

APPLYING VIDEO TEST AUTOMATION TO AUTOMATE MULTIMEDIA VERIFICATION WITH EMBEDDED LINUX SW

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WHO AM I?

- Name: Nguyen Bao. Nguyen (Nguyen Nguyen)
- Company: Renesas Design Vietnam Co.

- Career: 10 years experiences in embedded software development (both software development and verification)
 - ✓ Development for Multimedia framework on Real-time OS
 - ✓ Development for Multimedia plug-in for Android Stagefright on R-Car software platform
 - ✓ Development and verification for In-vehicle software platform
 - ✓ Development for test automation solutions of In-vehicle software platform
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ABOUT RENESAS AND RENESAS DESIGN VIETNAM



Sales Companies

Renesas Electronics America
Renesas Electronics Canada
Renesas Electronics Brasil-Servicos
Renesas Electronics Europe (UK)
Renesas Electronics Europe (Germany)
Renesas Electronics (China)
Renesas Electronics (Shanghai)
Renesas Electronics Hong Kong
Renesas Electronics Taiwan
Renesas Electronics Singapore
Renesas Electronics Malaysia
Renesas Electronics India
Renesas Electronics Korea

Manufacturing and Engineering Service Companies

Renesas Semiconductor Manufacturing
Renesas Semiconductor Package & Test Solutions
Renesas Semiconductor (Beijing)
Renesas Semiconductor (Suzhou)
Renesas Semiconductor (Malaysia)
Renesas Semiconductor (Kedah)
Renesas Semiconductor Technology (Malaysia)
Renesas Semiconductor KL

Design and Application Technologies Companies

Renesas System Design
Renesas Engineering Services
Renesas Design Vietnam
Renesas Semiconductor Design (Beijing)
Renesas Semiconductor Design (Malaysia)

Business Corporation

Intersil Corporation

- Renesas Design Vietnam Co., Ltd. (RVC) was founded in October 2004, as one of the main design centers in Renesas group.
- Business line: Design of semiconductor for both hardware and software.

AGENDA

- Introduction about Video Automation Test
- Achievement with Video Automation Test Development
- The approach for Video Automation Test
- How to apply Video Automation Test with Fuego
- The future plan

LEGEND

Acronym	Meaning
VAT	Video Automation Test
VAT PC	The PC used to launch VAT
Fuego	Fuego is a test framework specifically designed for embedded Linux testing .
HDMI	High-Definition Multimedia Interface
Ref data	The expected video playback output
VAT component	An application used to control VAT PC from Fuego



INTRODUCTION ABOUT VIDEO AUTOMATION TEST

INTRODUCTION ABOUT VIDEO AUTOMATION TEST

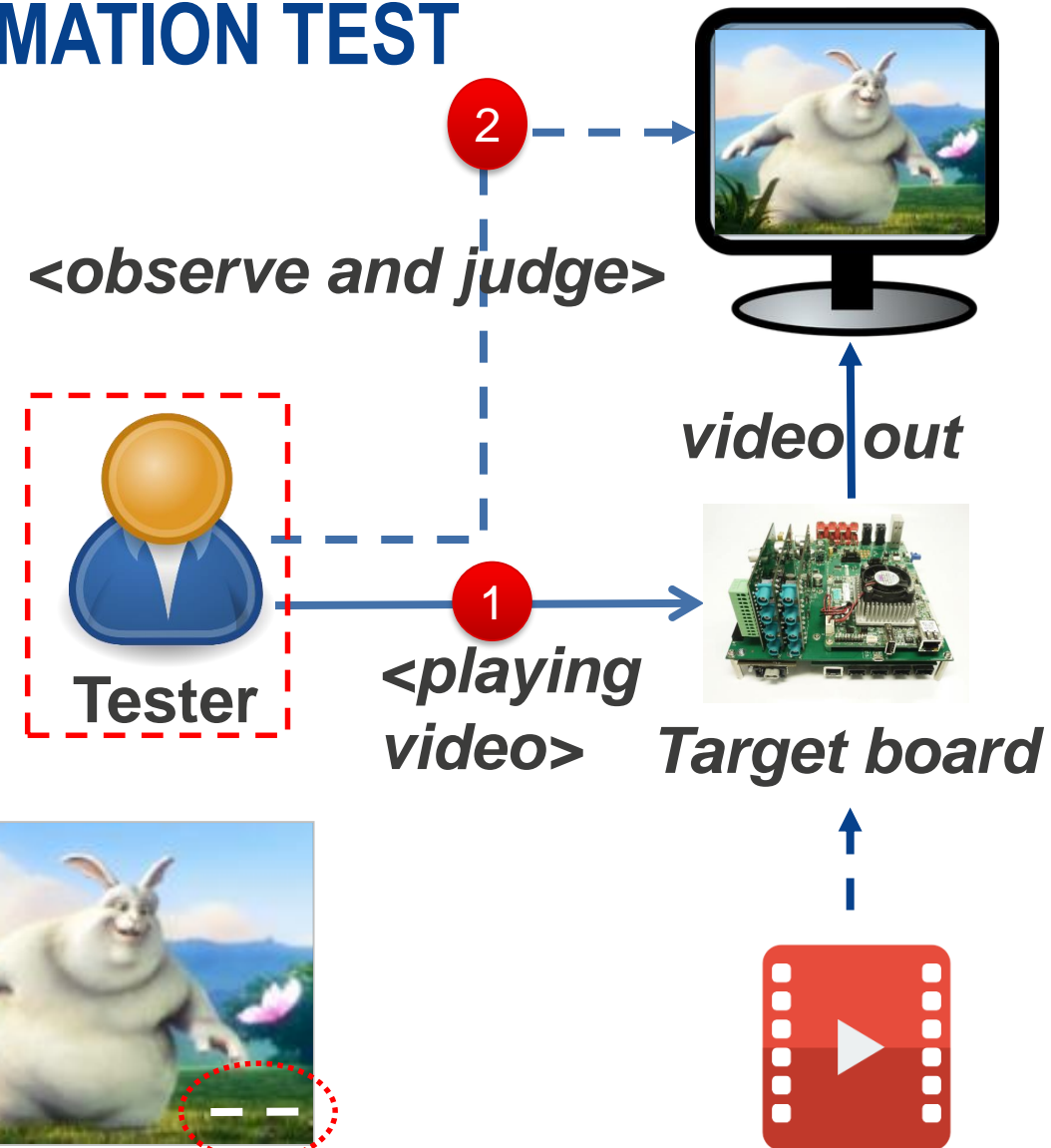
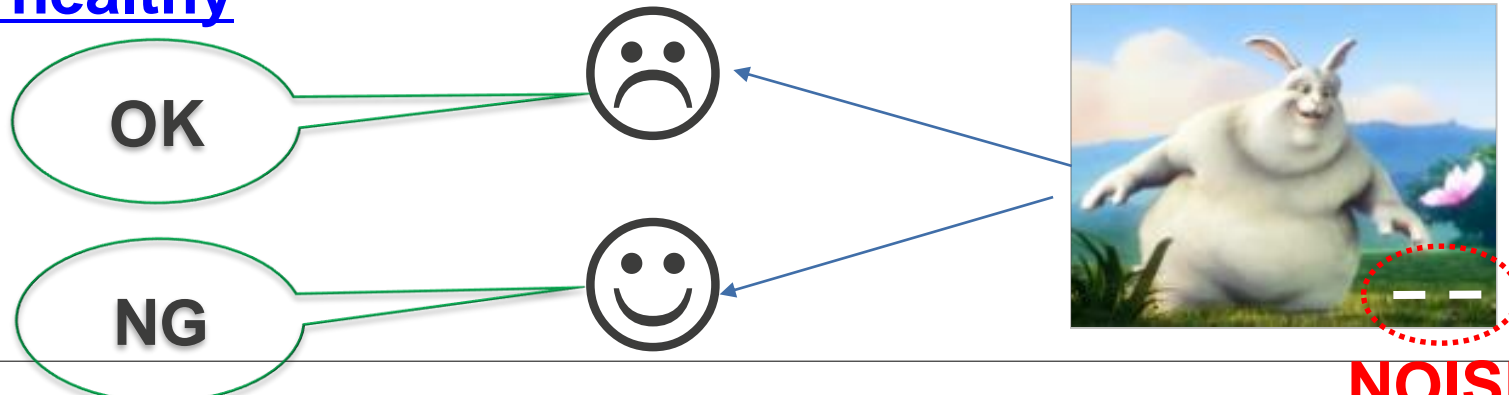
THE MOTIVATION

❖ The Video Manual test:

- Testers observe and judge the video's quality by human eyes

❖ Big problem:

- The video testing results are based on the tester's feeling / spirit / experience / healthy



NOISE

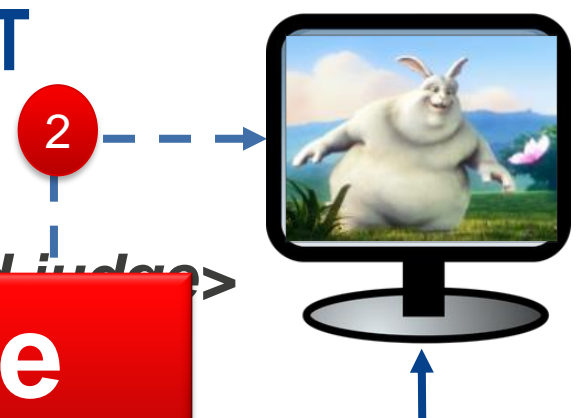
INTRODUCTION ABOUT VIDEO AUTOMATION TEST

THE MOTIVATION

❖ The Video Manual test:

- Test

The test result is un-reliable



❖ DEMAND:

→ Need to automate video testing, to make the reliable test results, NOT depends on Human Feeling

→ Replace “human role” by “**MACHINE ROLE**”

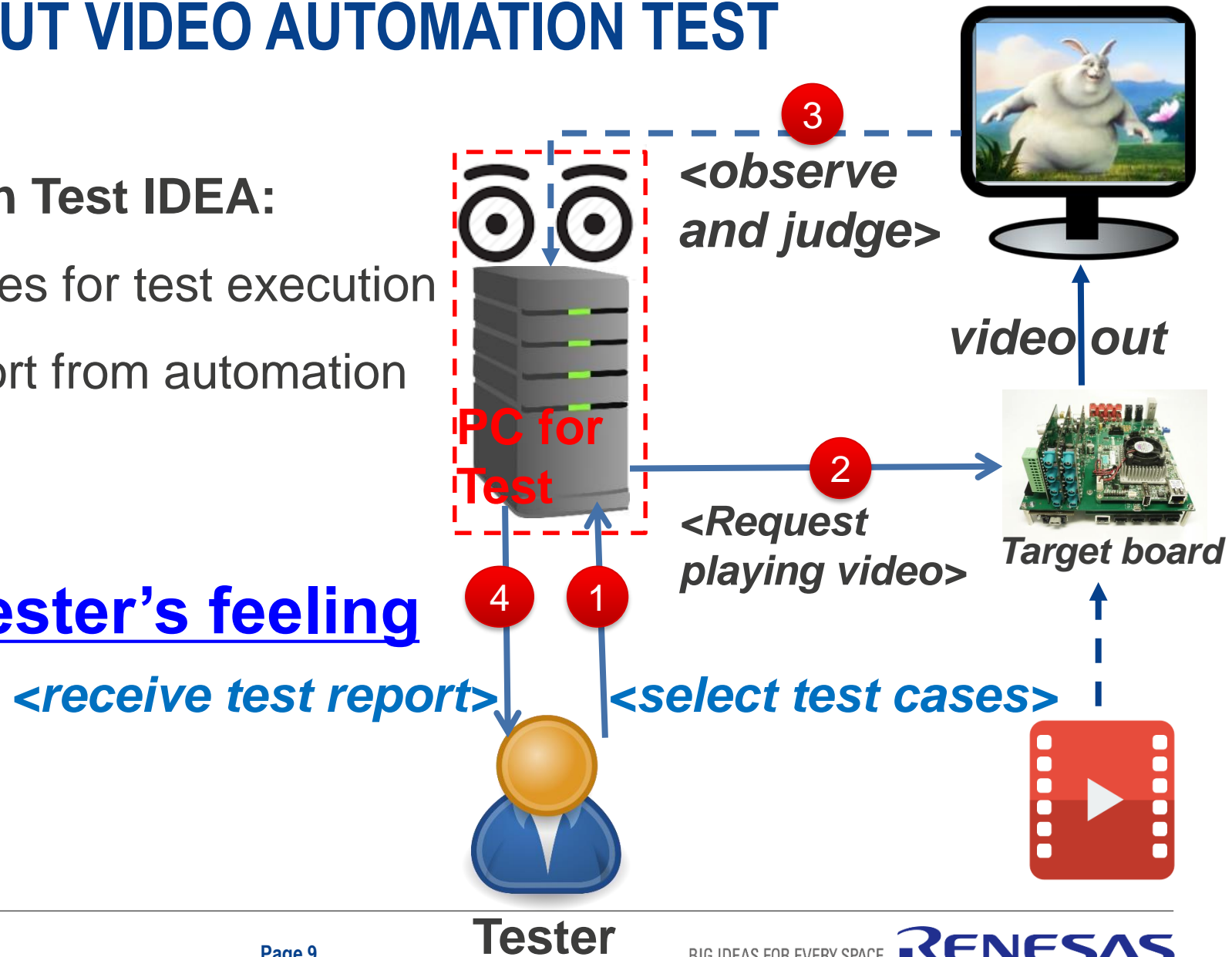
INTRODUCTION ABOUT VIDEO AUTOMATION TEST

POPOP THE IDEA

❖ The Video Automation Test IDEA:

- Tester **selects** test cases for test execution
- Tester **checks** the report from automation judgment
- The test result is:

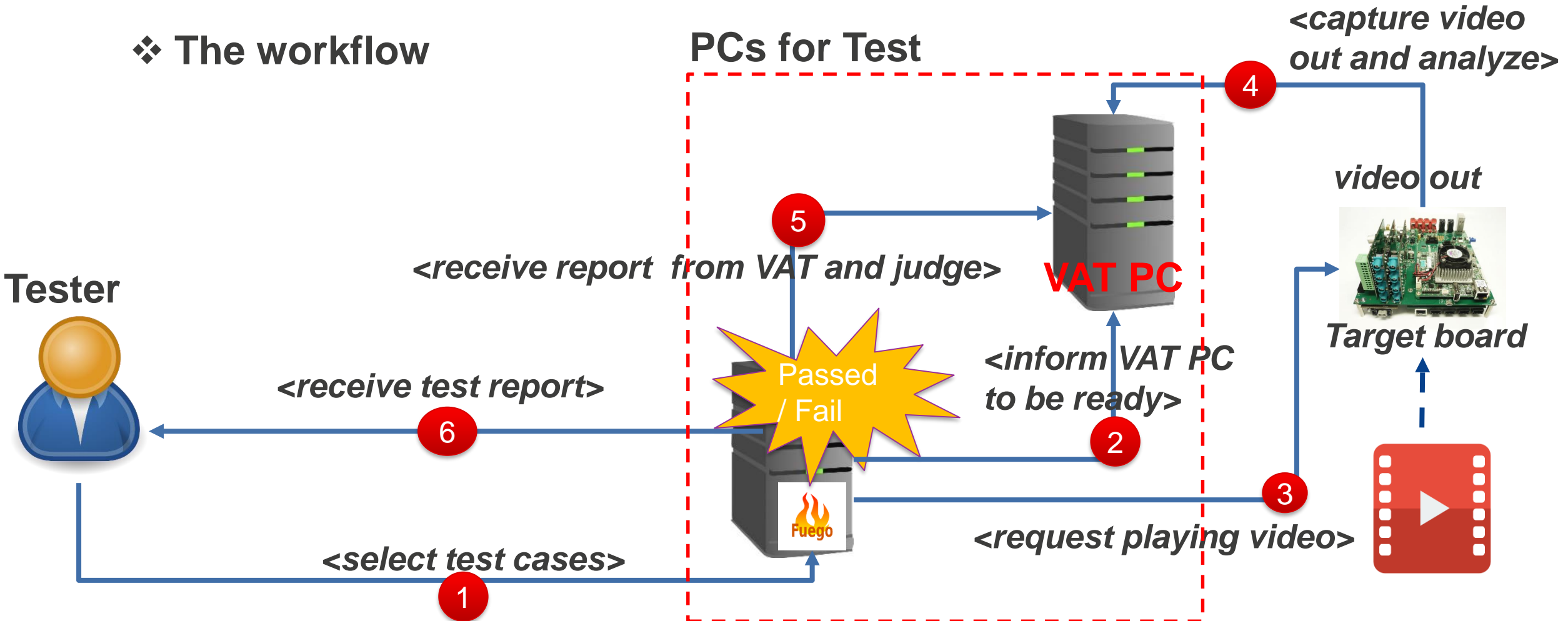
NOT depend on tester's feeling



INTRODUCTION ABOUT VIDEO AUTOMATION TEST

TRANSFORM IDEA TO SOLUTION

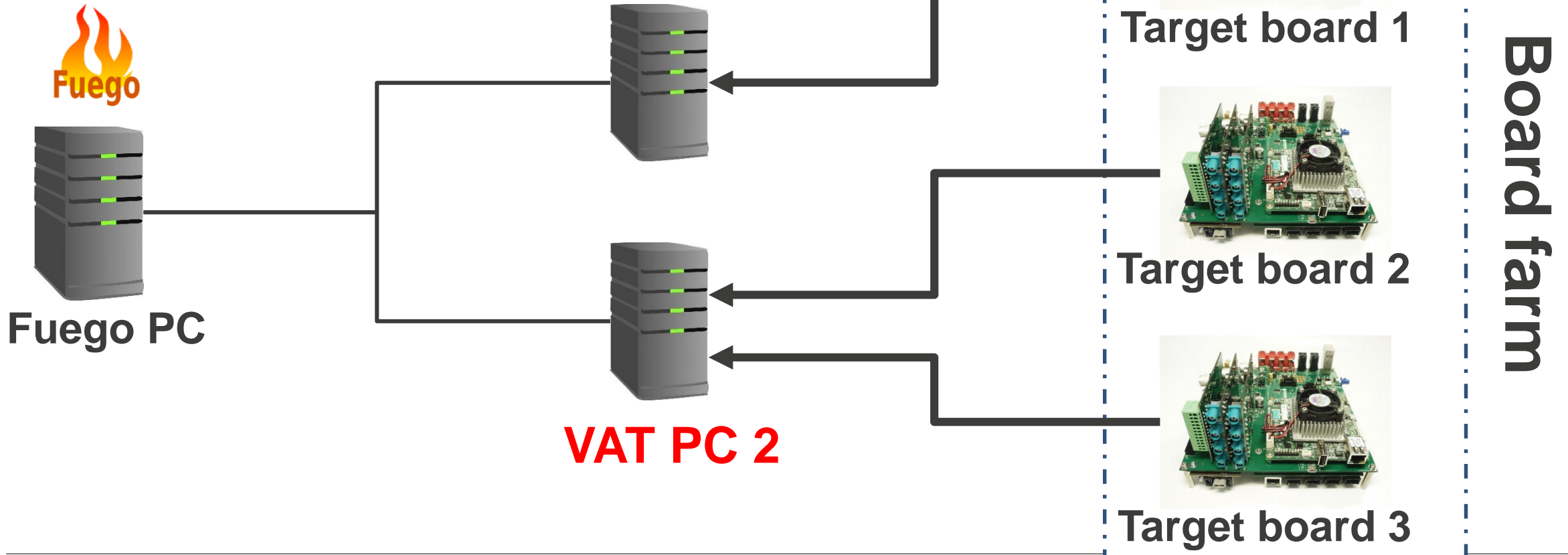
❖ The workflow



INTRODUCTION ABOUT VIDEO AUTOMATION TEST

TRANSFORM IDEA TO SOLUTION

❖ Devices connection



ACHIEVEMENT WITH VIDEO AUTOMATION TEST

VIDEO CODECS AND RESOLUTIONS

❖ Support Codecs:

MPEG2

MPEG-4



H.264
MPEG-4/AVC

H.265
HEVC
High Efficiency Video Coding

VP8

VP9

❖ Support video resolutions: 176x144, 352x288, 352x480, 352x576,
640x480, 720x480, 720x576, 1280×720, **1920x1080**, 2048×1080, ...,
3840x2160

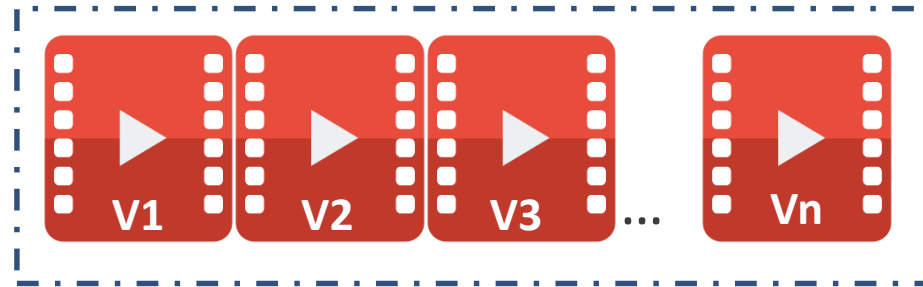
ACHIEVEMENT WITH VIDEO AUTOMATION TEST

USE-CASES

❖ Supported video/movie playback use-cases:



Simple video/movie playback



Sequence video/movie playback



Loop input stream and play

Repeat video/movie playback

ACHIEVEMENT WITH VIDEO AUTOMATION TEST

VIDEO AUTOMATION TEST PERFORMANCE

❖ With VAT PC specification

✓ OS: Ubuntu 14.04



✓ HW : Intel(R) Core(TM) i5-3570 CPU @ 3.40GHz, 8GB DDR3-1333 MHz RAM,
500GB HDD

✓ Video input signal: **HDMI 2.0**



✓ Performance: can adapt video playback on target board up to

FHD@60fps, UHD@30fps

ACHIEVEMENT WITH VIDEO AUTOMATION TEST

HUMAN TEST VS AUTOMATION TEST

Impact of Video Automation Test:

Compare the test run duration:

❖ Manual Test:

- Video content duration (E.g. 4 mins)
- Run test + fill report : $\sim(4 + 2)$ mins

❖ Automation Test:

- Video content duration (4 mins)
- Auto Run test + auto judge result + auto report: $\sim(4 + 3)$ mins

Total: **~7 mins** (1.16 times comparing with manual test)

Compare the productivity:

❖ Manual Test:

- 1 person / 1 board / 1 day: 50 TCs

❖ Automation Test:

- VAT PC / 1 board / 1 day (**24-hours**):
~150 TCs (utilize **overnight** testing)

THE APPROACH FOR VIDEO AUTOMATION TEST



THE APPROACH FOR VIDEO AUTOMATION TEST

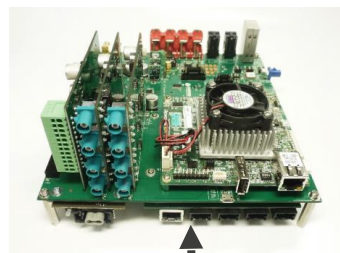
- ❖ Video automation test is developed to detect **issues** during video playback on target boards:
 1. **Frame skip**
 2. **Frame delay**
 3. **Frame mismatch**
 4. **Video Playback not smooth**

THE APPROACH FOR VIDEO AUTOMATION TEST

FRAME SKIP

- Definition: frame is **IN (A)** but **NOT IN (B)**

Target board



*video
out*



VAT PC

frames sequence in **video output (B)** :
f1 f2 f3 f4 f6 f9
Frames skip list: **f5 ,f7, f8, f10**



frames sequence in **test stream (A)** : f1 f2 f3 f4 **f5**
f6 **f7 f8** f9 **f10**

THE APPROACH FOR VIDEO AUTOMATION TEST

FRAME DELAY

- Definition: frame appears more than **one** time

Target board



*video
out*



VAT PC

frames sequence in **video output** (B) : f1
f2 **f2** f3 f4 f5 f6 f7 f8 **f8 f8** f9 f10
Frames delay list: **f2 ,f8, f8**



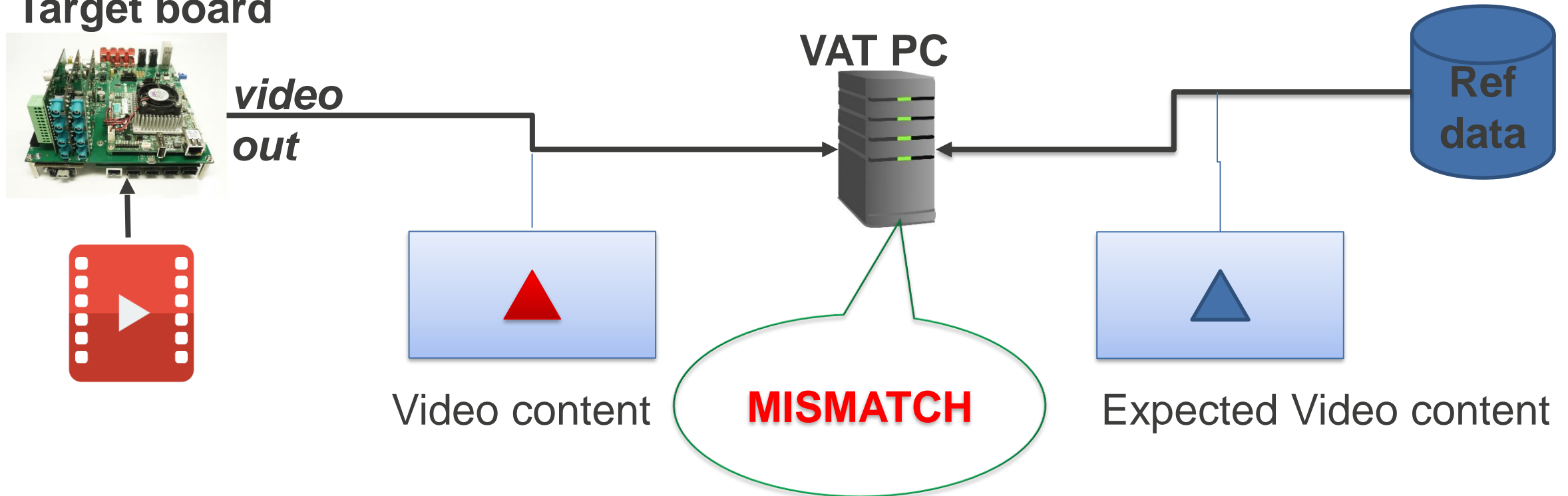
frames sequence in **test stream** (A) : f1 f2 f3 f4 **f5**
f6 **f7 f8** f9 **f10**

THE APPROACH FOR VIDEO AUTOMATION TEST

FRAME MISMATCH

- Definition: frame contains video out which is **different** from Ref data

Target board

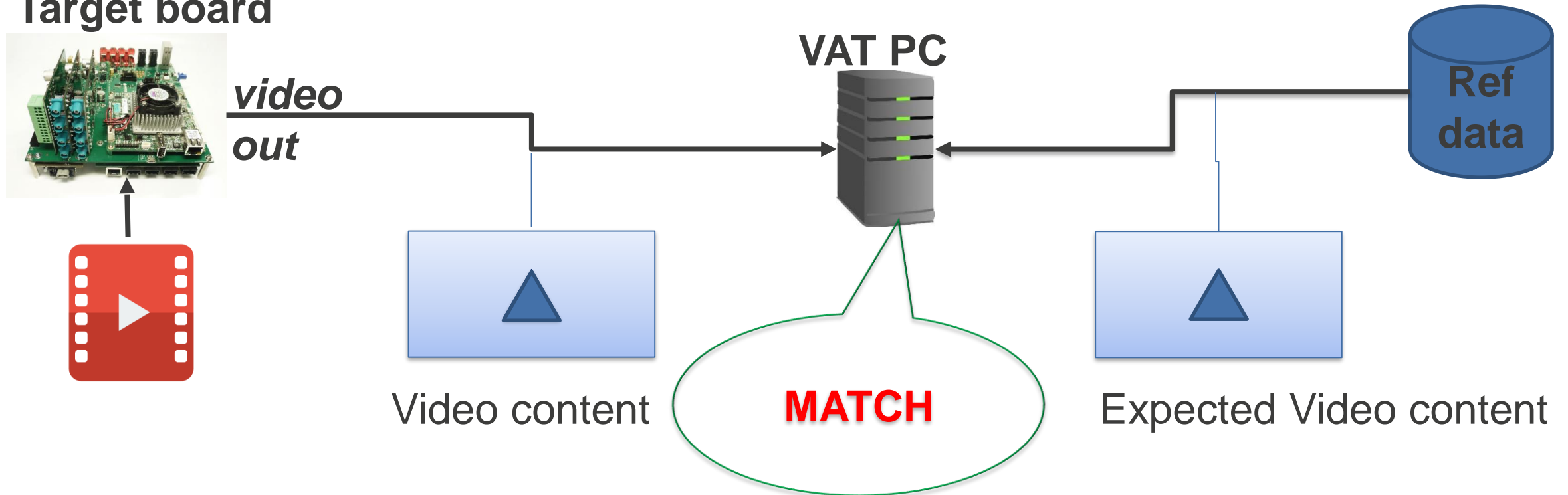


THE APPROACH FOR VIDEO AUTOMATION TEST

FRAME MISMATCH – CONT.

- Definition: frame contains video out which is **different** from Ref data

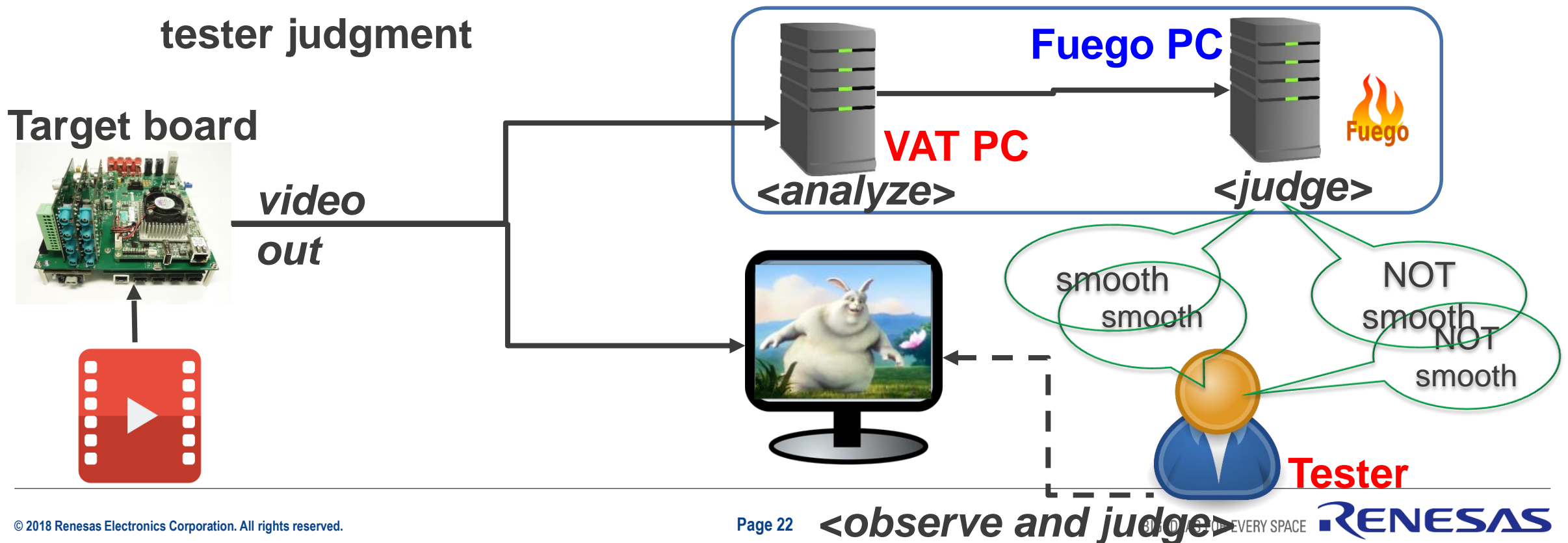
Target board



THE APPROACH FOR VIDEO AUTOMATION TEST


PLAYBACK NOT SMOOTH

- Definition: **lag** video playback
- Calibration: Video playback **judgment** feature is **calibrated** along with **tester judgment**



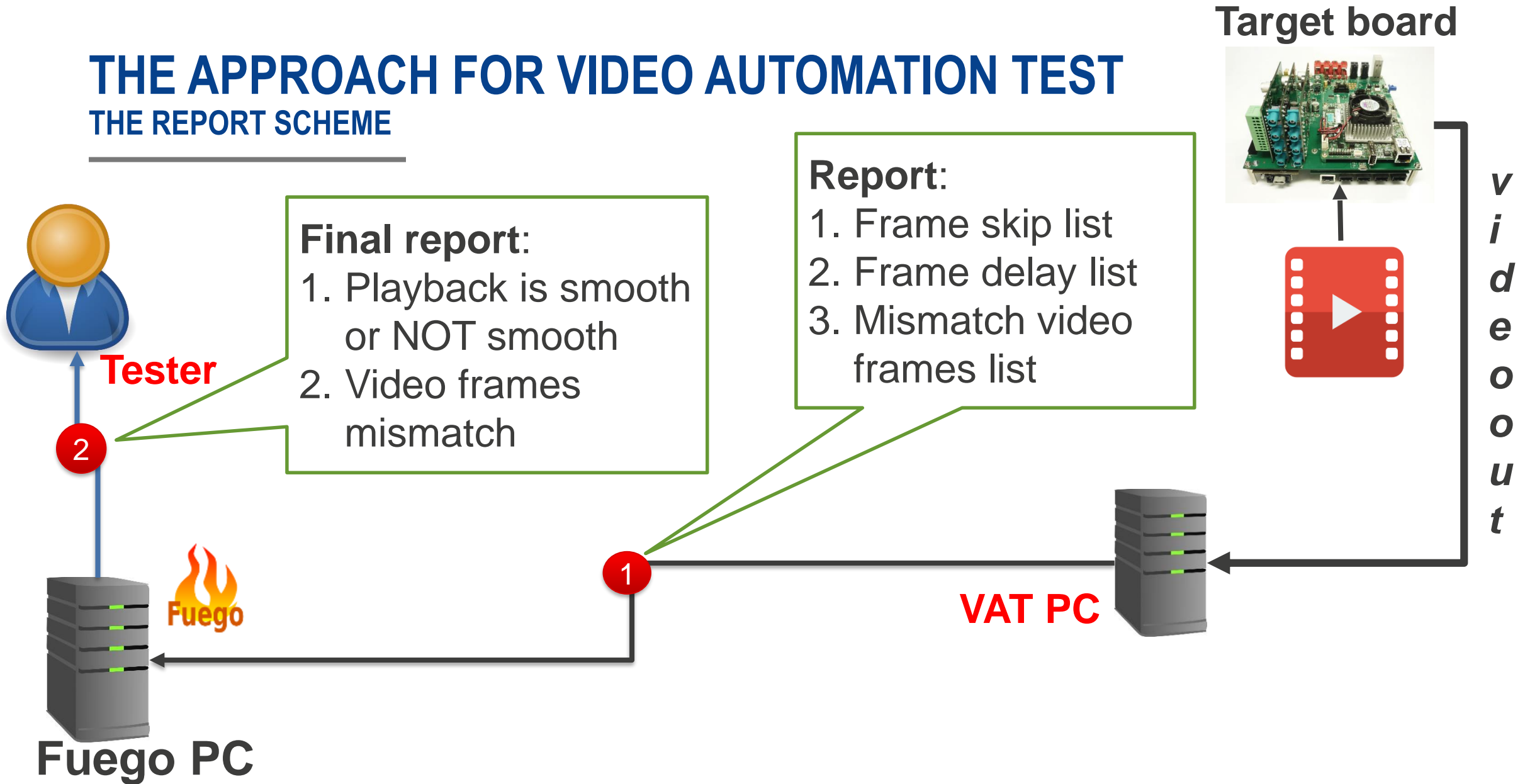
THE APPROACH FOR VIDEO AUTOMATION TEST

TOOLS SUPPORT VIDEO AUTOMATION TEST DEVELOPMENT

No	Item	Tools
1	Frame skip	 
2	Frame delay	
3	Frame mismatch	
4	Playback not smooth	Self development algorithm

THE APPROACH FOR VIDEO AUTOMATION TEST

THE REPORT SCHEME



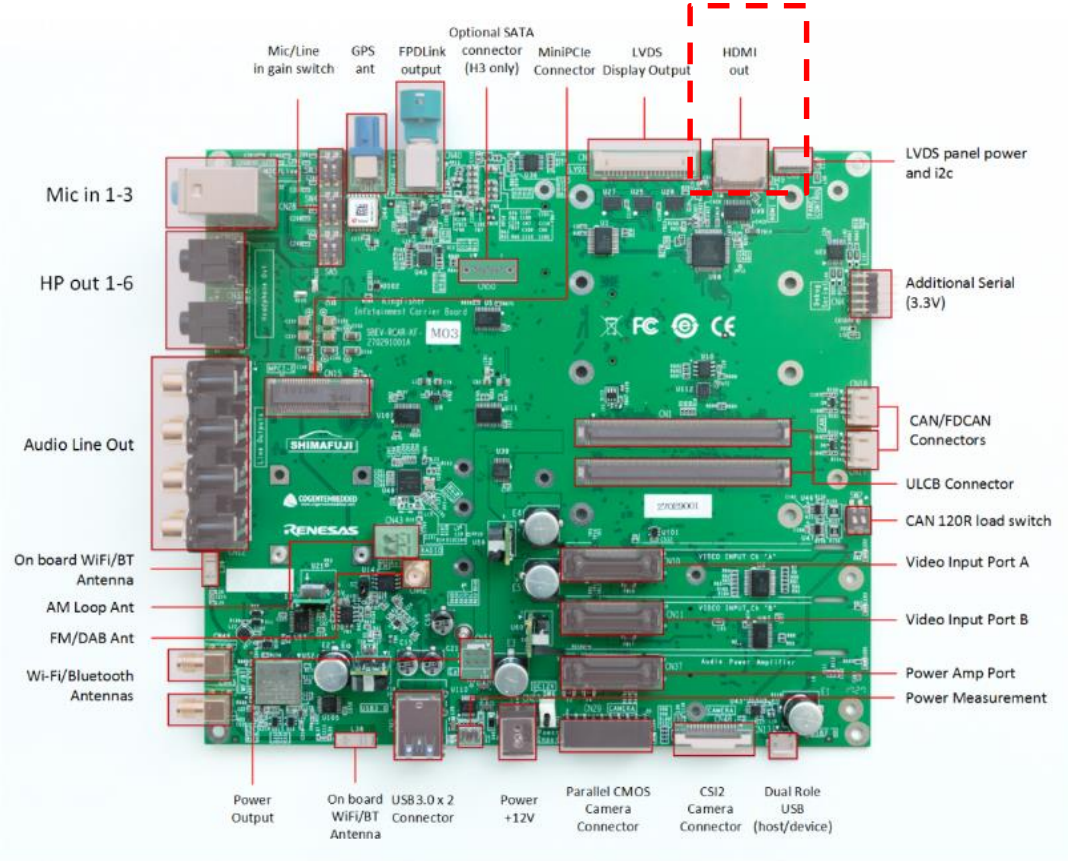
A detailed, high-contrast black and white photograph of an engine's internal components, including various pulleys, belts, and metal parts. A solid blue horizontal bar is overlaid across the top portion of the image, containing the title text in white.

HOW TO APPLY VIDEO AUTOMATION TEST

HOW TO APPLY VIDEO AUTOMATION TEST TARGET BOARD

- DO NOTHING

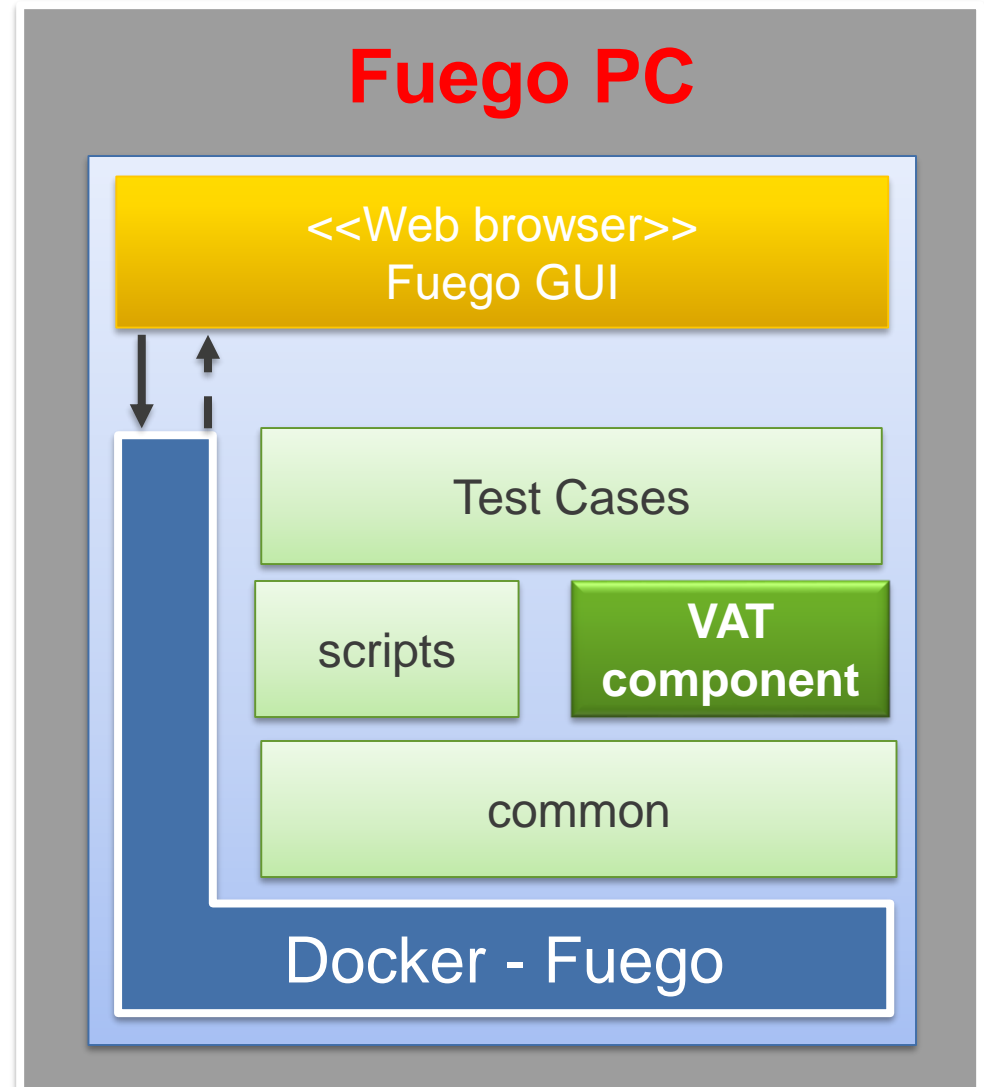
Video Out



HOW TO APPLY VIDEO AUTOMATION TEST

FUEGO PC

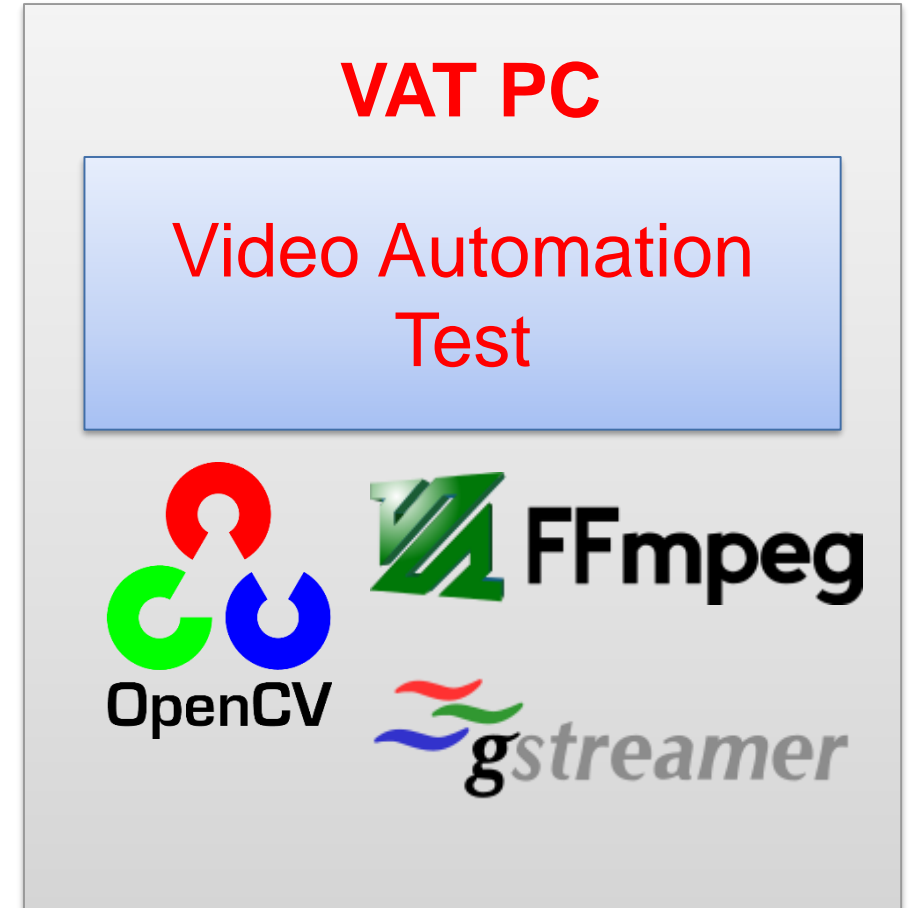
- Install **Fuego** on Ubuntu PC
- Install the **VAT component** to control Video Automation Test from Fuego side
- Compose video TCs



HOW TO APPLY VIDEO AUTOMATION TEST

VAT PC

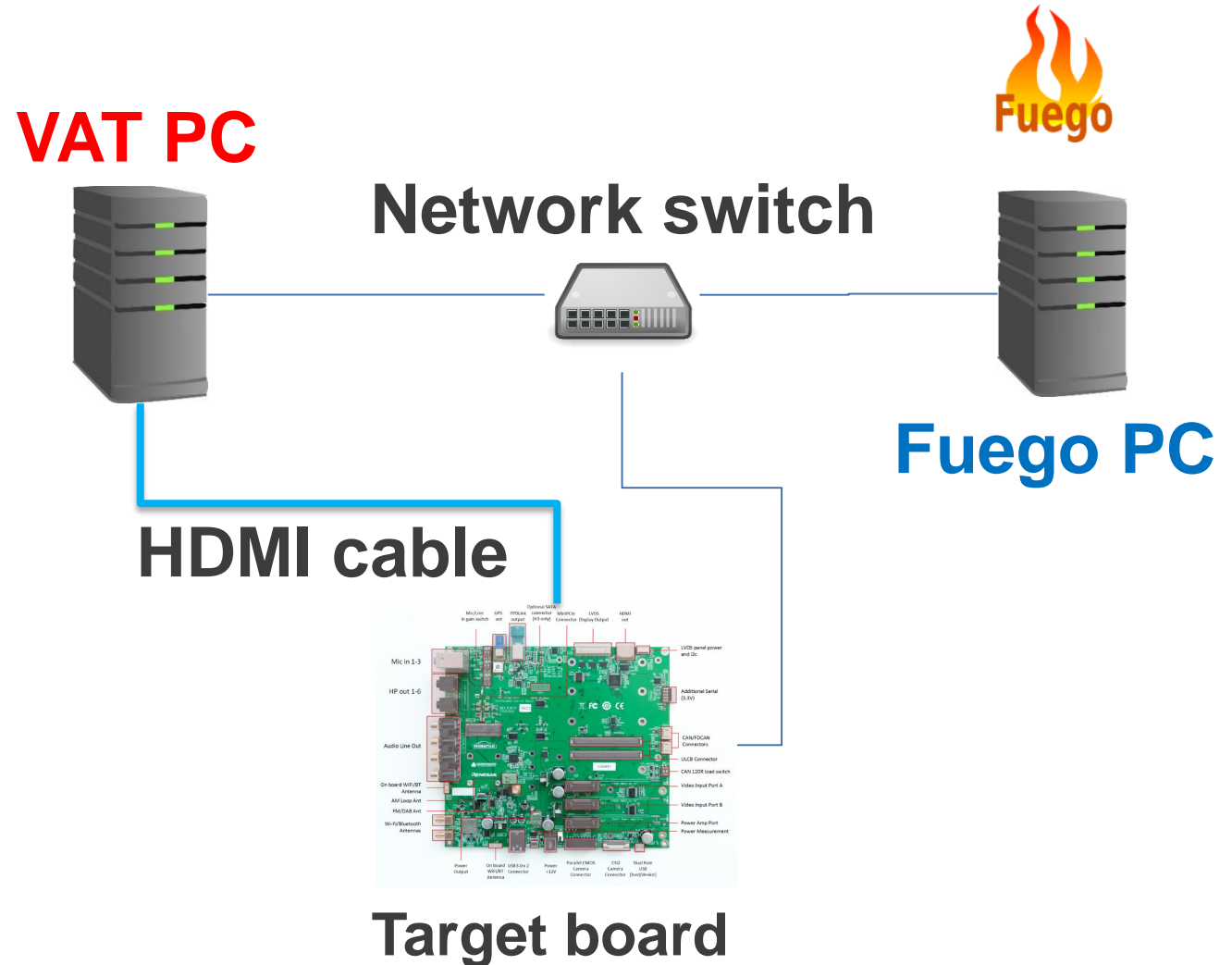
- Install the **Video Automation Test** on VAT PC
- Install Open Source Software: OpenCV, FFmpeg, Gstreamer



HOW TO APPLY VIDEO AUTOMATION TEST

HARDWARE CONNECTION

- Connect VAT PC, Fuego PC, target board to **same network**
- Connect **HDMI cable** from target board to VAT PC





THE FUTURE PLAN

CURRENT VIDEO AUTOMATION TEST STATUS

STRONG POINTS

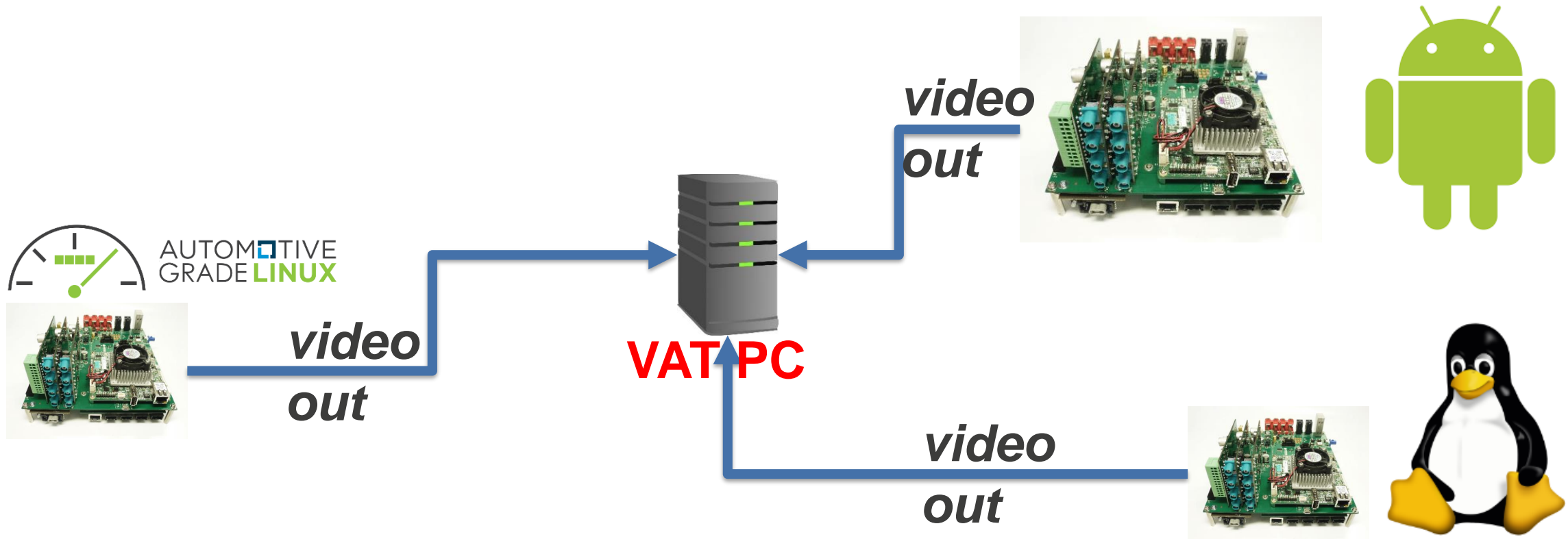
1. Thank to the **Fuego** - Automated test framework for the LTSI project.
2. Thank to the **Open Source Software** (E.g. FFmpeg, FFprope, OpenCV, ...)



CURRENT VIDEO AUTOMATION TEST STATUS

STRONG POINTS – CONT.

3. Independent on OSes/Open platform on target board



CURRENT VIDEO AUTOMATION TEST STATUS

STRONG POINTS – CONT.

4. Day and Night running

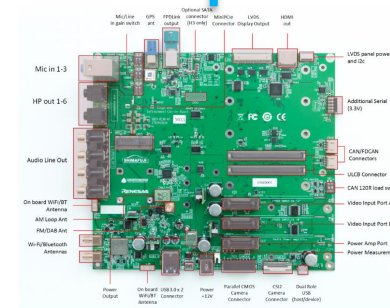
**24/7 service
for the test run
demand (*)**

VAT PC



Fuego PC

*video
out*



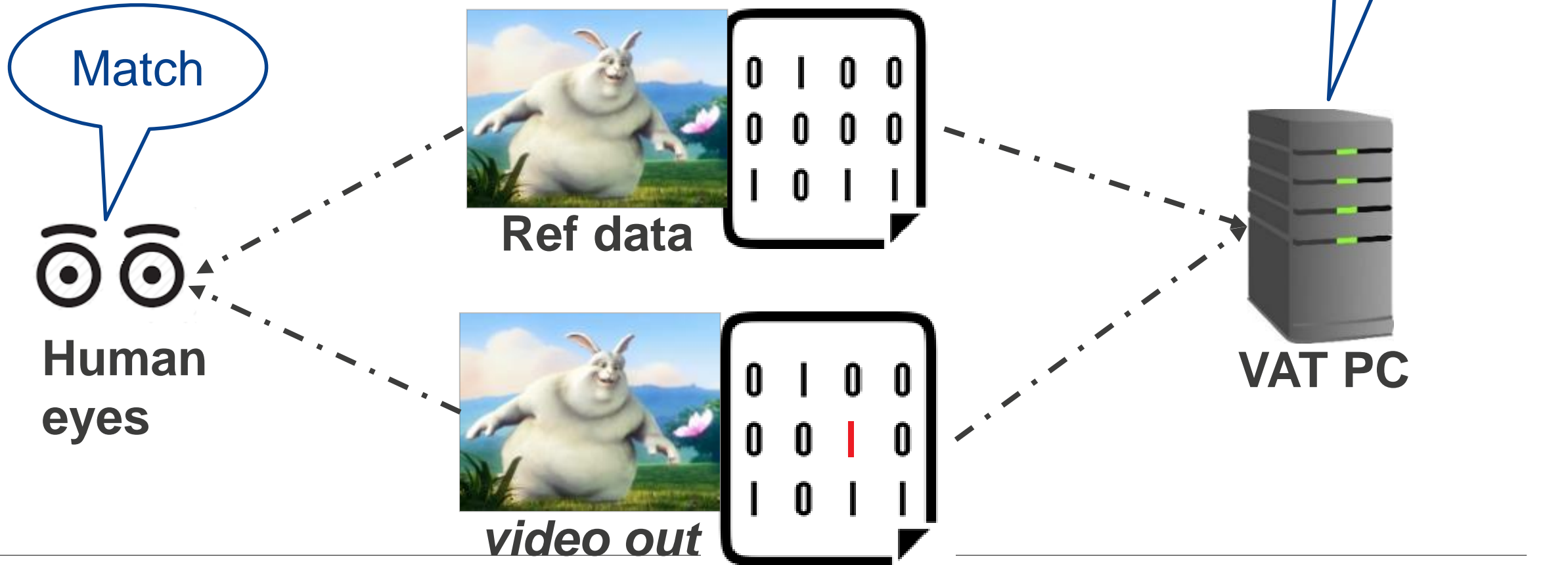
Target board

VAT supports Continuous Integration (CI) well

CURRENT VIDEO AUTOMATION TEST STATUS

NEED IMPROVEMENT POINTS

1. So **strictly** comparison since **NO** threshold in comparison



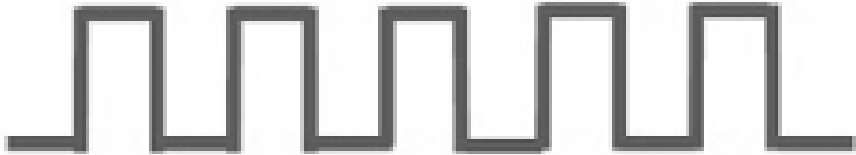
CURRENT VIDEO AUTOMATION TEST STATUS

NEED IMPROVEMENT POINTS

2. Video signal



Analog Signal



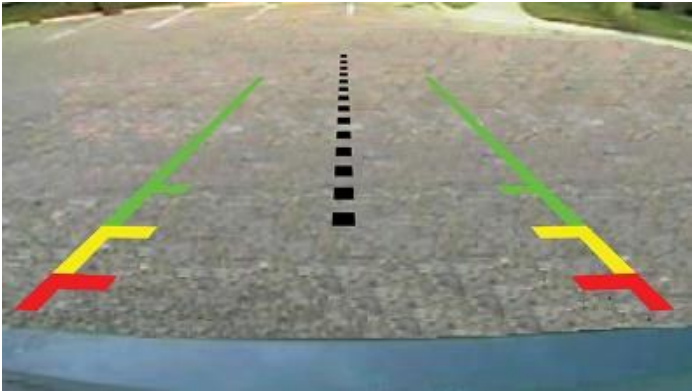
Digital Signal



CURRENT VIDEO AUTOMATION TEST STATUS

NEED IMPROVEMENT POINTS

3. Automation test video/movie playback only.



*video
in*



*video
out*



THE FUTURE PLAN

ACTION ITEMS

1. Support threshold



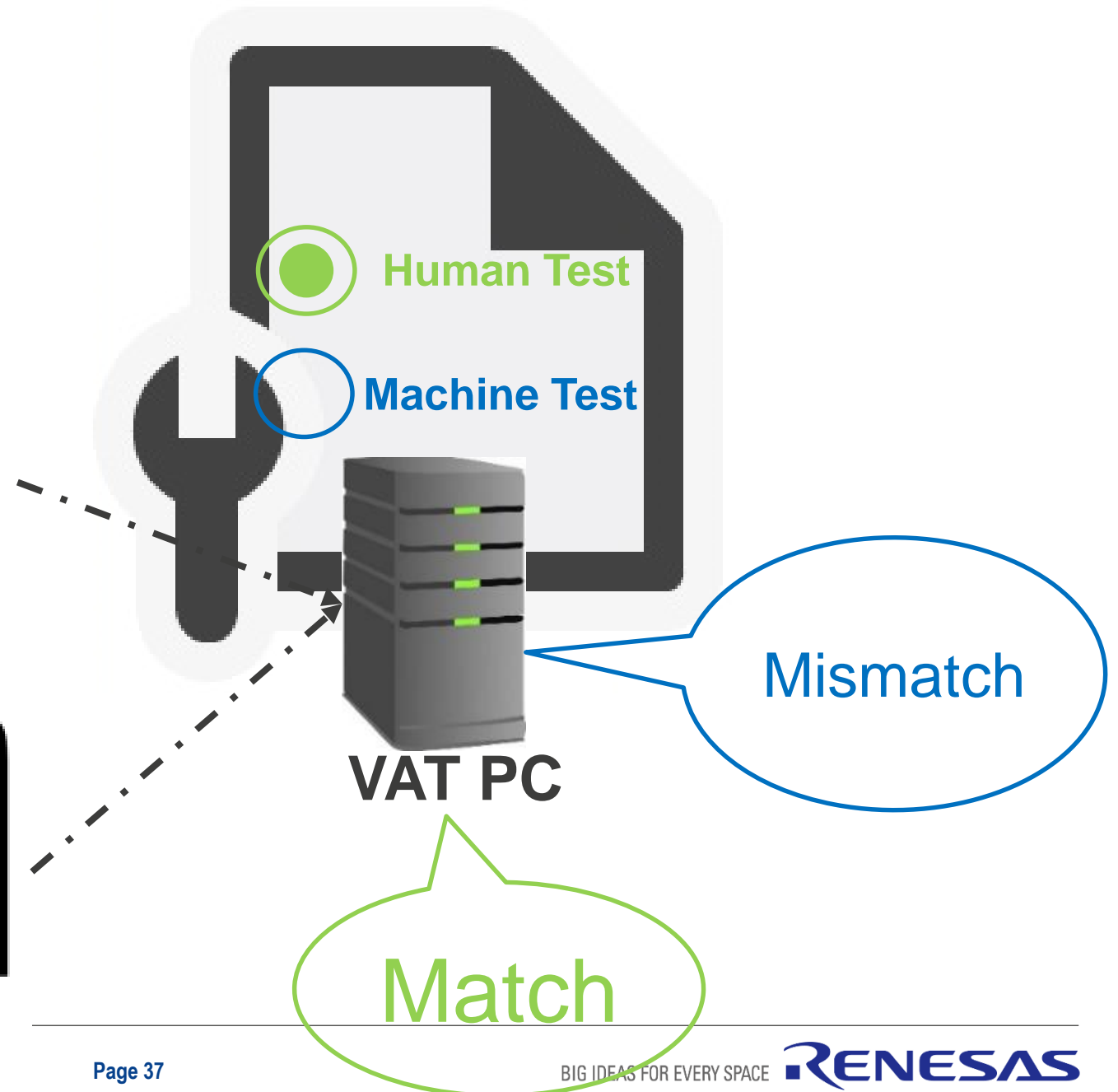
Ref data

0	1	0	0
0	0	0	0
1	0	1	1



video out

0	1	0	0
0	0	1	0
1	0	1	1



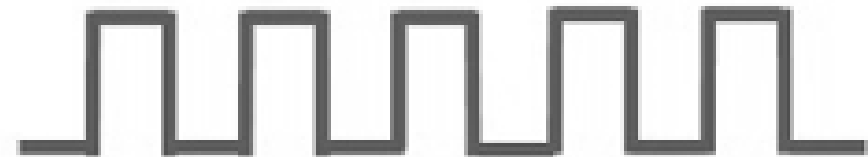
THE FUTURE PLAN

ACTION ITEMS

2. **Support** more Video signal types: Digital, **Analog**



Analog Signal



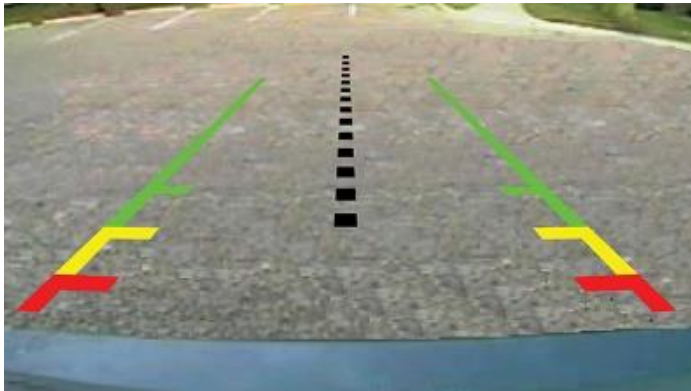
Digital Signal



THE FUTURE PLAN

ACTION ITEMS

3. Support Automation test video/movie playback and Record Video



➔
*video
in*



➔
*video
out*



THE FUTURE PLAN

ACTION ITEMS

- Summary improvement plan

No	Item	Current Support	Future Support
1	Comparison method	Threshold: NO	Threshold : YES
2	Video signal type	Digital : YES Analog : NO	Digital : YES Analog : YES
3	Use-cases	Video playback: YES Record Video: NO	Video playback: YES Record Video: YES

DEMONSTRATION

CONCLUSION



CONCLUSION

- By combination between the Fuego and the Open Source Software, it could make a Video Automation Test solution to replace the Human role by the Machine role



Video
Automation Test

- Thanks to the Video automation test, it could reduce the testing workload and get the reliable results

Q&A

THE END

THANK YOU VERY MUCH!



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APENDIX-FUEGO

❖ What is Fuego?

- **Fuego** is a **test framework** specifically designed for **embedded Linux testing**. It supports automated testing of embedded targets from a host system, as it's primary method of test execution.
- Fuego consists of a host/target script engine, with a Jenkins front-end, and over many pre-packaged tests, installed in a **Docker** container.
- **Tim Bird** (an enthusiasm Sony developer) gave a talk introducing Fuego, at *Embedded Linux Conference in April 2016*, and *Linux Conf Japan 2016*

Fuego = (Jenkins + abstraction scripts + pre-packed tests) inside a container

