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SMART PORTABLE LASER TRIANGULATION SYSTEM FOR ASSESSING GAP AND FLUSH IN CAR BODY ASSEMBLY LINE

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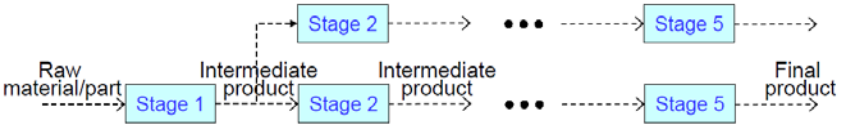
GO0D MAN (aGent Oriented Zero Defect Multi-stage mANufacturing)

- The GO0D MAN project (FOF-03-2016 - GA 723764) aims to **integrate** and combine **process and quality control** for a multi – stage manufacturing production into a **distributed system architecture** built on **agent-based Cyber-Physical Systems (CPS)** and **smart measuring systems** so to target the Zero-defect production.



- GO0D MAN supports the **real-time data collection** and defect diagnosis at **single process level**, as well as the inter-stage sharing and processing of information at **global level** using **data mining techniques**.

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GO0DMAN
AGENT ORIENTED ZERO DEFECT MULTI-STAGE MANUFACTURING

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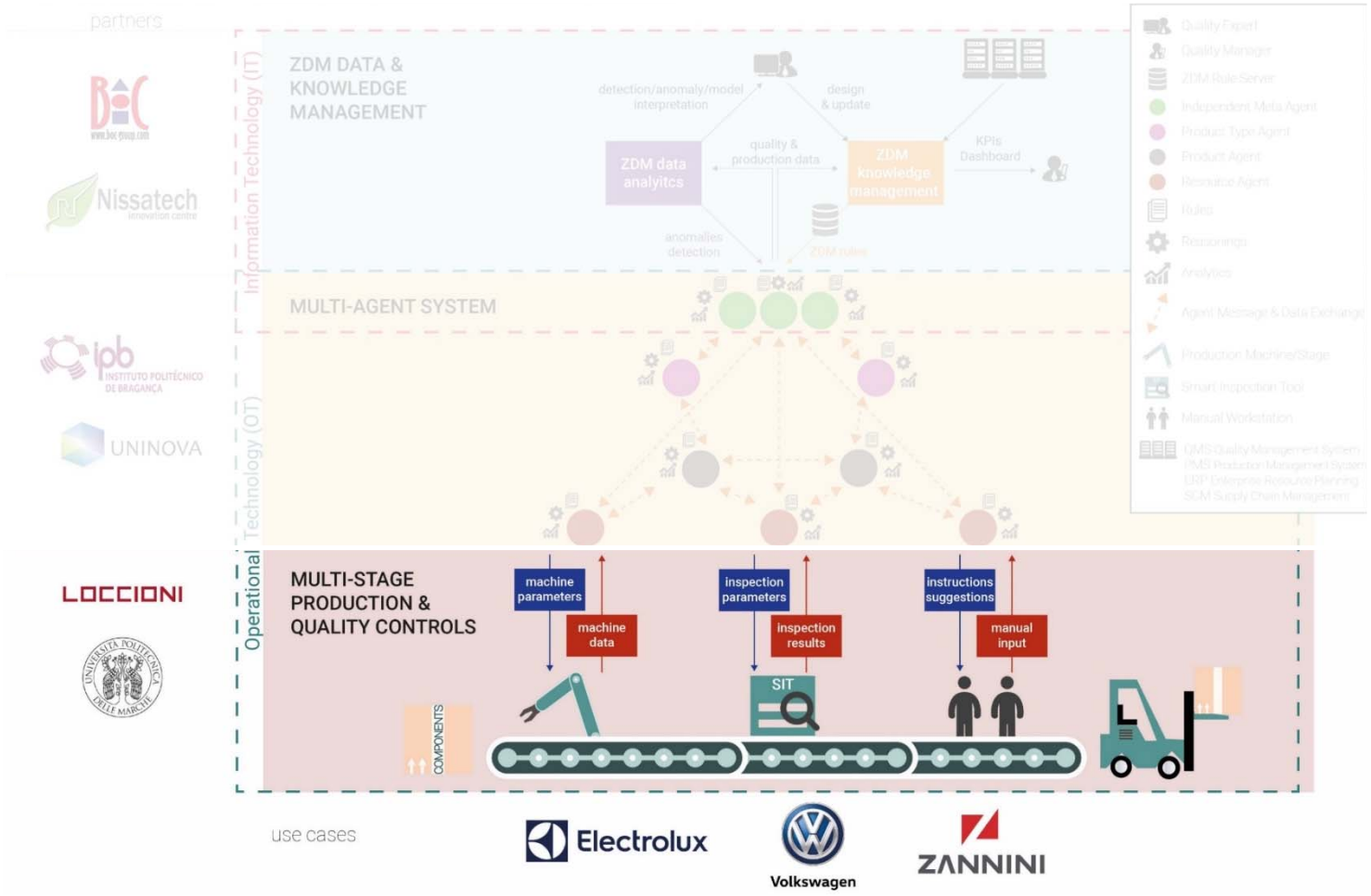
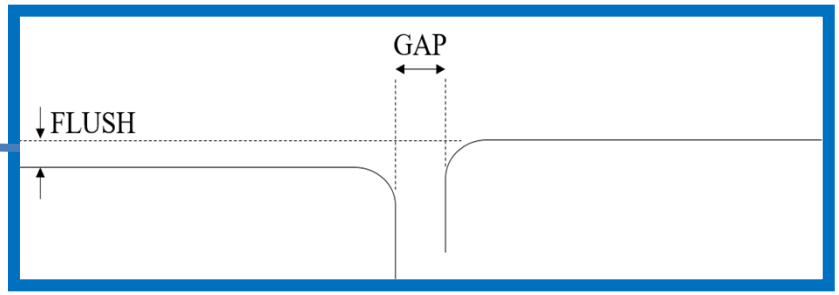


Outlook

- Target Sample and Measurement System requirements
- Smart Portable Laser Triangulation system:
  - Hardware characteristics
  - Software characteristics
  - Results
- Conclusions

Target Sample and Measurement Systems Requirements

	VWAE
Industrial Sector	Automotive: OEM
Production rates (per line)	Serial production: more than 625 vehicles per day. Cars are individually tracked on-line.
Production Process	Multi stage manual and semi-automatic assembly.



"HOW GAP AND FLUSH ARE CURRENTLY MEASURED?"

• **Manually** by operators, who exploit feeler gauges and dial gauges

Main issues:
- *No automatic data storage*
- *0.5 mm resolution (feeler gauge)*

- **"Gap" :** space between two opposite surfaces, measured along the tangent plane on the surfaces in exam
- **"Flush"** : mismatch between two surfaces, distance between the surfaces measured in the orthogonal direction to the tangent plane on the surfaces in exam

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GOODMAN AGENT ORIENTED ZERO DEFECT MULTI-STAGE MANUFACTURING

Target Sample and Measurement Systems Requirements

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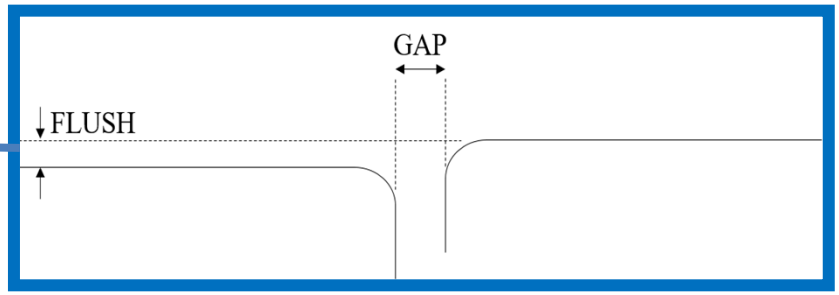

"HOW GAP AND FLUSH ARE CURRENTLY MEASURED?"

• **Automatically**, in dedicated measurement areas, exploiting non-contact methods based on optical triangulation

Main issues:

-Not always measure on all surfaces (i.e. rearlight, glass)

-Not always manage operator operations

- **"Gap" :** space between two opposite surfaces, measured along the tangent plane on the surfaces in exam
- **"Flush"** : mismatch between two surfaces, distance between the surfaces measured in the orthogonal direction to the tangent plane on the surfaces in exam

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Smartphone-based Gap&Flush Measurement System

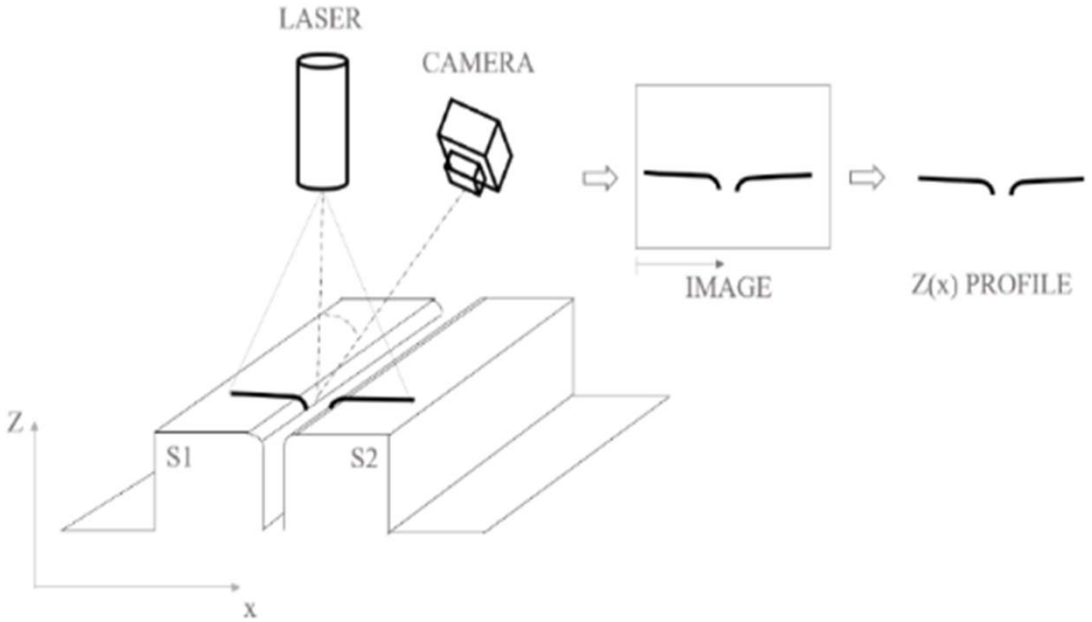
AUTOMOTIVE INDUSTRY:

possibility to work on very different surfaces of very different materials behaving differently from an optical point of view

ASPECTS TO CONSIDER:

Surface diffusivity

Light absorption



OPTICAL CHARACTERISTICS

-Laser triangulation system with a 405 nm laser wavelength

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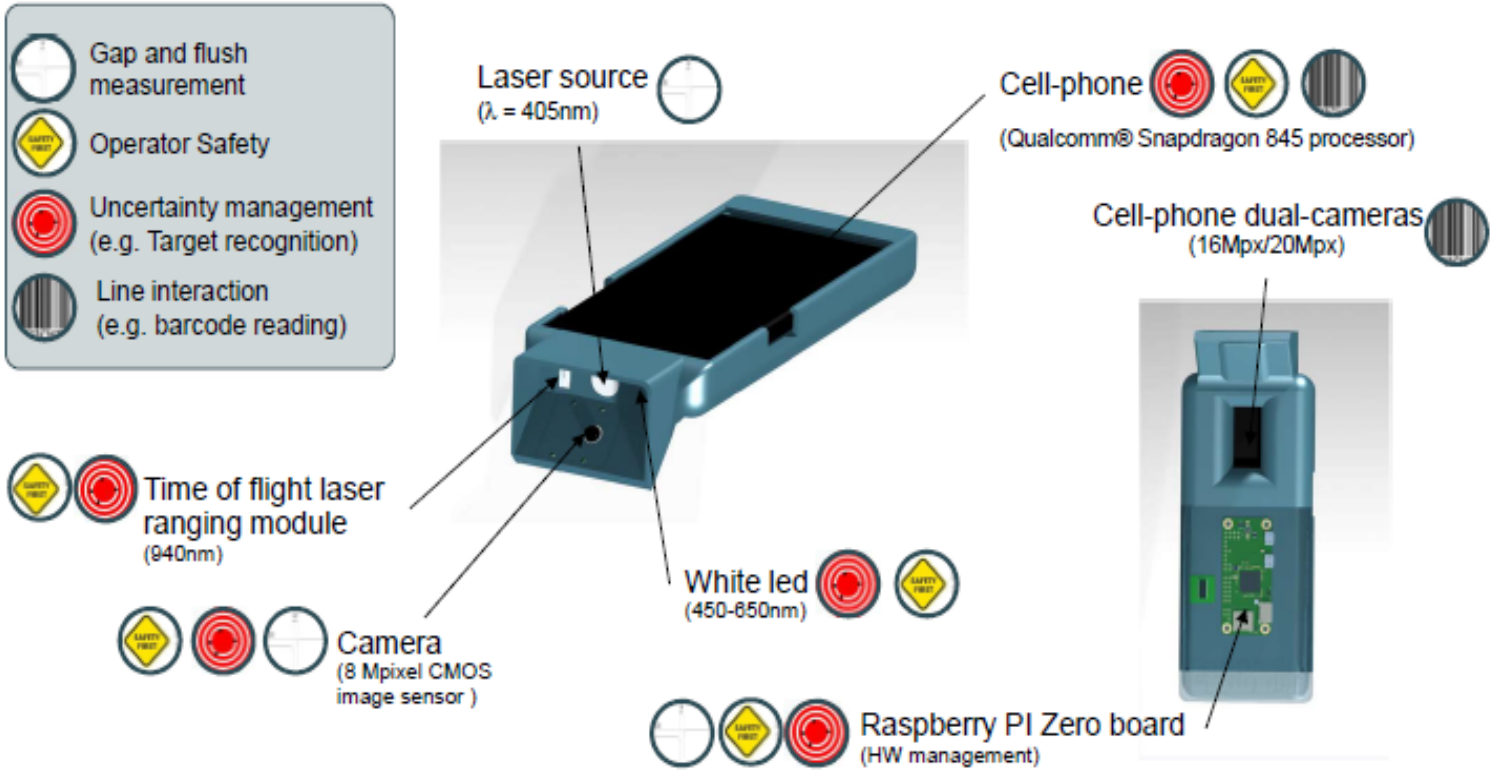
Smartphone-based Gap&Flush Measurement System

HARDWARE CHARACTERISTICS



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Smartphone-based Gap&Flush Measurement System

SOFTWARE CHARACTERISTICS

The software managing the whole device operates on four levels:

1. Interaction with the **operator**;

   INTERACTIVE HMI

   AUTOMATED RECOGNITION OF MEASUREMENT AREA

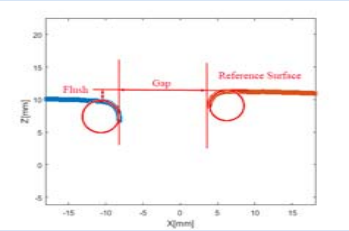
   - Conditional switch on/off of laser source (higher safety for the operator)
   - Exposure time adjustment based on target recognition

2. Interaction with the **production line**

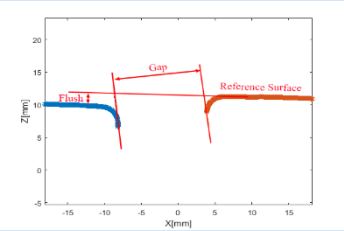
   BARCODE READER

   FEEDBACK TO THE OPERATOR ON GAP&FLUSH RESULTS

3. **Processing** of the image acquired and **extraction** of gap&flush data;



"FITTING" ALGORITHM



FEELER GAUGE/DIAL GAUGE ALGORITHM

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Smartphone-based Gap&Flush Measurement System

SOFTWARE CHARACTERISTICS

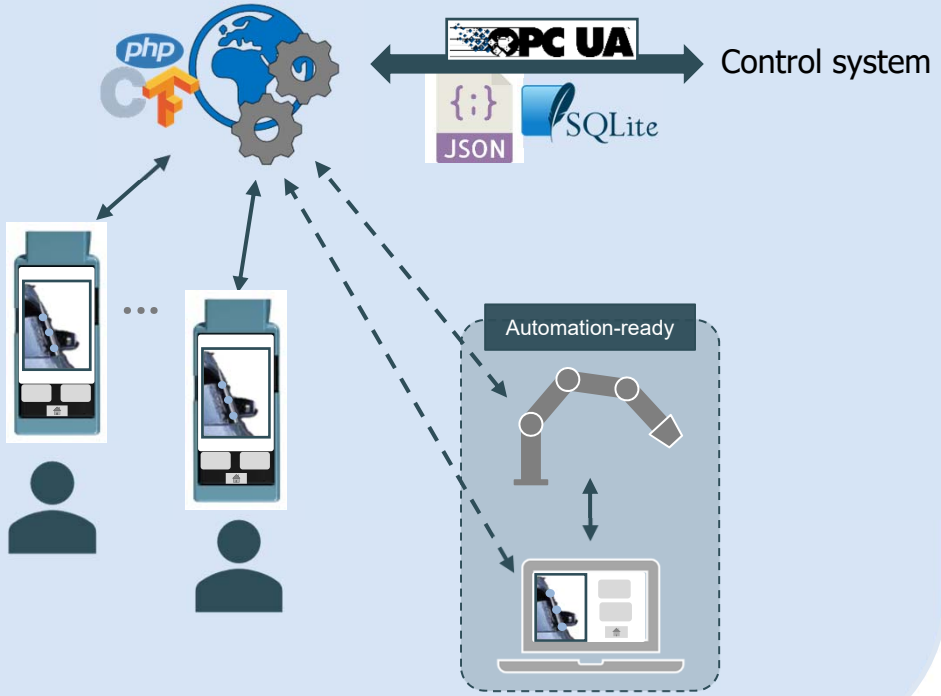
4. **Communication** with the plant middleware.

MULTI-AGENT SYSTEM ARCHITECTURE

OPC-UA PROTOCOL COMMUNICATION

SYNCRONOUS CONFIGURATION OF ALL DEVICES VIA REST SERVICE

LOCAL/GLOBAL STORAGE OF DATA USING SQL DATABASE ENGINE



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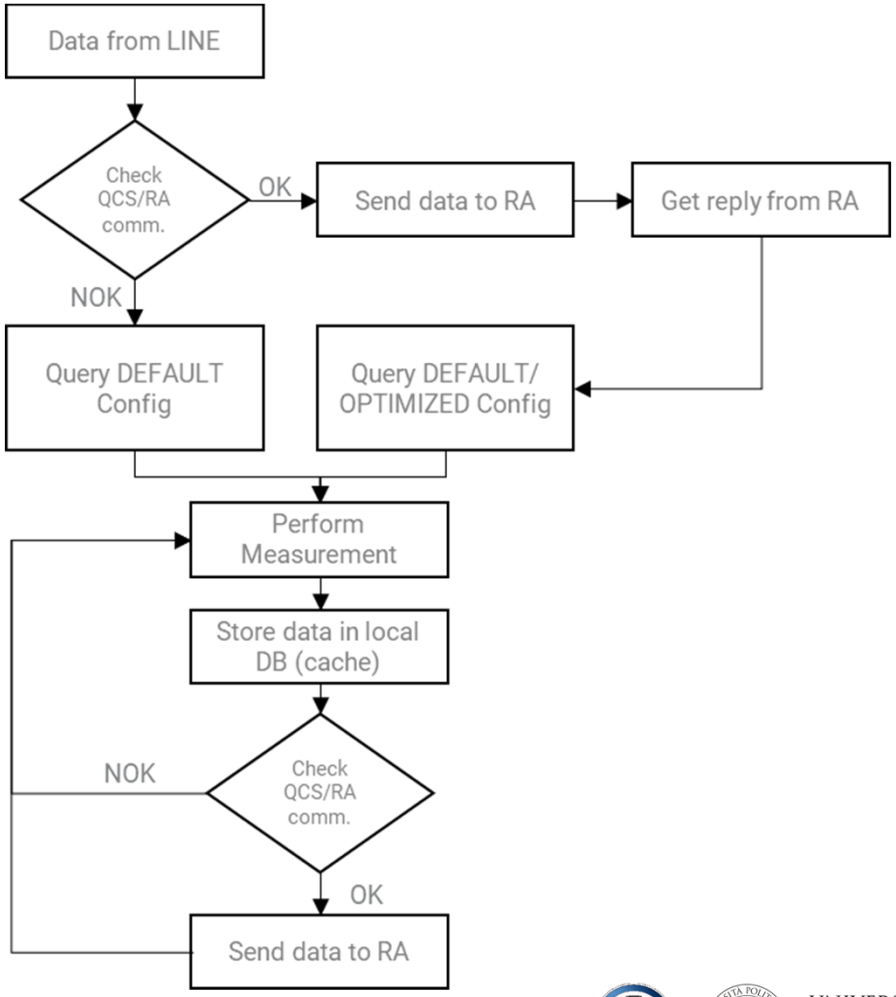
Measurement Procedure



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Smart features

1. Measure on very different surfaces

(**tailgate, rear glass, chromed components** and **rear headlights**)

2. Device **portability**

-Conditioned Switching ON/OFF of laser light (distance sensor, face recognition)

-Ergonomicity

-Hybrid Contact/Non-Contact operations

*-Measurement Point Recognition (*Feedback to the operator, adapt camera Exposure time)

-Car barcode reader

3. Other features

-**Cell-phone** based plug-in design

-**Wifi**-based data communication

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RESULTS

GAP Uncertainty budget analysis (GUM type A)

Number of acquisitions	42
Standard uncertainty u_G3F	0,19 mm
Standard uncertainty of reference u_pins	0,003 mm
Combined uncertanty u_combined_G3F	0,19 mm
Expanded uncertanty U_G3F (95% confidence level)	**0,38 mm**

Reference pins resolution: 0,01 mm

FLUSH Uncertainty budget analysis (GUM type A)

Number of acquisitions	42
Standard uncertainty u_G3F	0,16 mm
Standard uncertainty of reference u_dial gauge	0,003 mm
Combined uncertanty u_combined_G3F	0,16 mm
Expanded uncertanty U_G3F (95% confidence level)	**0,33 mm**

Reference dial gauge resolution: 0,01 mm

CONCLUSIONS

1. A smartphone-based measurement device exploiting laser triangulation to assess gap and flush in the production line of car assembly has been presented
2. A series of sensors have been embedded in the device to guarantee reliability of the measurement
3. The optimized laser wavelength makes it possible to perform measurements on multi-material behaving differently from an optical point of view (reflective, translucent, transparent parts)
4. Safety for the operator is ensured by the conditional switch on/off the laser source in accordance to a series of events (e.g. stand-off distance compliant to requirements)
5. Compliance to Industry 4.0 requirements is guaranteed by the use of OPC-UA communication protocol.

CONTACTS

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