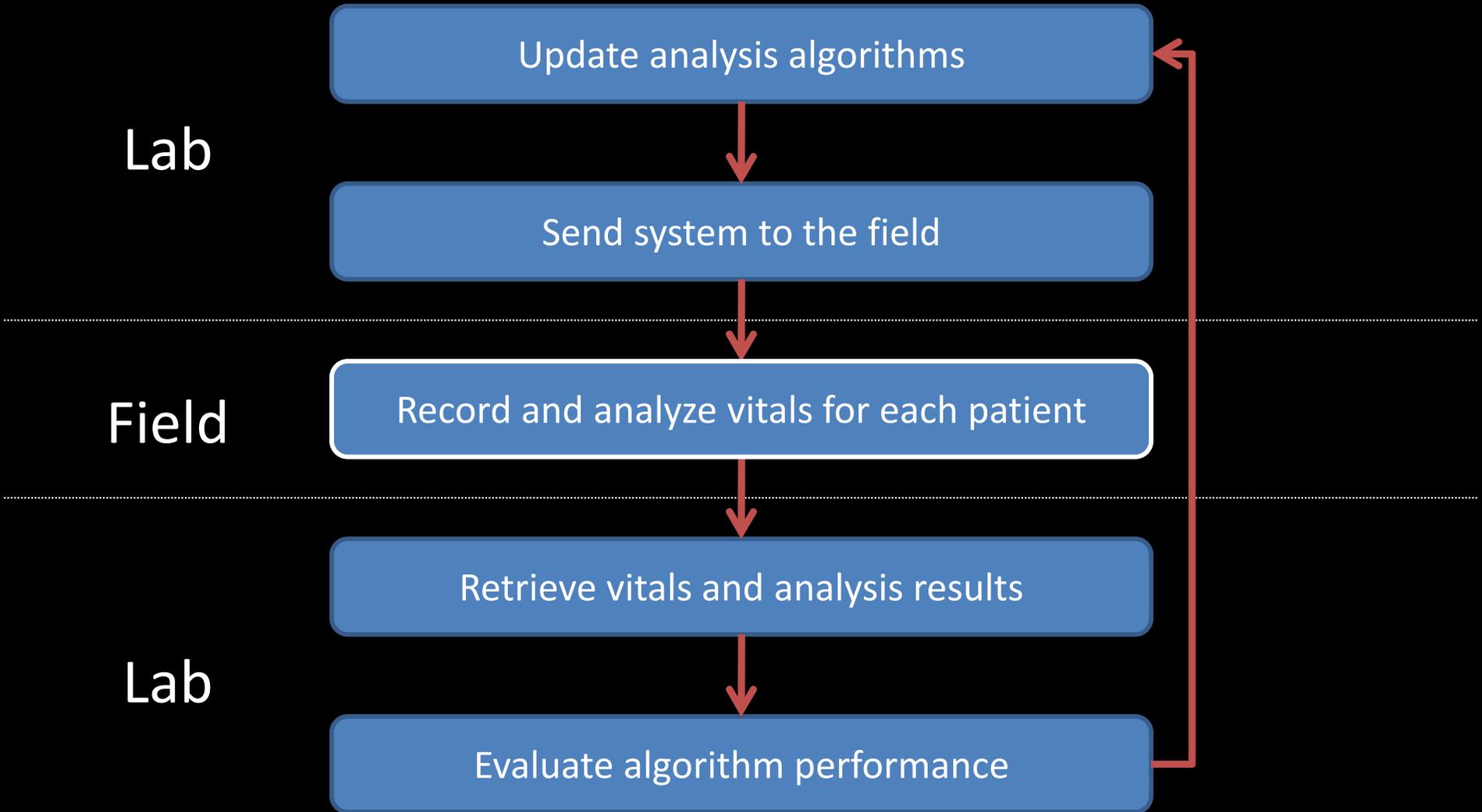
Field

Record and analyze vitals for each patient

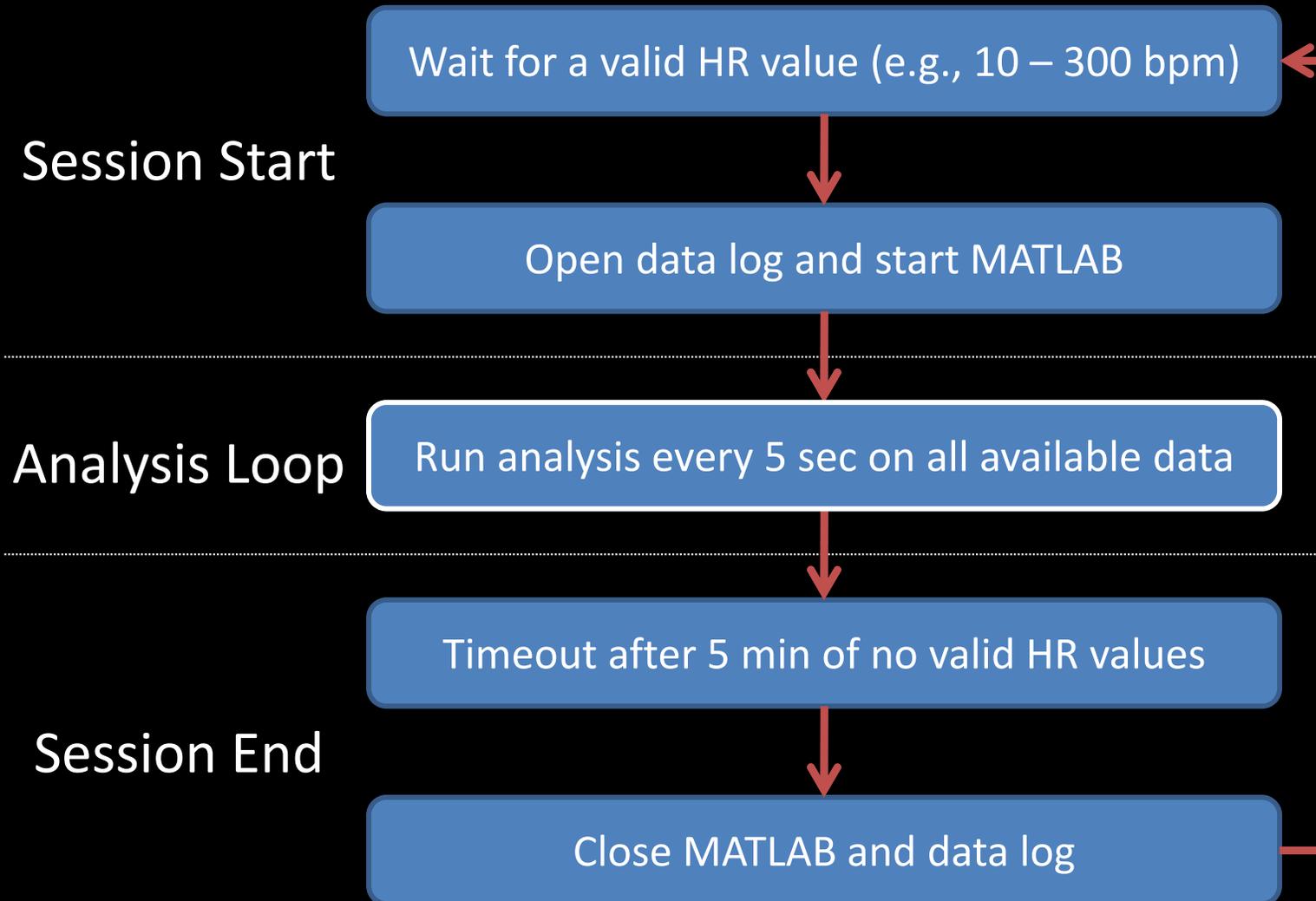
Retrieve vitals and analysis results

Lab

Evaluate algorithm performance



# Recording Session



# Analysis

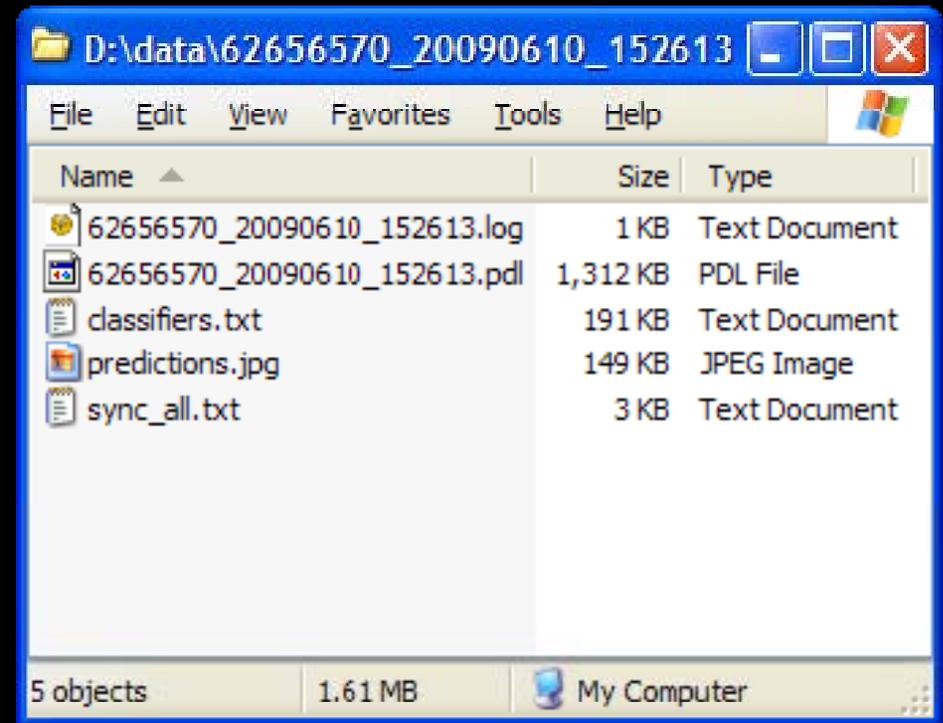
Heart  
Rate

ECG



# Session Output

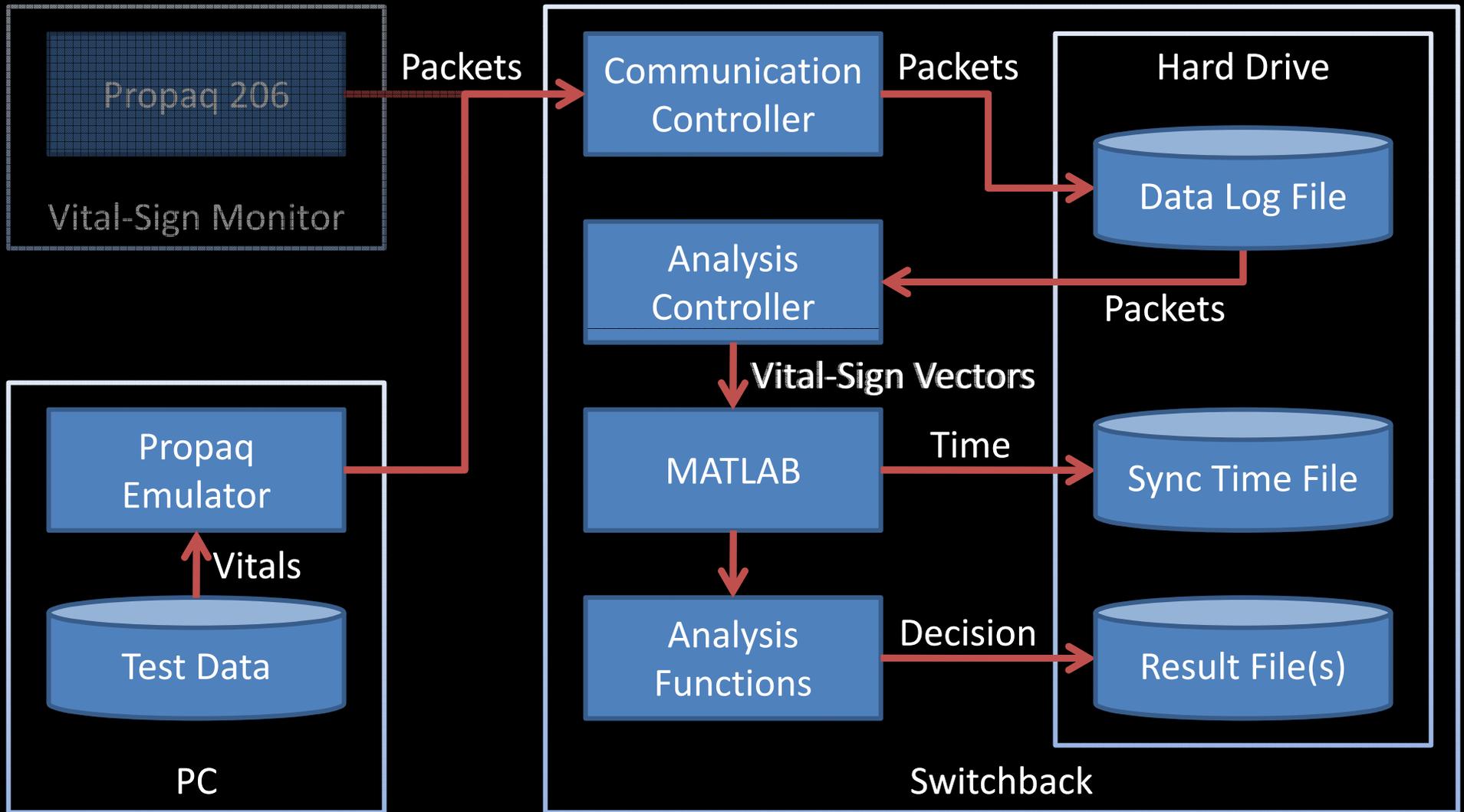
- Propaq data log
  - Exact copy of all data sent/received
  - Data and system timestamps
- Analysis log
  - Start/end time
  - Errors
- Analysis output



# Pre-deployment Testing

- Developed a Propaq Emulator to control data transmission.
- Tested failure scenarios that are possible in the field:
  - Missing/corrupt data points
  - Broken connection
- Selected 20 patients at random and checked if APPRAISE results matched those on the desktop.

# Testing Data Path



# Testing Results

- We were able to perfectly duplicate numeric data values and their quality indices.
- All real-time analysis output matched desktop results.

# First Deployment

- Received IRB approval from U.S. Army and Massachusetts General Hospital as of May 2009.
- System being used by Boston MedFlight air ambulances since July 29<sup>th</sup> 2009.



# First Deployment

- **Collect** vitals for patients transported to Massachusetts General Hospital.
- **Qualify** numeric and waveform data:
  - Heart rate
  - Respiratory rate
  - SpO2
  - Systolic and diastolic blood pressures
- **Predict** major internal hemorrhage.

# Prospective Testing Hypothesis

Our classifier will be able to achieve at least **80% sensitivity** and **60% specificity** in major hemorrhage prediction.



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Questions?