

# **Fluorescent Mark Technology for DPM Applications Data Matrix Mark Protection & Authentication**

Presented by  
2D Technology Group, Inc.  
Constellation 3D Vostok, Ltd.

## **Today's Agenda**

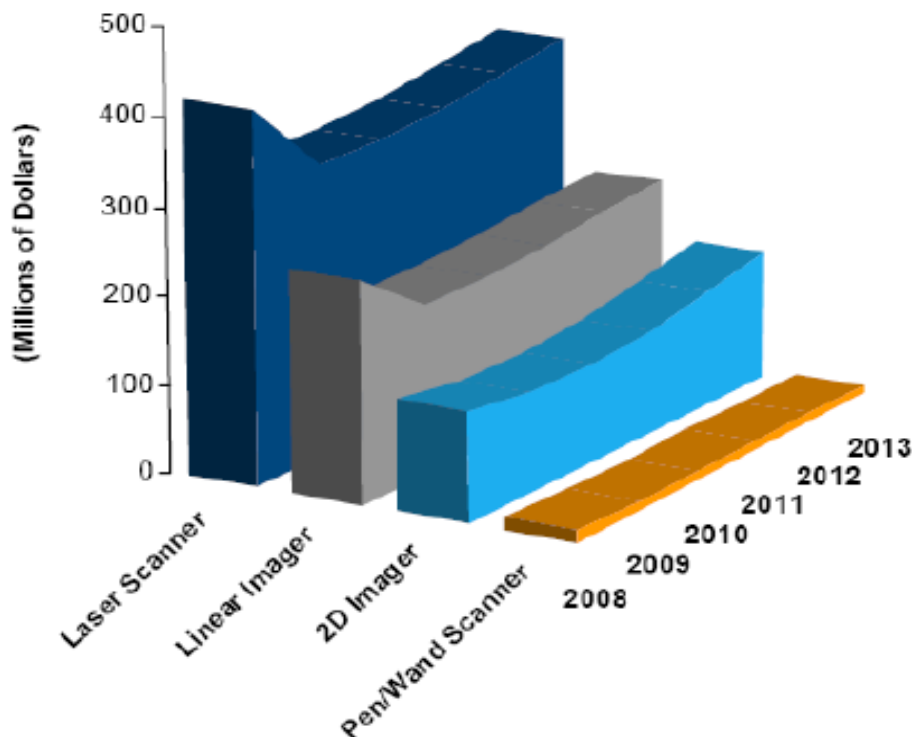
- Macro economic trends impacting the future of barcode industry
- Combined/Fluorescent DPM Reader
- Data Matrix Protection & Authentication
- Case Study

# **Trends impacting the future of barcode industry**

- **Increased Global Demand and Manufacturing**
  - Further development of standards and solutions
  - Deeper integration (Enterprise, Value Chains)
  - Global expansion into core and emerging markets
- **Enhanced Security**
  - Value chains, pedigrees, and chain-of-custody
  - Gathering, securing, sharing, routing, and leveraging of business intelligence
- **Increased Mobility**
  - Broader deployment: emphasis on convergence with a wider range of enterprise and mission critical systems and consumers

## Macro economic trends: 2D Imagers

**Global Handheld Scanner  
Revenues by Product Type**  
2008 = \$810.3 Million

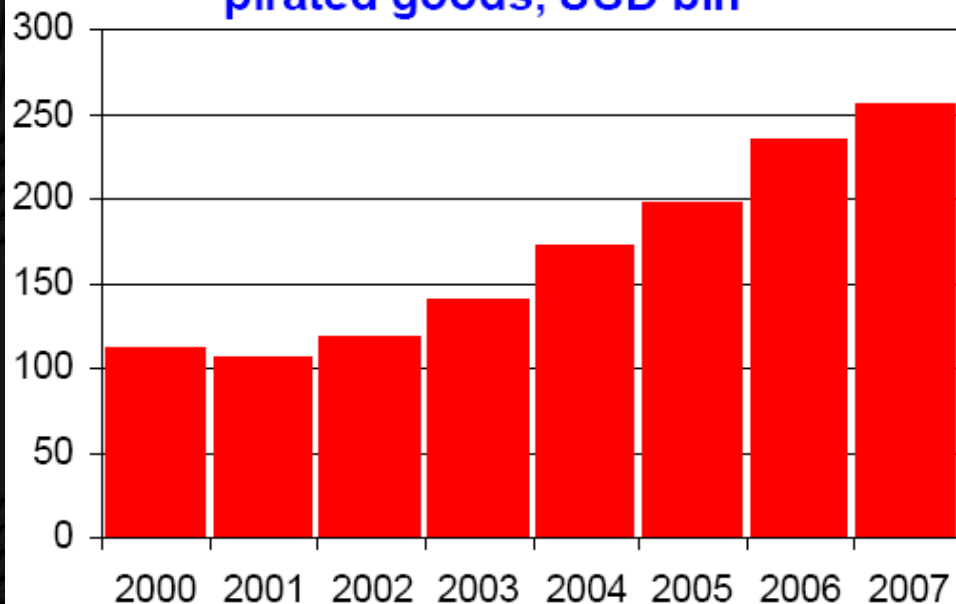


- Enterprises are increasingly required to place more information on each label.
- 2D Imagers will remain the fastest growing segment.
- DPM is becoming the standard commercial business practice.

Source: VDC Research, Handheld Scanners, Supply Side Analysis: The 2009 AIDC Business Planning Service

## Enhanced Security: Protection From Counterfeiting

International trade in counterfeit and  
pirated goods, USD bln

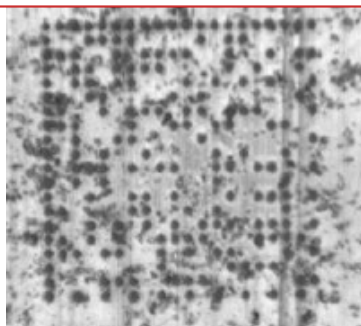


Source: OECD

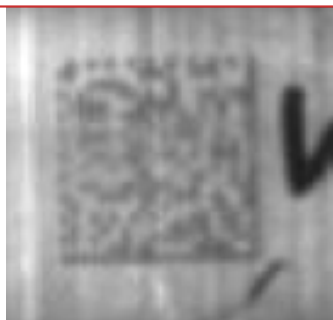
- 2007 – 1.95% of global trade was of counterfeit and pirated products
- Problem most serious in:
  - Defense industry
  - Aerospace industry
  - Automotive industry
  - Pharmaceutical industry
  - Consumer goods

## Technological Challenges: DPM Applications & Security Attributes

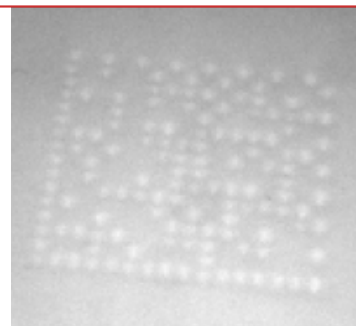
- The influence of substrate surface on symbol image quality / decodability remains the major challenge of the DPM Technology.



Noisy Background



Faded / Poor Focus



Low Contrast



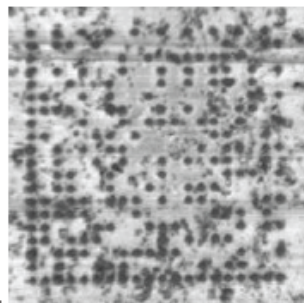
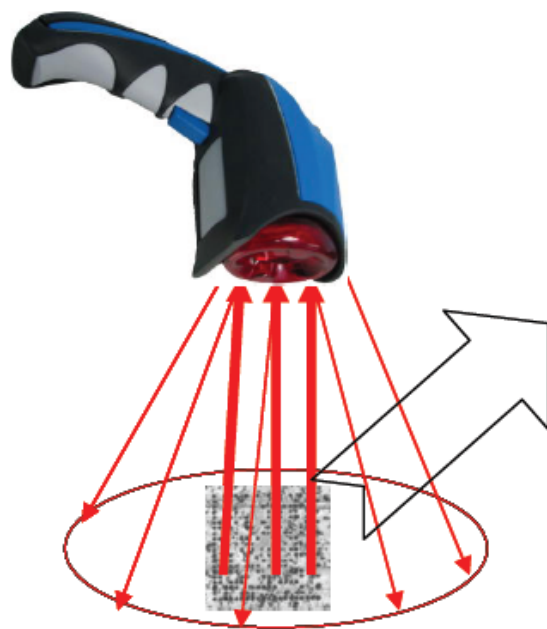
Uneven Lighting

- Barcodes were designed to be information symbols only
  - No protection features
  - Easy target for counterfeiters

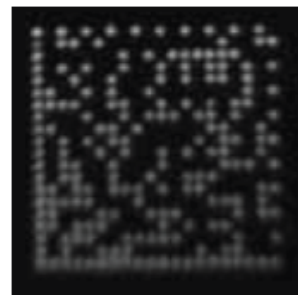
## DPM Reading – Solution Concept

- Remains a challenge because of “reflective scheme” of collecting symbol data.
- Precise control of the DPM mark illumination demonstrated improvement, but the problem remained.
- We have replaced “reflective scheme” with Fluorescent Technology:
  - Applied fluorescent material on DPM modules
  - Illuminated DPM mark with “fluorescence exciting” light
  - DPM elements change color of the illumination light
  - Camera with color filter captures only the light from fluorescent DPM elements

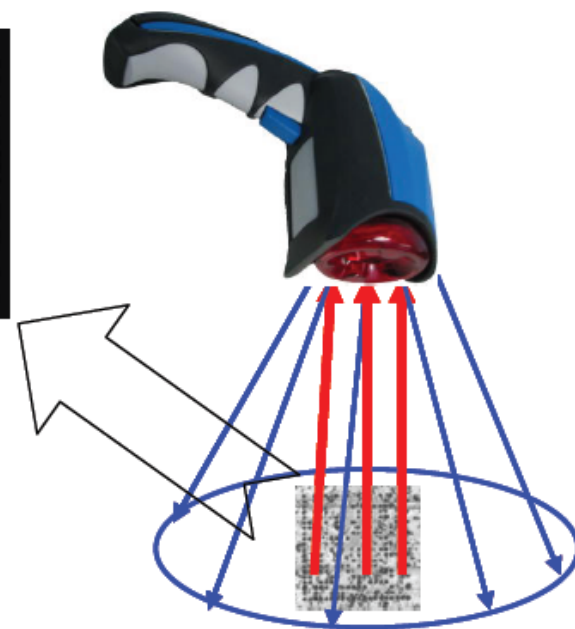




**Reflective  
Technology**



**Fluorescent  
Technology**





## **Implementation Steps of Combined DPM Reading**

1. Development of “conventional” (“reflective lighting”) DPM Reader
2. Development of fluorescent material suitable for DPM applications
3. Testing fluorescent material
4. Development of fluorescent mark application methods
5. Development of “Fluorescent Reader” integrated with the previously developed “traditional” one.
6. Testing Combined DPM Reader capable of “reading” all kinds of DPM marks

# Conventional (“Reflective Lighting”) DPM Reader

## Hardware features:

- dual-mode illumination
- high resolution (1.4 MPX) matrix
- optics for “deep” depth of field
- DM6435 microprocessor



### Image

**Sensor** 1440 x 1080 high-resolution pixel array

### Lighting/Optics

**Illumination** software controlled; bright & dark field illumination at 617 nm

**Focal Point** approximately 60 mm (2.36 in)

**Field of View** 20x20 mm at 0 mm target distance  
70x70 mm at 150 mm target distance

**Aiming** ranging optics over 2 LED's at 620 nm

### Memory

**DDR2 Memory** 64 Megabytes

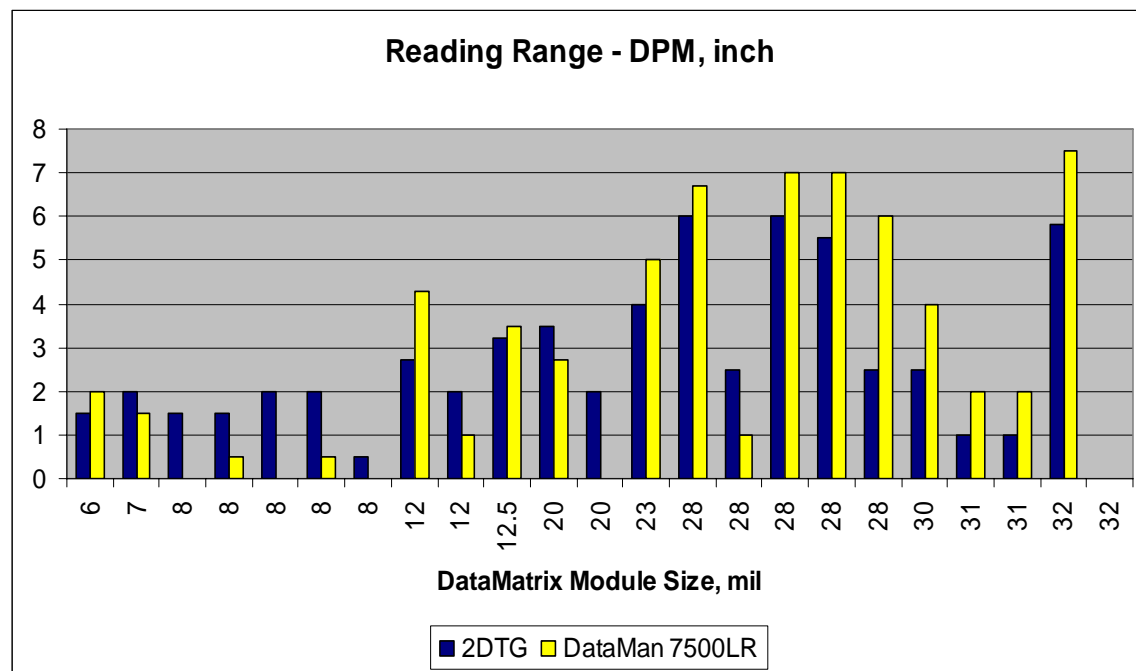
**Flash Memory** 16 Megabytes

## “Conventional” DPM Reader – Calibration Tests

- DataMan7500LR vs. 2DTG Reader.

2DTG reader:

- Better for small symbols (up to 10 mil)
- Similar for mid-size marks (10-20 mil)
- Slightly inferior for bigger marks (greater than 20 mil)



## Fluorescent Materials For DPM Applications

- Evenly dispersed luminophore materials were chosen
- Needed to satisfy two basic “design” requirements:
  - “Transparent” for ~600nm emission light
  - Exciting light wavelength in a visible part of spectrum
- Materials should last as long as the DPM mark itself
- Objective was to develop the material to satisfy following requirements:
  - The highest adhesion to the host surface
  - The highest thermostability
  - The highest photostability
  - The highest resistance to the aggressive medium
- More than 200 compounds have been tested

## **Fluorescent Material Tests**

<b>Test Parameters</b>	<b>Standard Number</b>	<b>Standard Title</b>
<b>Adhesion</b>	ASTM D 3359-02	Standard Test Methods for Measuring Adhesion by Tape Test
<b>Thermostability</b>	ASTM D 2485-91	Standard Test Methods for Evaluating Coatings For High Temperature Service
<b>Photostability</b>	ASTM G154 – 06	Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials
<b>Resistance to aggressive medium</b>	ASTM D1308-02	Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes
<b>Moisture resistance</b>	ASTM D 870-02	Standard Practice for Testing Water Resistance of Coatings Using Water Immersion

*All tests were performed in accordance with the appropriate ASTM standards*

## Fluorescent Material Test Results

- **Adhesion** – expected life under the “normal” operating conditions - 20 years
- **Photostability** – expected life under the “normal” solar radiation conditions - 20 years
- **Thermostability** – expected life under the temperature conditions below 100°C (212°F) - 20 years
- **Resistance to the rapid temperature-change** – up to 145°C (293°F)
- **Resistance to aggressive medium** (acetone\*, gasoline, machine oil, boiling water) – expected life 20 years
- Provides **additional wear protection** for DPM mark

\* for the photostabilized materials only

## Fluorescent Material Application Technologies







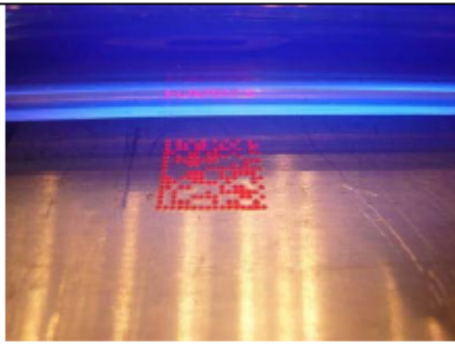
- Described in detail in the Patent Application No. RF2009139034 “Fluorescent Information Mark and Methods of its Application” by C3DV
- Application procedure for Dot Peen mark that was used in this study:
  - **Step 1:** Self-adhesive tape attached where the mark will be
  - **Step 2:** Dot Peen mark is planted “through” the tape
  - **Step 3:** Fluorescent polymeric compound is applied
  - **Step 4:** Tape is removed from the surface



*The above procedure for Dot Peen Mark “fluorescent modification” takes ~ 40 sec.*



# Fluorescent Compound Application Procedure

<u>STEP 1</u>	<u>STEP 2</u>	<u>STEP 3</u>	<u>STEP 4</u>
			
Application gears	Making Dot Peen Mark	Dot Peen mark as seen in UV-light	
			

## Combined / Fluorescent DPM Reader

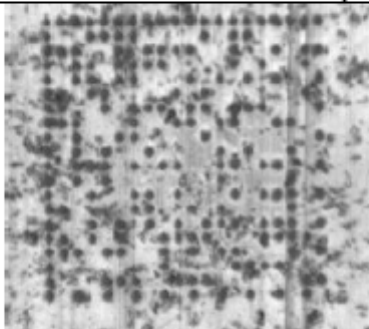

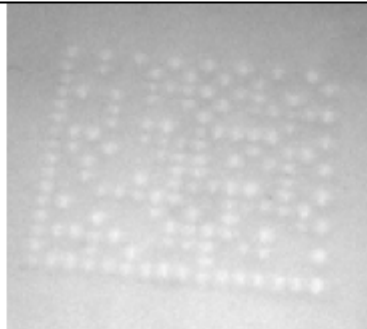
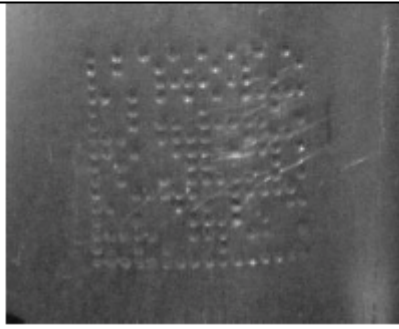


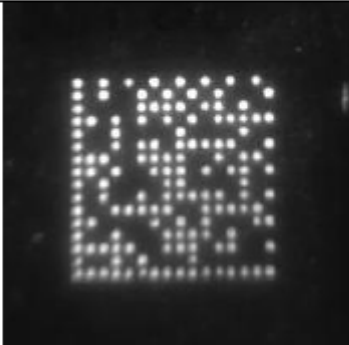
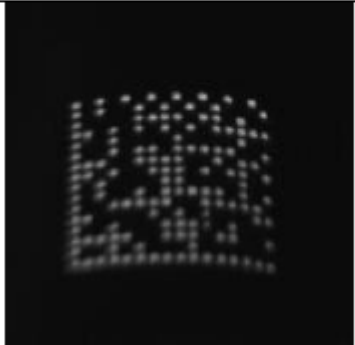
Developed by upgrading the conventional Reader platform.  
Upgrade includes:



- Additional illumination “ring” with 6 “Blue” LEDs (470 nm) for initiating fluorescent emission light (~610nm)
- “Exit channels” for “blue” light in the exit window
- “Narrow red” filter ~600nm
- Control software allowing to automatically adjust operational mode (fluorescent or conventional)

## Combined DPM Reader Tests – Image Direct Comparison

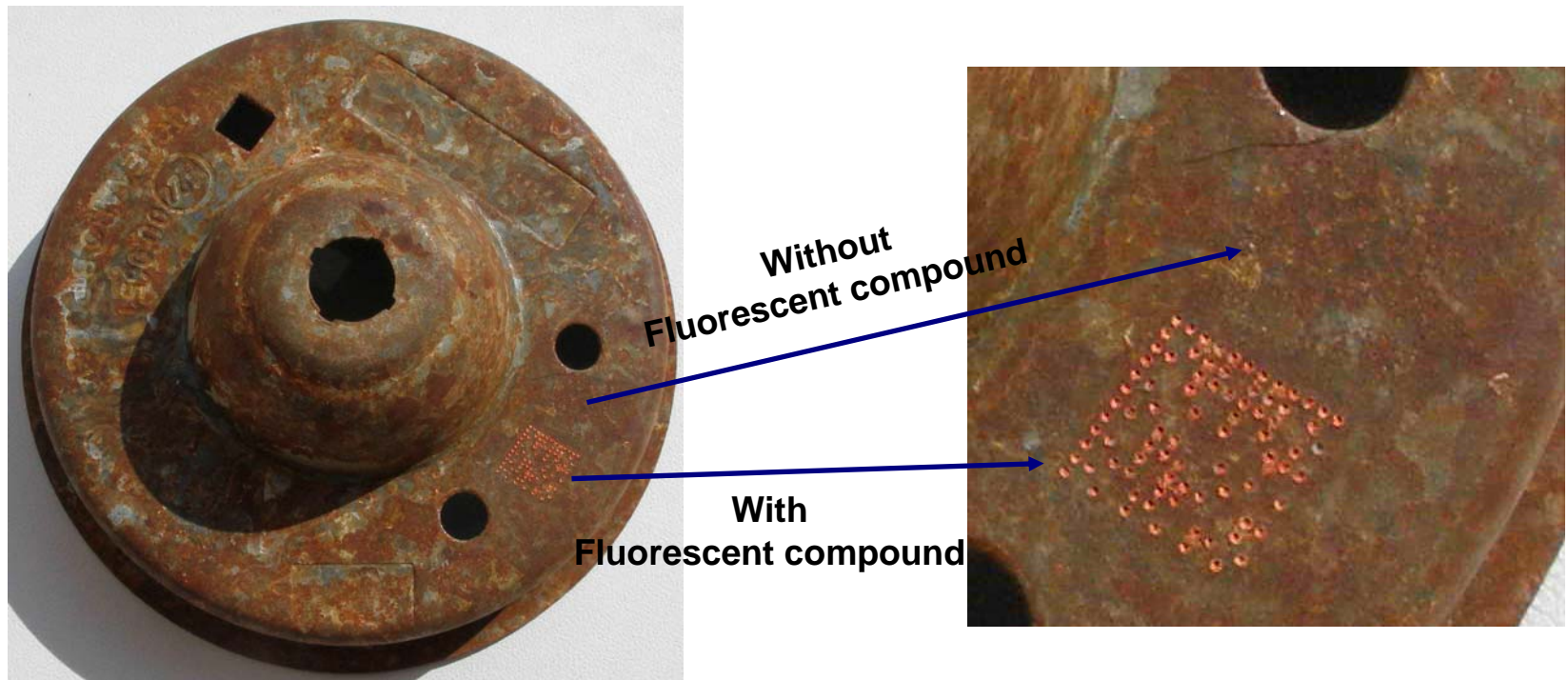
Direct comparison of images captured by combined Reader in conventional and fluorescent modes

	Noisy Background (Duralumin – distressed surface)	Faded / Poor Focus (Duralumin – scratched surface)	Low Contrast (Teflon)	Rounded surface (Copper)
Conventional				
Fluorescent				



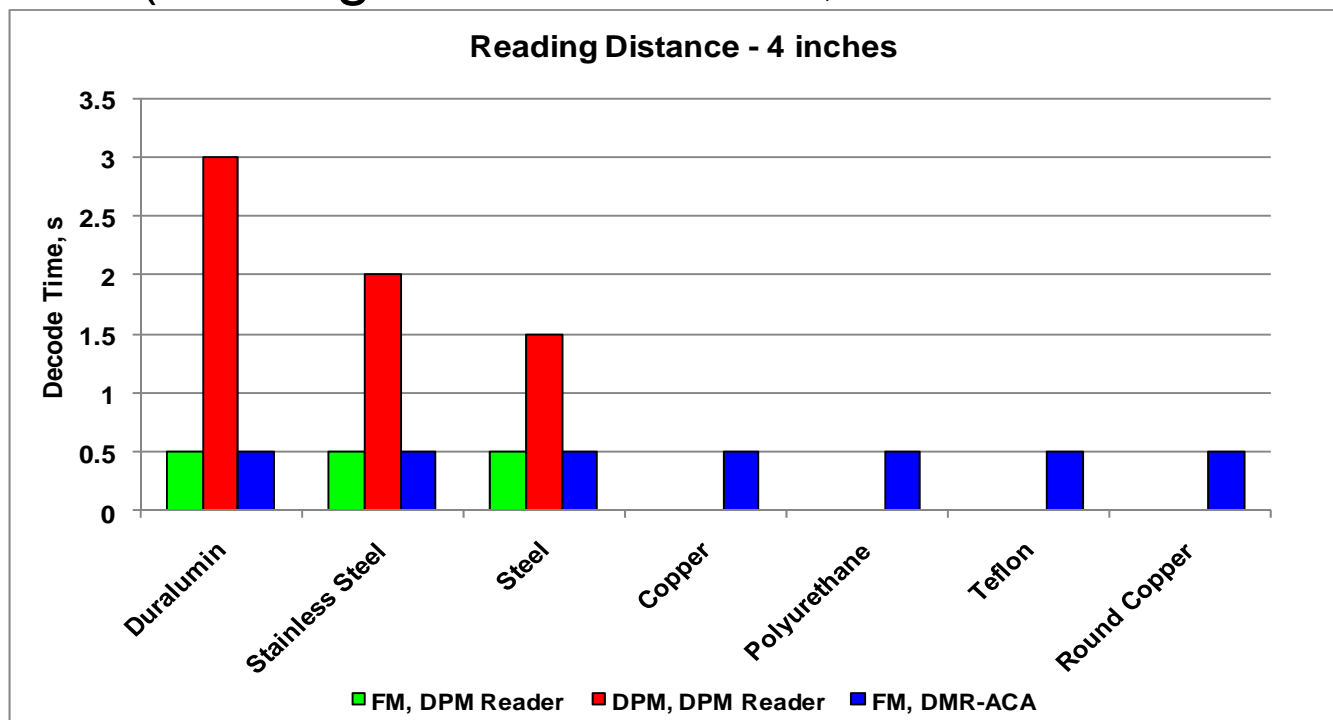
## Fluorescent compound – additional protection for DPM mark

**Salt spray test** (100 hours) of anodized “LADA” (Russian automobile) horn part (in accordance with ISO 9227 - Corrosion tests in artificial atmospheres -- Salt spray tests, 2006):



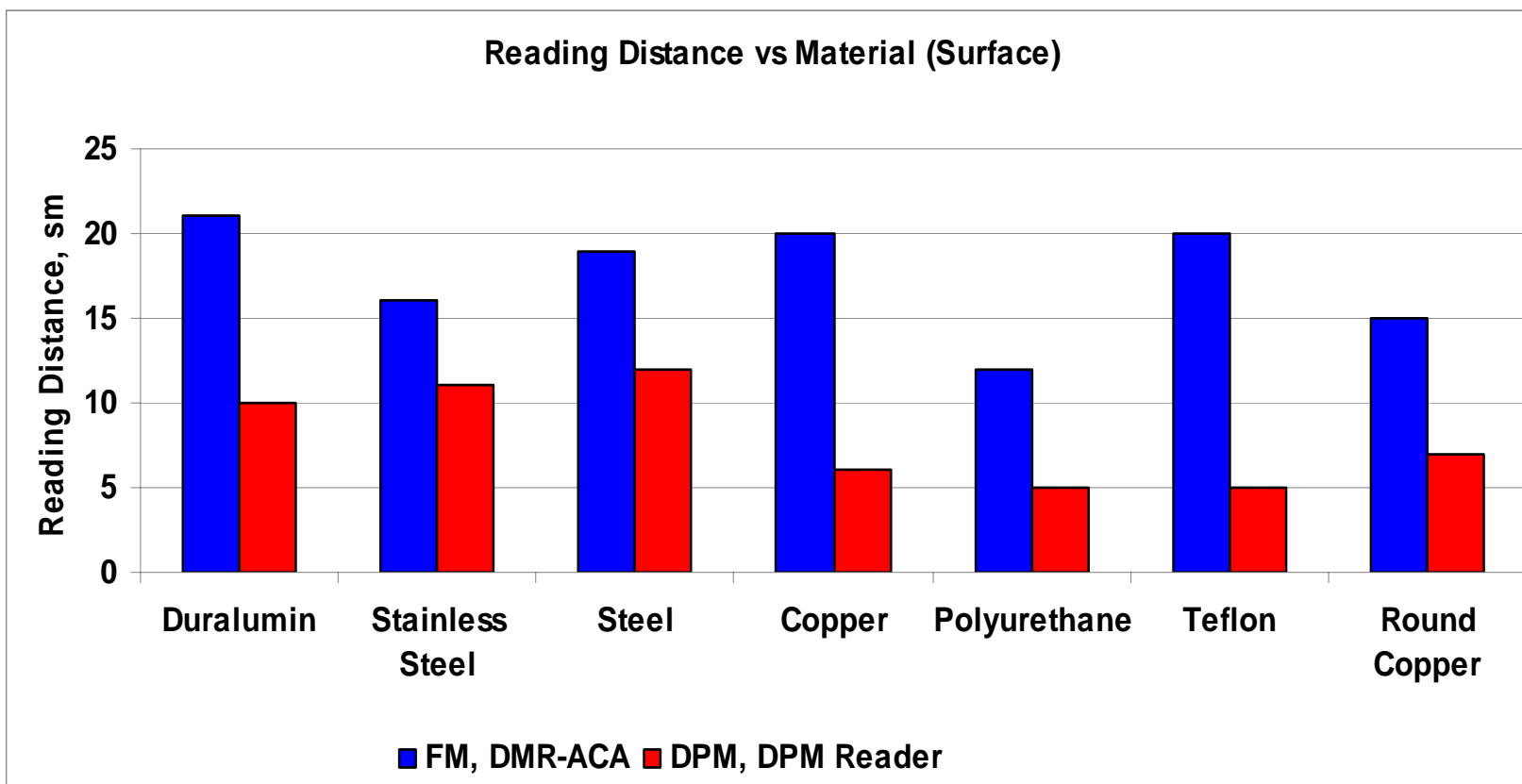
## Combined DPM Reader Tests (cont'd)

- Fluorescent mode – “reads” any surface on 1st try
- Conventional mode - needs substantial time or can not “read” at all (reading distance – 4 in., module size – 15 mil.)



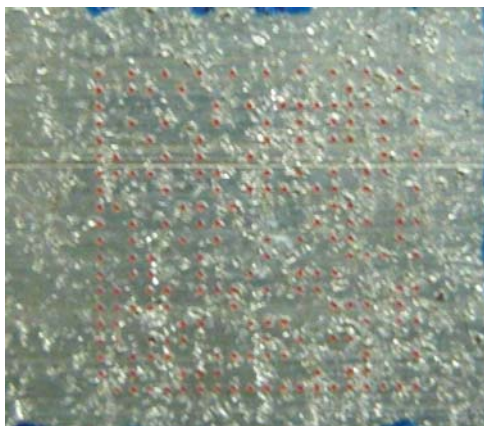
## Combined DPM Reader Tests (cont'd)

Fluorescent mode reading distance approximately 2x greater than conventional (module size – 15 mil)

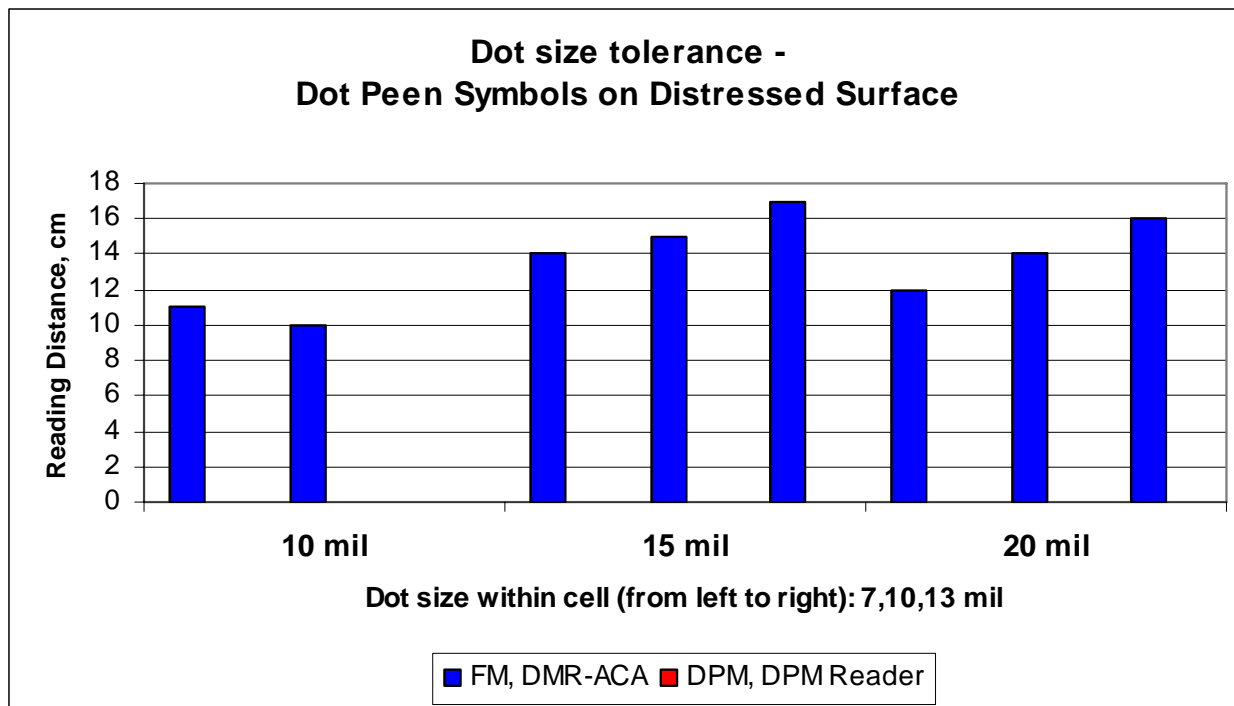


## Combined DPM Reader Tests (cont'd)

- Fluorescent mode - allows for greater dot size tolerance
- Reader demonstrates stable decoding for the dot size of ~30% of cell size for fluorescent mark
- “Distressed samples” are not decodable by conventional DPM Readers)



20 mil Data Matrix sample with 7 mil dot size on distressed surface





## **Combined DPM Reader: Competitive Advantages**

- Multifunctional device that can be effectively used for both conventional and fluorescent DPM marks
- Fluorescent technology eliminates the “substrate influence”
- “Reads” fluorescent DPM symbols at greater distances
- Decoding ability does not depend on the angular position to the surface
- Greater dot size tolerance
- Substantially more reliable and cost effective

## Data Matrix Protection & Authentication

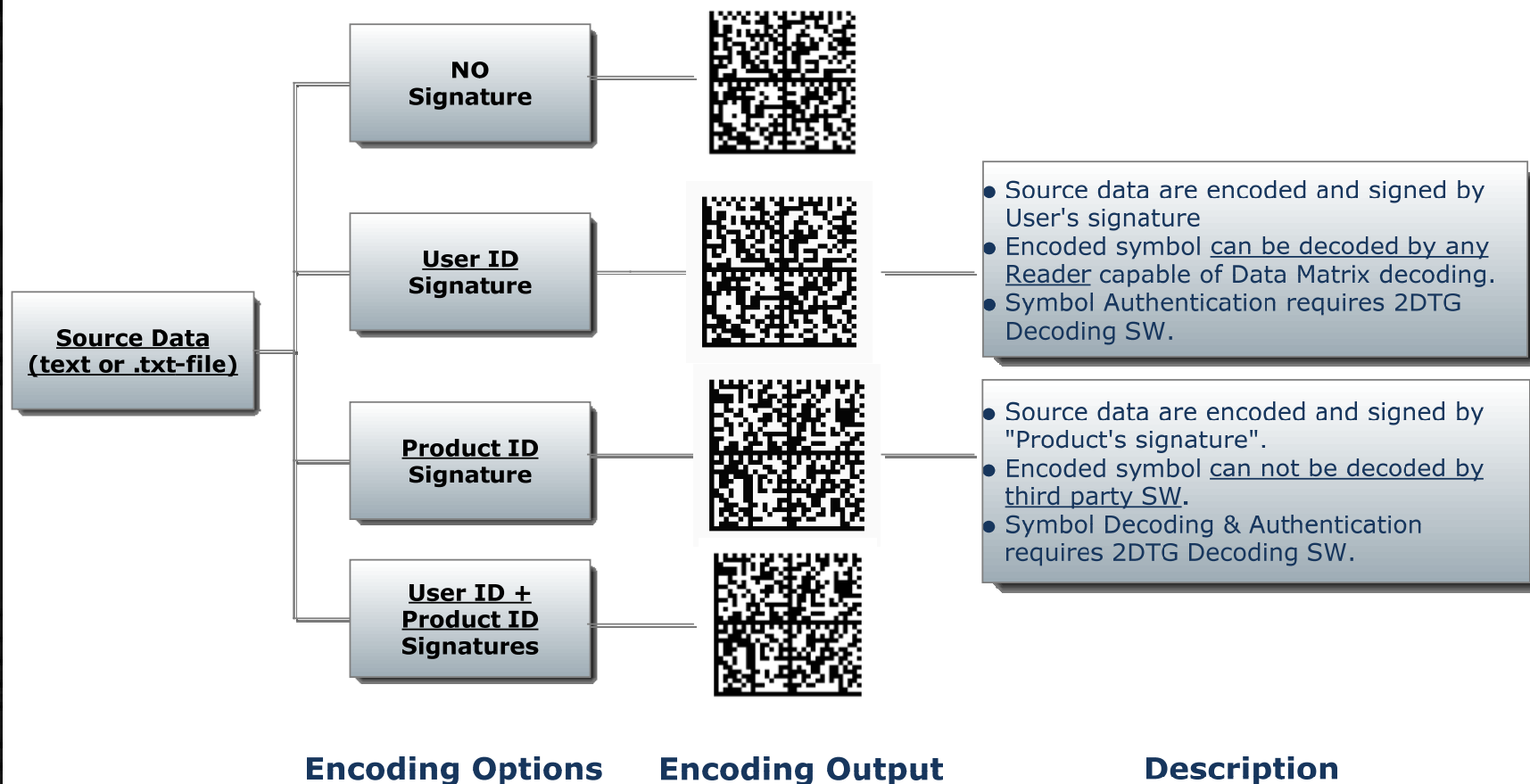
- Protection built on a concept of digital signatures – **User Signature and Product Signature**
- **icDM Protection Suite (icDMPS)** allows to encode/decode text information and to protect it from counterfeiting
  - **icDMPE** has a proprietary built-in mechanism to create digital signatures to the encoded Data Matrix symbol for user, product, or both
  - **icDMPD** checks signature for authenticity while extracting the information from the symbol
- Packages can be used together or separately.

## Digital Signature Parameters

- **User Signature** - unique digital characteristics depend on:
  - Sequence of characters in the input array of the encoded data
  - Matrix dimensions
  - User ID (16 alpha-numeric characters)
  - Image can be decoded by any decoding software.
  - Signature authentication requires the **icDMPD** decoding software
- **Product Signature** - “characteristics” depend on:
  - Matrix dimensions
  - Sequence of Matrix Code Words
  - User ID
  - Product ID (up to 200 alpha-numeric characters)
  - Image cannot be decoded by any decoding software
  - Both decoding and signature authentication requires **icDMPD** decoding software

# Data Matrix Encoding

## Protection & Authentication - Encoding Diagram



# Data Matrix Decoding

**Decode Output**

**Authentication Settings**

**User ID verification info**

**Authentication Results**

**Decode DM with professional Options**

**Options**

max DM Count: 100

Speed: Robust

Mirror: Normal & Mirror

Color: Any

Label Mode: Standard

Symbol Quality: Yes

Filter: Non

Signature: Both

Product ID: None  
UserSign  
ProdSign  
**Both**

**Image Info**

Time (ms): 14

Decoded DM: 1

Error Code: 0

User ID: OK

**Symbol Info**

Mirrored: no

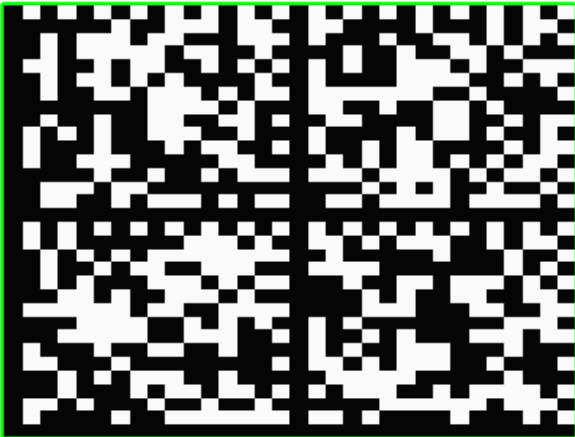
Dotpeenstage: no

Matrix color: Black

**Authentication**

User: OK

Product: OK



**Symbol info**

row	col	dim1	dim2
19	19	32	32

**Symbol Quality**

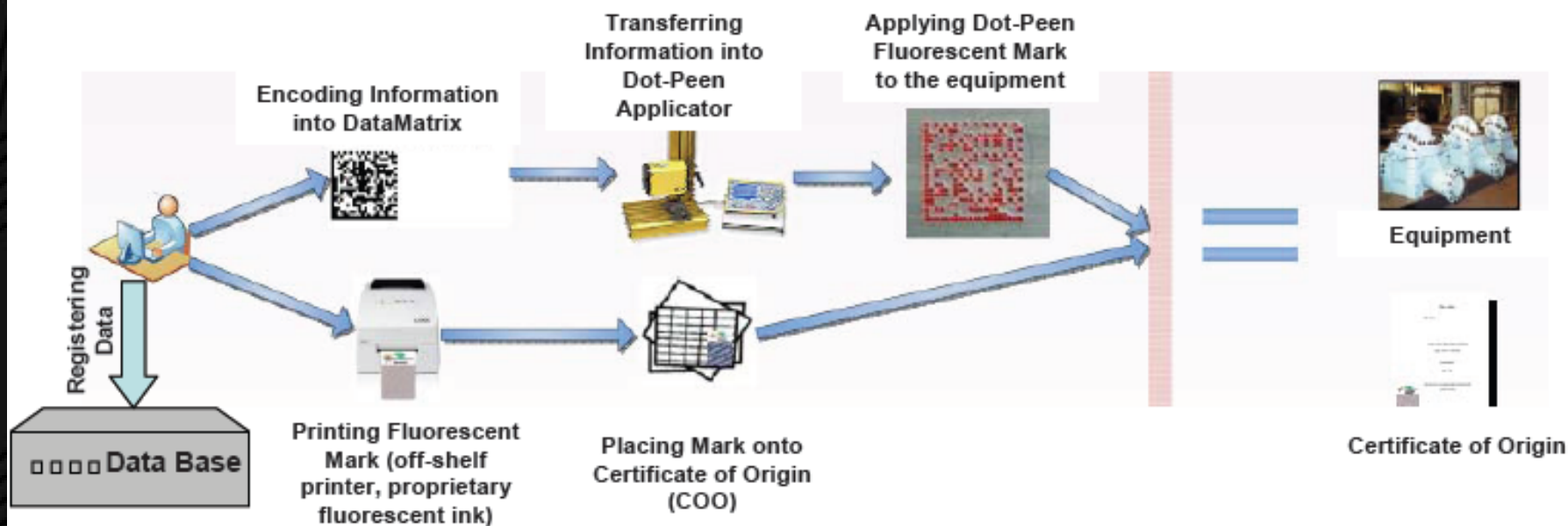
	Value	Grade
Axial Nonuniformity	0	4
Grid Nonuniformity	0.064	4
Symbol Contrast	96	4
Unused Error Correction	0.944	4
Fixed Pattern Damage	4	4
Modulation		4
Decode Grade		4
Overall Grade		4

**Symbol Data**

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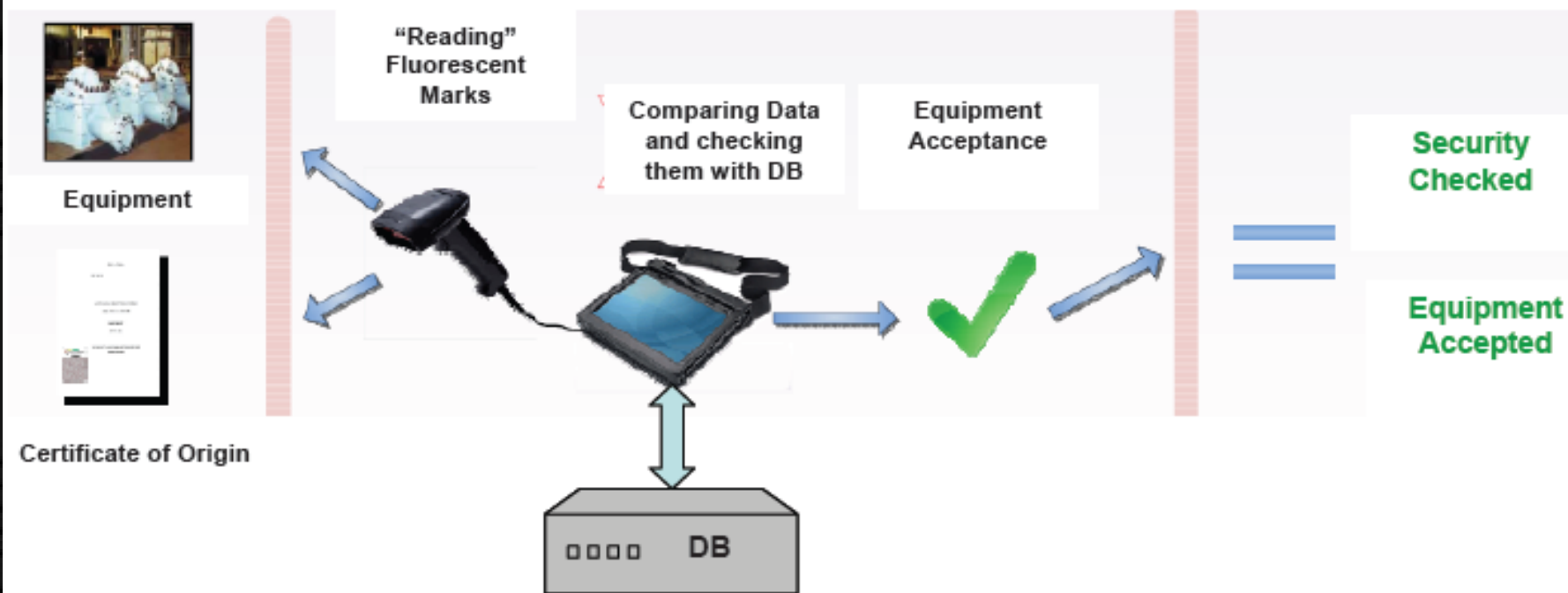
## Case Study

### Marking the equipment and Certificate of Origin (COO) at the manufacturing plant



## Case Study

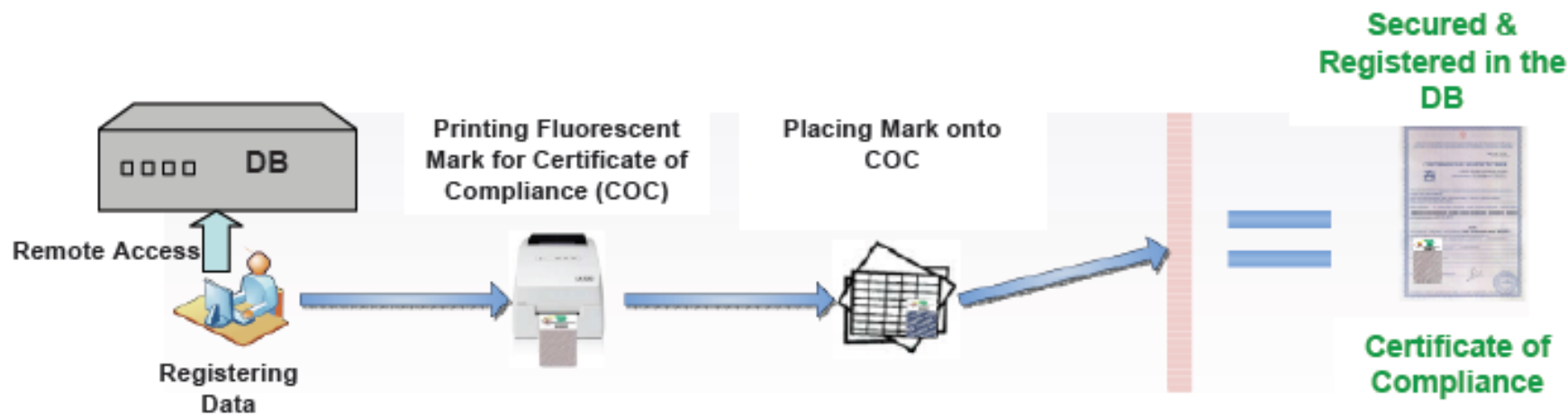
### Outgoing inspection at the manufacturing plant





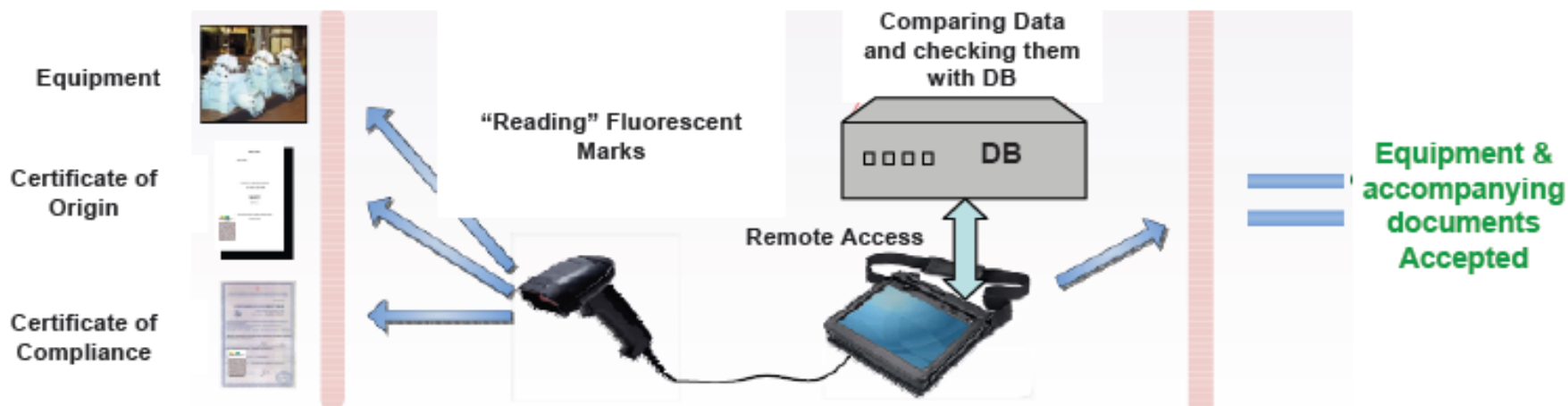
## Case Study

### Marking Certificate of Compliance (COC) at the Certification Center



## Case Study

### Incoming Inspection at the Atomic Power Plant



# Questions



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