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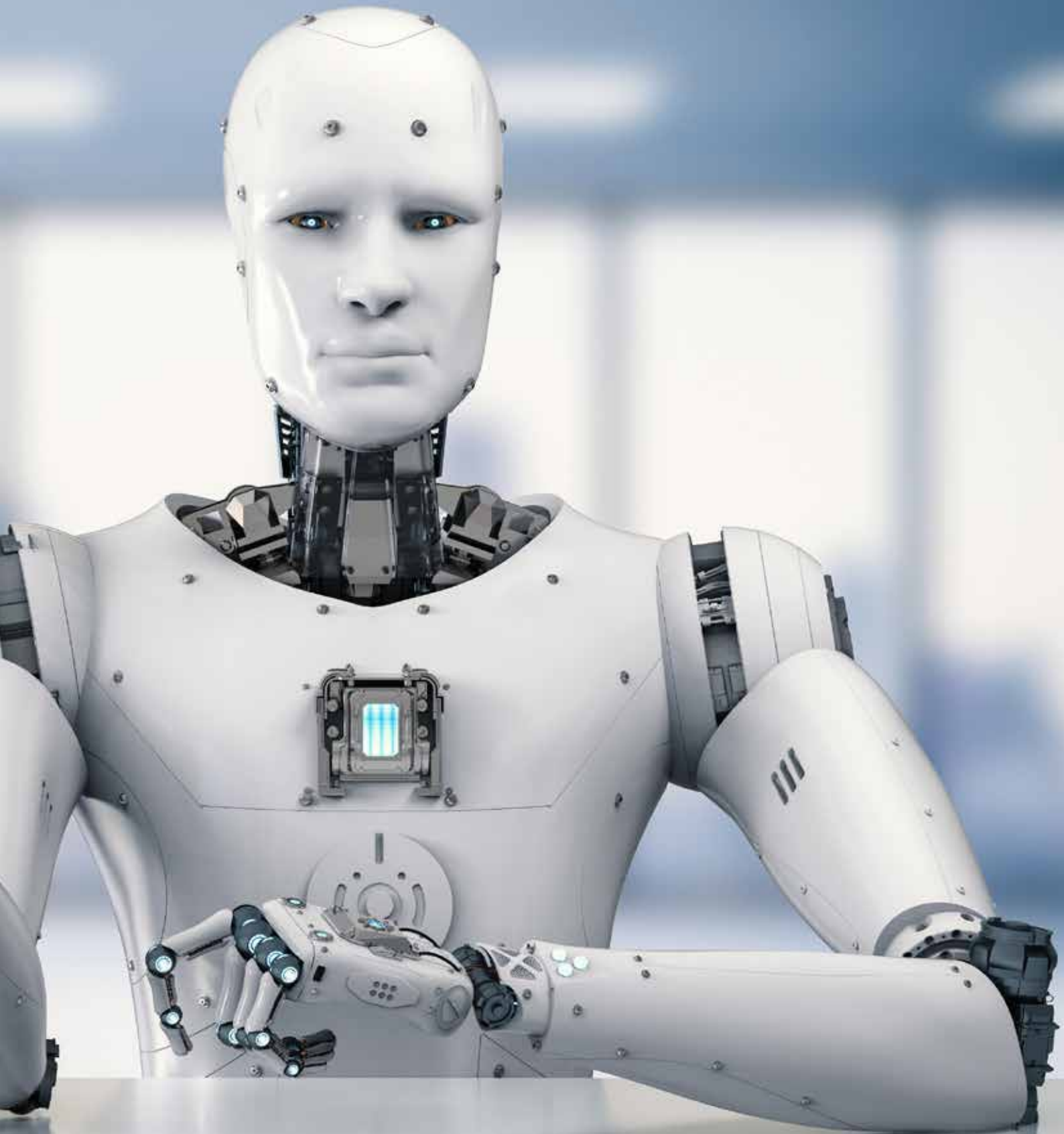
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# *Robotic process automation in a virtual environment*





# State of automation in modern enterprises



Enterprises in the service industry are now widely cognisant of the applicability of robotic process automation (RPA) techniques to achieve significant productivity gains while being cost conscious. RPA's ability to reduce processing time and errors, enhance scalability and compliance, and enable staff to focus on value-adding activities rather than repetitive tasks has been vindicated across industries and is now widely accepted. Firms which embraced these automation techniques early in the game have been able to gain significant benefits:

## Cost reduction

Software robotics brings immediate reduction in operational cost beyond labor arbitrage, and realises rapid return on investment.

## Value focused talent

The priorities of the workforce shift to innovation, strategy and other business development activities.

## Scalability

A virtual workforce can respond to growth events (e.g. organic, acquisitive) with speed, agility and resiliency. Robots are managed from the control room and require little IT expertise.

## Employee and customer satisfaction

Increased employee satisfaction through focus on higher value activities will, together with fewer errors, result in more satisfied customers.

## Quality and compliance

The automated nature of software robotics reduces errors and leaves a digital audit trail that increases accuracy and regulatory compliance, enabling programmable controls.

## Revenue enhancement

Software robotics increases revenue growth through a shorter cycle time to service customers.

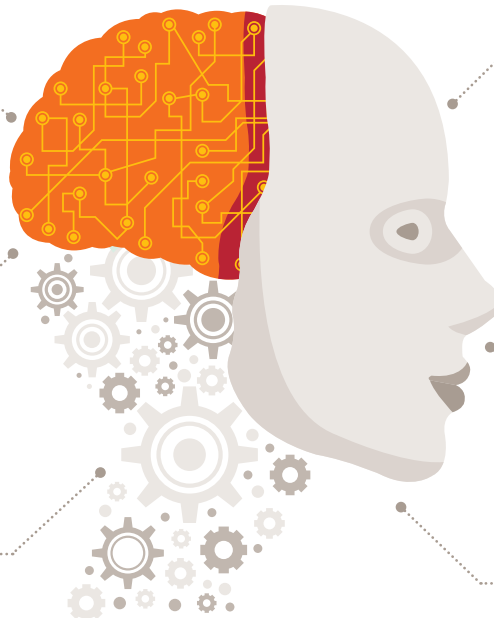
*There is a one-to-one relationship between a bot and the tasks it automates for a single worker (full-time equivalent or FTE). In others, a single bot automates tasks performed by three to five workers. Savings are easy to calculate.*

24/7

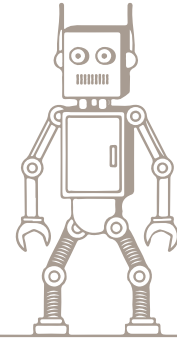
Robots never sleep and many of today's digitally enabled processes can be orchestrated to operate autonomously 24x7, driving real-time transactions.

## Speed to value and low risk

Software robotics has a quick time to delivery and avoids invasive traditional system integration. Weeks or months instead of years.



RPA benefits



In this era of technology disruption, enterprises are under immense pressure to digitise operations, and they see a future where human work can be augmented through the use of software robotics. These enterprises are beginning to view a digital workforce as part of their digital transformation strategy by combining elements of RPA, artificial intelligence (AI) and analytics to automate business processes. *While implementing organisations reap the above benefits of successful RPA implementation, the RPA product vendors and service providers also undergo a constant evolution cycle to tackle technical obstacles that adopting organisations face in automating processes and RPA tool integration/interaction with all applications/systems within their environment.*

The RPA market is expanding rapidly, but to be sustained, RPA must offer broader support for application types, and for both virtual and cloud-based systems. As RPA continues to progress both in capability and scope, business use cases are expanding beyond mainframe, legacy, desktop, and web applications into the realm of remote and virtualised environments. We are already seeing a healthy mix of automation environments such as physical machines, Windows servers, terminal servers, virtual machines (VMs), virtual desktop infrastructure (VDI) and remote desktop protocol (RDP).

Having said that, every RPA architect or developer who has tried to automate a process on a **‘virtual environment’** knows the pain that comes with building automations in that environment. For the purpose of this paper, we will focus on how the RPA tools access the remote applications on virtual environments, insights into pain points, and existing workarounds for automating such processes. While there are multiple RPA solutions in the market, this paper provides presents a case study on how Automation Anywhere (a leading RPA service provider) has further enhanced its current virtual environment automation capabilities in their upcoming release of Automation Anywhere v.11.



*‘It was not long ago that we were talking to a potential client about the relative merits of automation, especially robotic process automation. Although the client acknowledged the above merits to a great extent, they put forth a list of challenges that they had heard about RPA implementations pertaining to the RPA tool capabilities on virtualized environments (e.g. Citrix/remote desktops/VDIs).’*

**– Sumit Srivastav, Intelligent Process Automation Leader, PwC India**



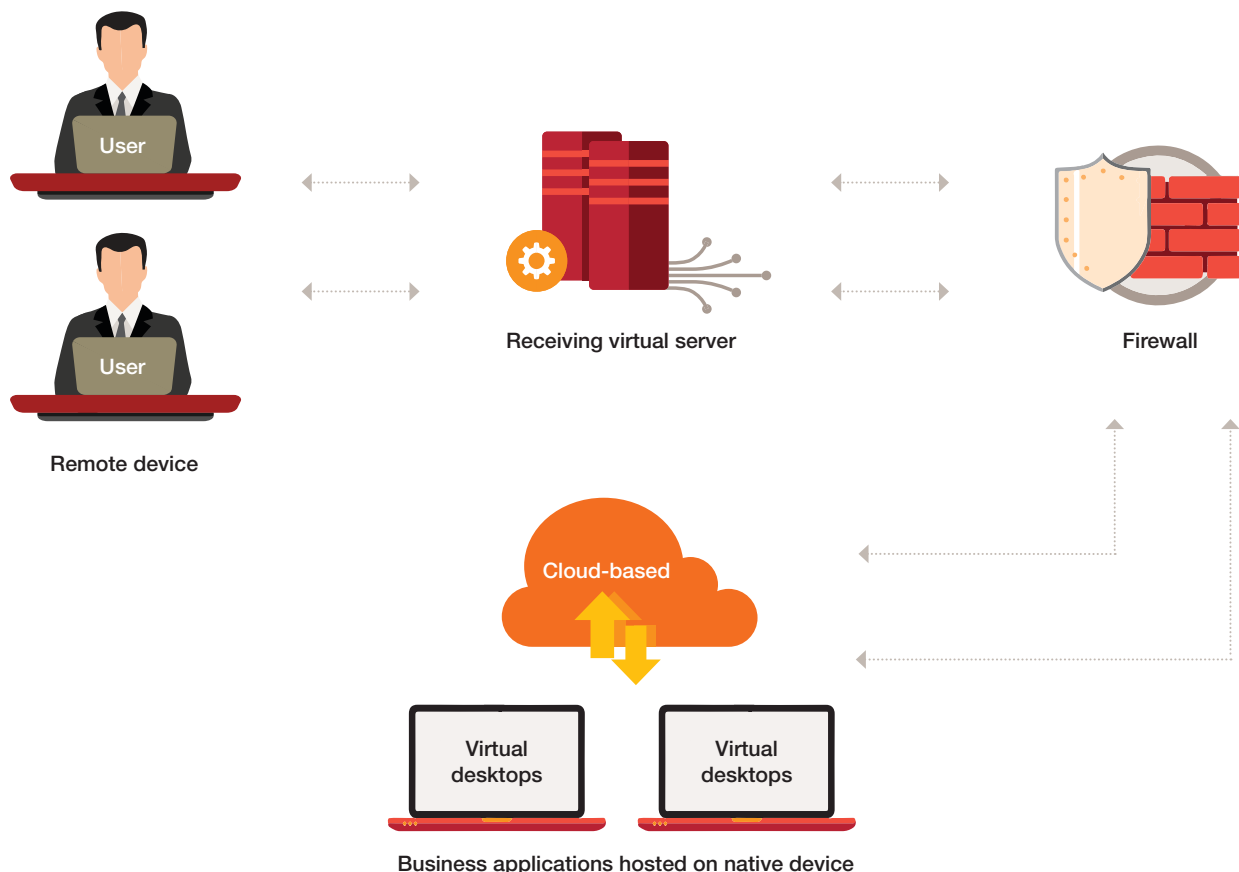
# How does a virtual environment work?

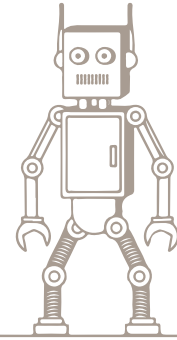
There are many service providers in the market today who provide server/cloud-based application and desktop virtualisation for organisations (e.g. Citrix, VMware Horizon, Microsoft RDP, Oracle's Secure Global Desktop). This helps organisations to remotely display an interface, typically from a VDI instance, enabling individuals of an enterprise to work and collaborate remotely regardless of device or network. This allows Windows desktops and applications that are located behind a firewall to be accessed from any remote device with any operating system.

Server/desktop virtualisation renders the display of a business application in the form of images from a desktop instance running behind the firewall. Let's call the device behind the firewall the native device, and the device outside the firewall the remote device. For clarity, the business applications run only on the native device and the remote device only runs the virtual display software.



Indicative application deployment over a virtual environment





It may be noted that Citrix is one of the most extensively used applications and desktop virtualisations products within financial services organisations. Having said that, the challenges with using RPA tools to automate processes on such environments apply to all remote display products.

### Why do enterprises opt for virtual environments?

#### **Enhanced security and compliance**

One important benefit that drives the use of virtual environments is that they keep data secure behind the firewall. They remotely render the user interface, providing no access to the underlying application, data, or user-interface objects. By rendering the display only, the transactional data remains behind the firewall and within the data centre boundaries. This enforces complete isolation of business data from the user's operating system and other applications installed on it, thus ensuring business applications and data are secure from any threats or attacks. RPA vendors provide additional RPA-specific security controls to ensure secure and compliant virtual desktop execution. (See the section below on 'managing Citrix infrastructure'.)

#### **Low cost**

Host applications can be run on a few servers running the native devices as VDI instances rather than on hundreds of laptops or desktops. Any change in configuration or application update needs to be done only on these few servers where the native devices reside. This also helps organisations implement strategies like bring your own device (BYOD) on the remote device, subsequently helping them save millions in management, device and licensing costs.

#### **High availability**

Improved failover strategies provide better 24x7 application availability.



#### **Flexibility**

Users can access the provisioned application executing on the native device from anywhere with any remote device like a smartphone or laptop.

#### **Maintenance**

Data backup and restoration can be easily done within the data centre where the application is hosted.

So, what is so hard about automating a process on a virtual environment? Some of the common challenges faced by RPA developers are discussed below:

## 1 *Managing the virtual infrastructure*

- Many enterprises with virtual installations will not allow RPA to execute on the native device for security and confidentiality reasons, which forces the RPA tool to execute the automation on the remote device. The preferred method to run RPA would be for the automation to execute on a run-time installed on the native device, enabling the RPA tool to read and use the underlying UI elements (objects). Native devices typically run on VDI instances from where the display will be rendered to the remote devices. Building automations on the native device makes development easier and the resulting automation is more accurate and easier to maintain.
- Remote devices typically reside outside a firewall, travelling over the Internet using remote display protocol. In this scenario, the automation executes on the remote device running only the rendered images—for example, a pixel display with no UI software drawing the display. This was previously described as a surface automation.





## 2 *Developing automation on virtual environments: Surface automations*

In a virtual environment, the bot is looking at a *picture*. Therefore, developers have to rely on the image the bot sees to automate the respective process step and eventually the entire process, which is not foolproof. The term ‘surface automation’ is frequently used to refer to automations that rely on the picture/image. Although this may sound simplistic to a human, many RPA platforms are unable to accommodate this type of functionality to 100% efficiency and surface automations are generally regarded difficult and challenging for the reasons outlined below:

- RPA tools use the UI via Object IDs for automation and this is not available in any virtualised environment.
- Coordinated use of pixel-by-pixel scanning of image, anchors, X/Y coordinates and optical character recognition (OCR) are required in order to correctly locate and interact with the image. This can fail when the screen resolution changes.
- For security reasons, sometimes the clipboard is not enabled between the virtual server and client, making it difficult to move data between the server and client. If the clipboard is not enabled, one needs to find a way (e.g. sending keystrokes) of working with the data. The task would become even more difficult if the volume of data is huge.
- Even with safeguards in place, additional control criteria and dynamic delays need to be implemented to take care of system latency.
- Automation becomes increasingly difficult on virtual applications with screen objects like date pickers, which cannot be controlled using the keyboard (wherein the date needs to be selected using the mouse only).

As a result of the above challenges, developers can use only **image recognition, co-ordinate based (mouse clicks/keystrokes) and OCR-based functions** to automate in a virtual environment. The next section provides insights on how this can be achieved.



# Existing methods of automation in a virtual environment

There are a few workarounds available to developers automating processes on Citrix environments:

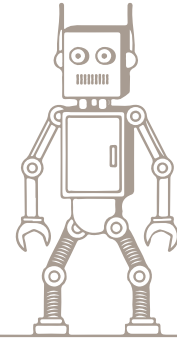
## 1 *Coordinate-based automation*

This is the most static automation approach where the RPA tool searches the target UI element at predefined X/Y coordinates. Once the image is found, the tool can perform mouse actions on that image such as left click, right click and double click. After that, data entry at that location can be performed using keystrokes or data extraction can be performed using OCR. Coordinate-based automation provides fastest automation execution.

**Failure modes:** This method would fail if the screen resolution or element/object position changes.

**Workarounds:**

- Explore if image-based automation or OCR-based automation can be performed.
- Identifying elements on the screen and using them as an anchor to then do a relative click on the actual element is a temporary fix that can be put in place to avoid failures due to screen resolution changes.
- Building utilities that check screen resolution changes before triggering the process bot.



## 2 *Image-based automation*

In this approach, the RPA tool scans the business application pixel by pixel, until the targeted UI element's (object) image is found. Once the image is found, the tool can perform mouse actions on that image such as left click, right click and double click. After that, data entry at that location can be performed using keystrokes and data extraction can be performed using OCR. The RPA tool can be trained to search for a target image by configuring parameters such as match percentage, comparison Mode (e.g. grayscale, monochrome), tolerance and image occurrence.

### **Failure modes:**

Change in system display and UI properties.

Changes in the default font/style and colour properties of the Windows apps and buttons.

### **Workarounds:**

- Configure RPA tool parameters such as match percentage, comparison mode (e.g. monochrome), tolerance and image occurrence.
- Explore if coordinate-based automation or OCR-based automation can be used.

## 3 *OCR-based automation*

In this approach, the business application image is converted to text using OCR technology and the RPA tool searches for the target application object by locating a specific text occurrence. Once the text is found, the tool can perform mouse actions on that object (text) such as left click, right click and double click. After that, data entry at that object can be performed using keystrokes and data extraction can be performed using OCR.

### **Failure modes:**

Accuracy percentage (like to like match) of the data extracted via the OCR functions is not 100% and, in some cases, may require manual human intervention to validate the data before this can be further processed by the bots.

### **Workarounds:**

- Try the automation using a different OCR engine since some business applications give best results with a particular OCR engine.
- Explore if image-based or coordinate-based automation can be used.

# Automation capability analysis of Automation Anywhere Enterprise v.11 in virtual environments

The currently available mitigations to the potential automation roadblocks may not be perfect and a foolproof solution may not exist. Automation Anywhere has been working behind the scenes to tackle such roadblocks to Citrix automation and is gearing up to bring about a revelation in how Citrix-based automation will be done in the near future. PwC was given early access to the latest version of Automation Anywhere Enterprise v.11. We performed a thorough study and comparison of some of the key functions/commands used in the previous version (Automation Anywhere v10.5) and the latest Automation

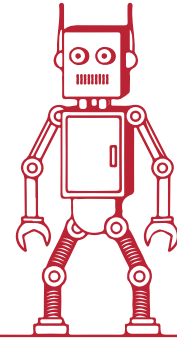
Anywhere v.11. The table below compares and assess the abilities of the two versions and scores them on the parameters listed below:

- Read and extract data;
- Write/update data;
- Launch applications on Citrix;
- Perform advanced functions such as match percentage and tolerance (image comparison mode);
- Search options and on-screen automations.

The table below provides a view on how Automation Anywhere Enterprise v.11 scores on the same assessment parameters compared to the older version:

Segment	Assessment dimension	Automation Anywhere V10.5	Automation Anywhere V11
Read/extract	Scrape data	Medium	Best in class
	Scrape relative	Low	Best in class
	Select and copy (editable fields)	Medium	Best in class
	Image occurrence	Medium	Best in class
	Bulk data extraction (out of the box)	Low	Best in class
Write/update	Image and text occurrence	Low	High
	Click on a text in an image (OCR click)	Medium	Best in class
	Click relative to text/image	Medium	Best in class
	Set text	High	Best in class
	Bulk data entry (out of the box)	Medium	Best in class
Launch apps	Keyboard actions	High	Best in class
	Click image	Medium	Best in class
Advanced	Intelligent automation using SMART screen automation technology	Low	Best in class
	Comparison modes with match% and tolerance	Best in class	Best in class
	Search a locally saved (PC) image	High	Best in class
	Resolution independent image recognition	Low	Best in class
	Auto mode to search UI element	Low	Best in class
Overall capability		Medium	Best in class





## Automation Anywhere Enterprise v.11 – a preview

Here are some of the key highlights and a quick insight into Automation Anywhere Enterprise v.11.

### Next-generation virtual environment automation

- **AISense:** Automation Anywhere has embedded AI, machine learning (ML), natural language processing (NLP) and computer vision (CV) to develop learning algorithms for their RPA suite of products. AISense simplifies Citrix automation capabilities and becomes more accurate as it learns from the user.

AISense uses computer vision to intelligently create dynamic linking between objects by determining their composition. This intelligent linking delivers change-resilient automation. AISense excels in accurately automating applications even where labels and text change their relative position.

AISense is enabled in cases where standard object-based automation is not available or unreliable, for example, in applications exposed over Citrix, applications accessed over remote desktop, or legacy applications like Delphi, QT, or Flex.

- **Support dynamic objects:** AISense uses advanced computer vision to understand the composition of a page. This automation is resilient to changes in the location of UI objects, changes in format and color of the objects, and changes in the structure of the objects.
- **Resolution-independent image recognition:** Automation Anywhere's advanced image recognition engine can accurately locate application images even when the machine resolution, scale or zoom level has changed. This ensures automation accuracy in cases where development and production machines have different configurations.

- **Auto mode to search UI element:** AI-powered smart screen automation automatically switches between OCR mode and image mode to increase accuracy of the software robot.
- **Image and text occurrence:** If the system searches for a particular UI element through image or text identification (OCR) and the given image/text is present more than once on the screen, Automation Anywhere's smart screen automation enables the user to pick the desired image or text. This is important because many IR/OCR methods pick the first occurrence of the image, which may not be accurate.
- **Data burst:** Automation Anywhere's 'data burst' technology inputs data from all UI elements after just a single scan of the application screen or image. This saves many hours of execution time compared to other techniques that require multiple scans of the same screen before each data input.
- **Bulk data extraction:** Automation Anywhere's bulk data extraction technology extracts data from all UI elements after just a single scan of the application screen or image. Like data burst, this saves many hours of execution time compared to other techniques that require multiple scans of the same screen before each data extraction.

Automation Anywhere has made significant changes to enhance the automation capabilities of its Enterprise v.11 offering, whilst it continues to maintain the ease at which both business and technical users can automate processes. On the basis of our study, we find that this version is an interactive and easy-to-use RPA tool with an equally impressive enhanced Citrix/virtual desktop automation capability.

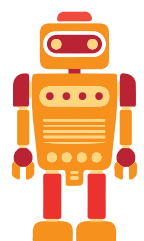
Enterprises have seen and accepted that automation on virtual environments/remote desktops using RPA tools is not as easy as standard UI-based automation. As other RPA vendors in the market are working on future versions of their tools and similar enhancements, we will bring about a series of thought papers to cover other key players and product enhancements in the RPA world.

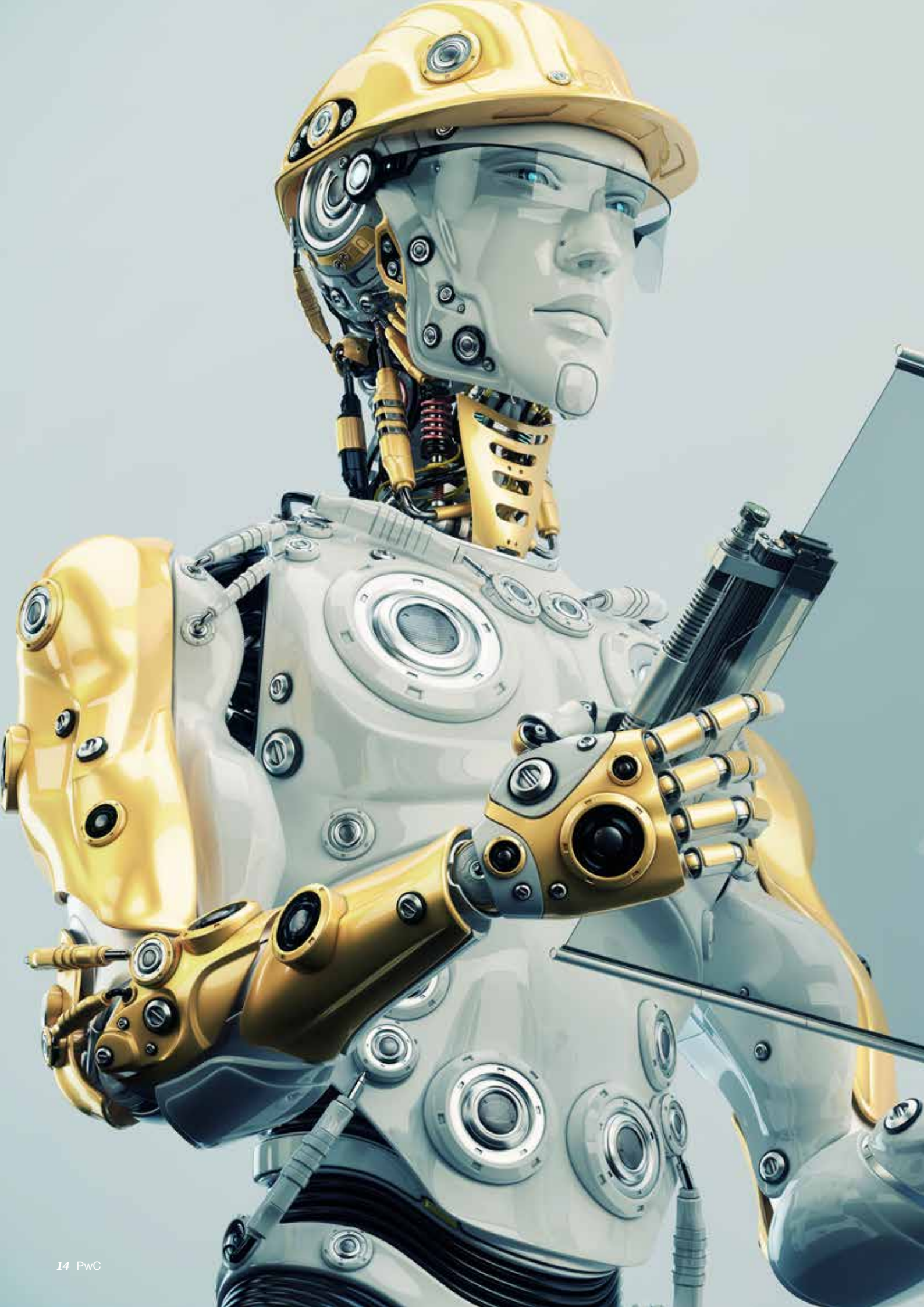
Irrespective of movement of text boxes or labels, the system is able to automate seamlessly.



### Indicative example:

Irrespective of movements to the UI elements (username, password), AISense ensures breakfree automation.





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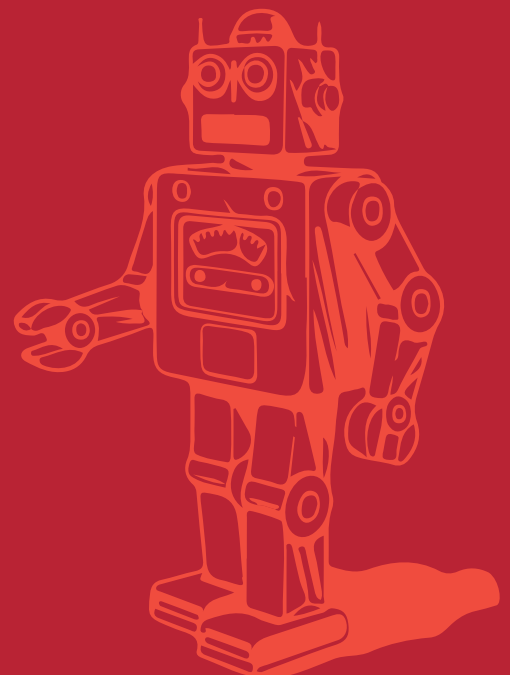
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