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Simulation to Business • Knowledge to Profit

MAXIMIZING RETURN ON OPERATOR TRAINING INVESTMENT: VIRTUALIZATION AND WEB BASED TECHNOLOGIES

Manel Serra

Joe

- *Basic Sciences and Engineering Fundamentals*
  - A refresh on **Basic Sciences** and **Engineering** concepts

Fundamentals

- *Unit Operations of Chemical Engineering*
  - The behavior of **Unit Operations** (Pumps, Heaters, Vessels, etc.)

Equipment

- *Processes & Systems Insights*
  - The **Processes** and **Systems** of interest of the producing plant

Processes and Systems

- *DCS & SIS Training*
  - Operation of the **Control** and **Safety** systems

DCS and SIS

- *Occupational Health & Safety*

OHS

Skilled Operator

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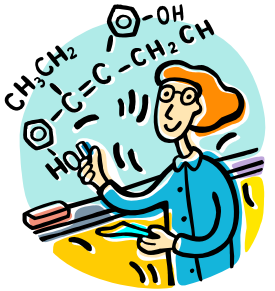


- Training for plant and control room operators has been typically approached as a classroom activity:
  - Formal teaching lessons, often given by experienced plant personnel
- Limitations to the typical approach:
  - Interest and retention of course content
  - Availability of the training resources
    (in time and space)
  - Fully booked operator agendas
  - Fully booked instructor agendas

- Even when a 1st session was arranged, it is extremely rare that refresher sessions happen!

- Solution to these issues require:
  - Ubiquitous availability of training resources in time and space
  - Flexible organization and delivery of sessions
  - Engaging training environments and methodologies

Dynamic Model-based learning environments

Joe

Fundamentals

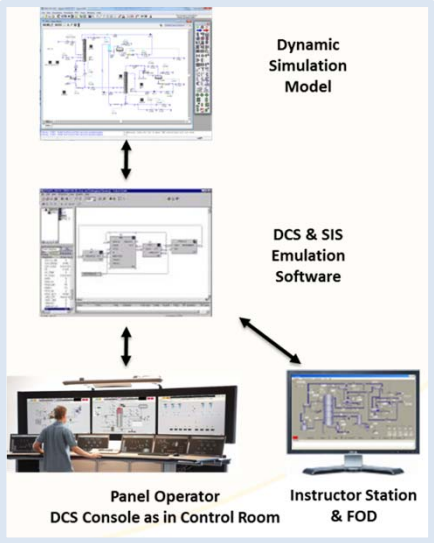
Equipment

Processes and Systems

DCS and SIS

OHS

Skilled Operator



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What an Operator Training System Is (in 1 min)?

In a way similar to the pilots of aeroplanes, who need to get trained in flight simulators,

Flight Simulator

Pilot cockpit

Airplane

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What an Operator Training System Is (in 1 min)?

In a way similar to the pilots of aeroplanes, who need to get trained in flight simulators, plant control room operators are trained in simulated educational environments (OTS)

OTS

Control Room

Plant

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What an Operator Training System Is (in 1 min)?

In devoted training rooms, from an instructor station, training scenarios are launched and the student-operator responses are evaluated

Operations

- Changes in Utilities' conditions
- Changes in feedstock conditions
- Changes in production flowrates

Safety

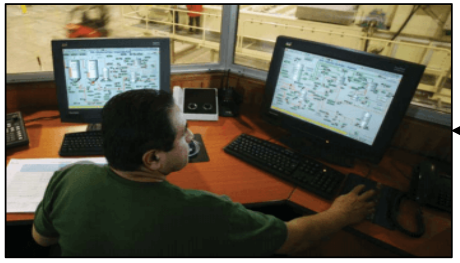
- General or Partial Power Failure
- Instrumentation Air Failure
- Critical Utilities Failures

Procedures

- Start-up
- Planned Shutdowns

Equipment Failures and Malfunctions

- Column Failures
- Heat Exchangers Fouling
- Failure in Field Instrumentation and Control Valves



Instructor

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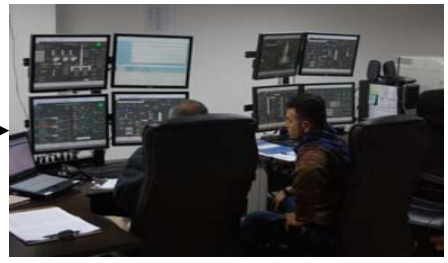
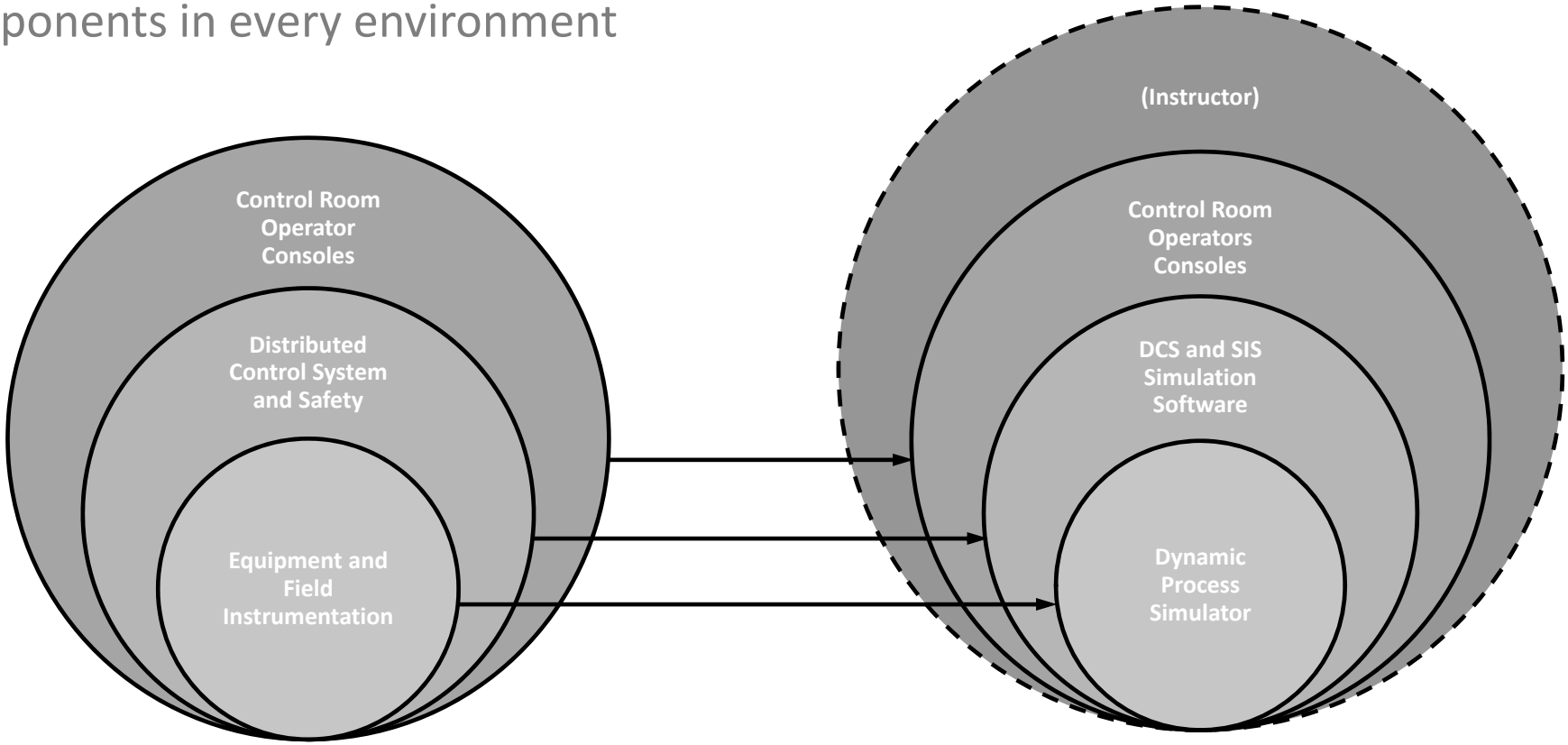


Control Room Student / Operator

What an Operator Training System Is (in 1 min)?

- Components in every environment



Work Environment (Processing Plant)

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Training Environment (OTS)

Dynamic Model-based learning environments

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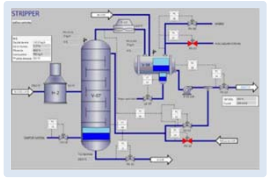
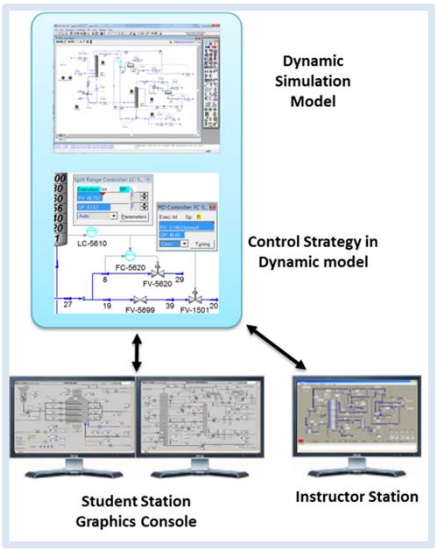
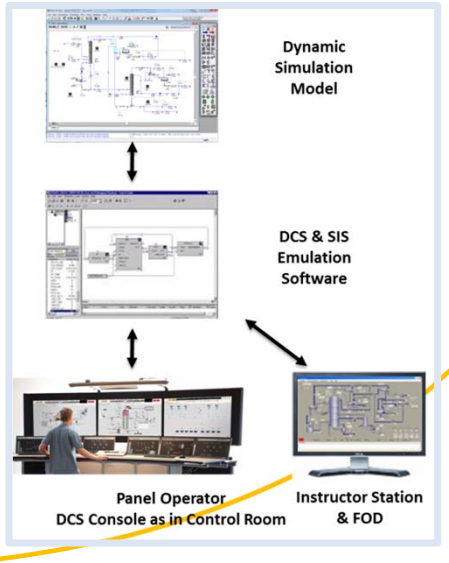
Fundamentals



Equipment



Processes and Systems



Skilled Operator

DCS and SIS

OHS

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WEB-BASED OTS

- Traditional OTSs have been based around the configuration of a training room, filled with hardware and software hosting a single installment of a the emulated plant and the emulated control system.
- Inprocess has developed a framework that allows remote access to training resources, especially complex OTS systems.
- The framework combines state of the art technologies in virtualization and remote presentation of applications, provided by market leaders: Microsoft, Citrix, VMWare…
- This training framework enables corporations to directly deal with the limitations described.

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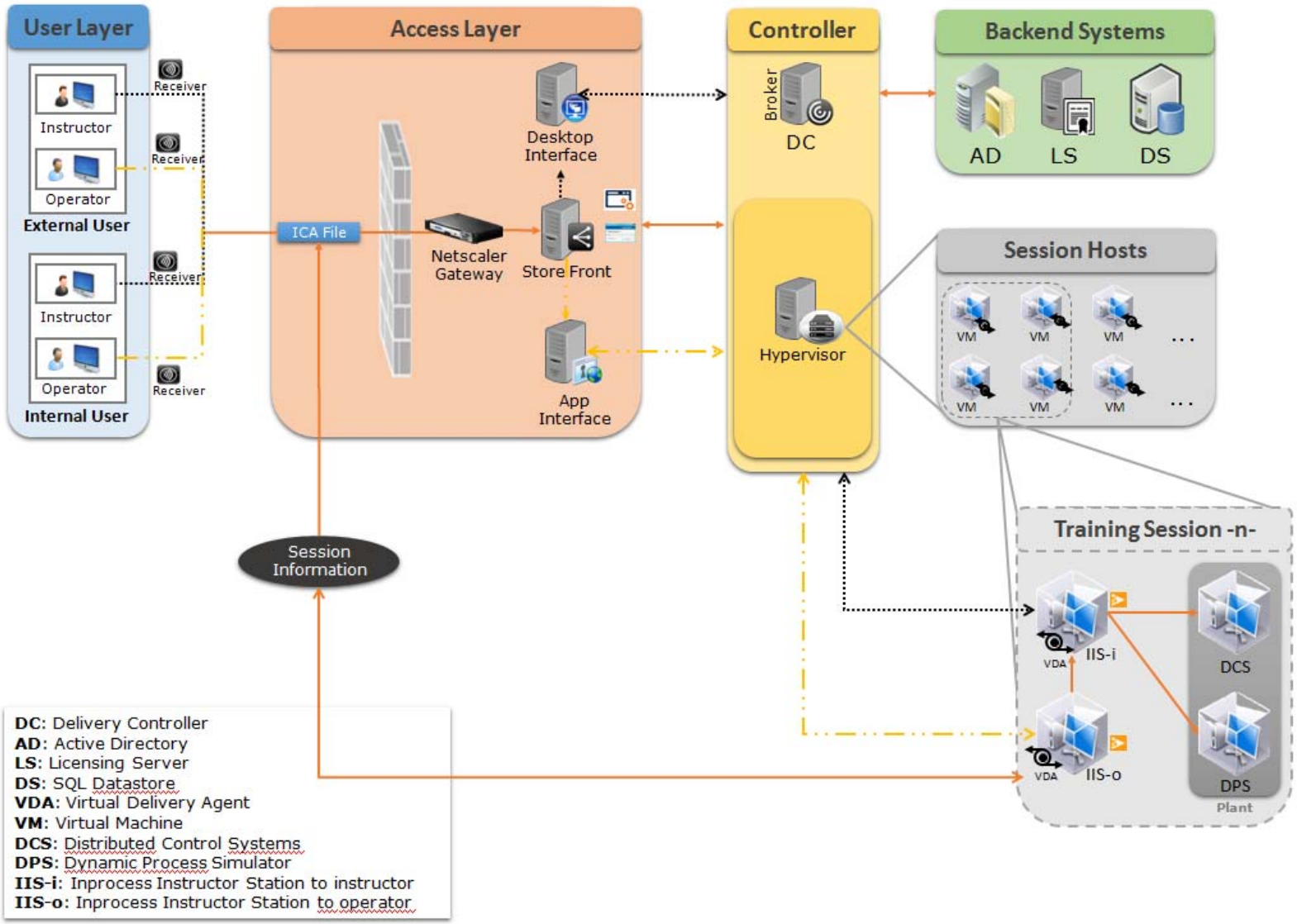
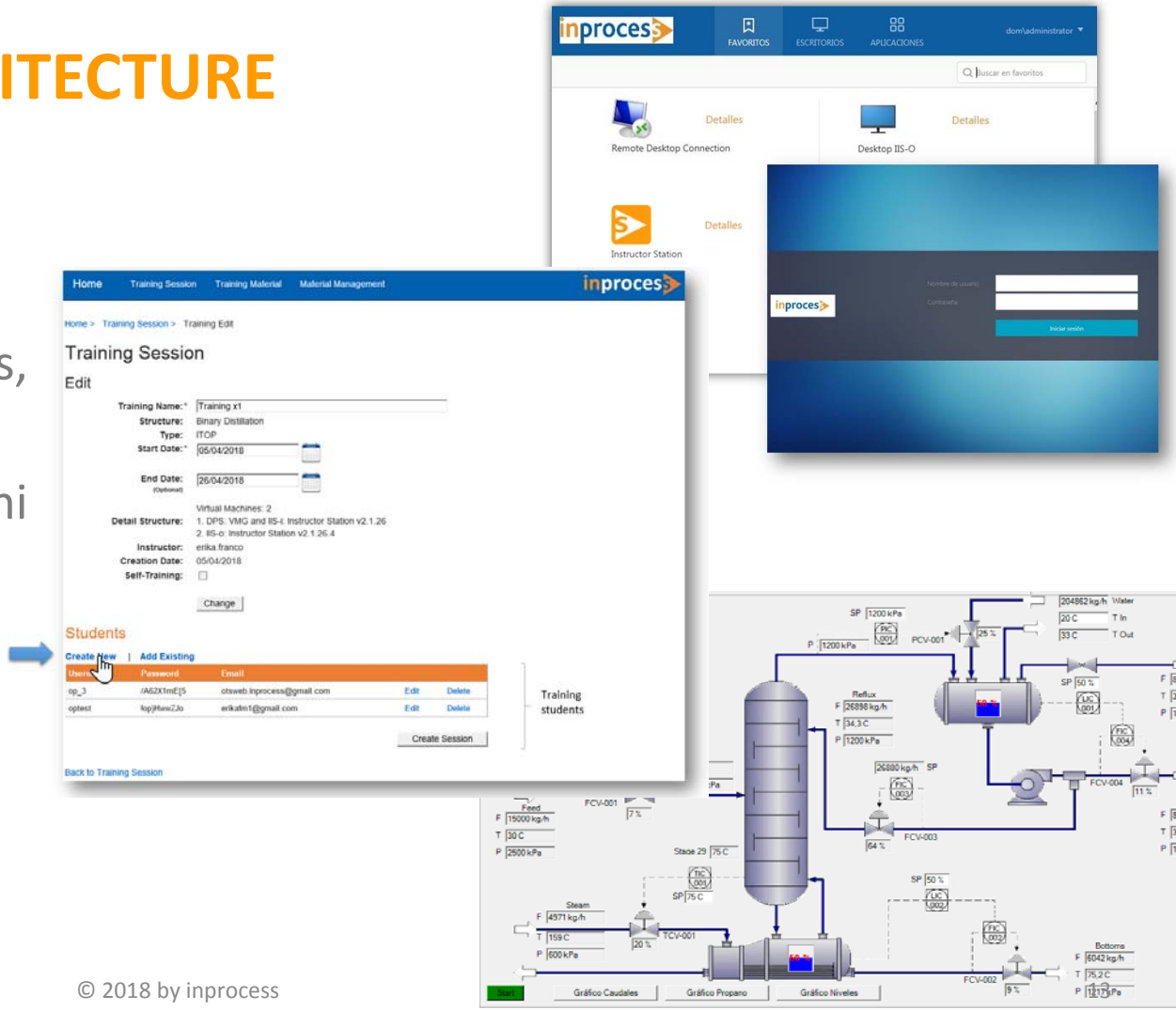

User Layer
Instructor
Operator
External User
Instructor
Operator
Internal User
Receiver
Receiver
Receiver
Receiver
Access Layer
ICA File
Netscaler Gateway
Desktop Interface
Store Front
App Interface
Controller
Broker
DC
Hypervisor
Backend Systems
AD
LS
DS
Session Hosts
VM
Session Information
Training Session -n-
VDA
IIS-i
VDA
IIS-o
DCS
DPS
Plant
DC: Delivery Controller
AD: Active Directory
LS: Licensing Server
DS: SQL Datastore
VDA: Virtual Delivery Agent
VM: Virtual Machine
DCS: Distributed Control Systems
DPS: Dynamic Process Simulator
IIS-i: Inprocess Instructor Station to instructor
IIS-o: Inprocess Instructor Station to operator

WEB-BASED OTS: ARCHITECTURE

- State of the art technologies in virtualization and remote access: Microsoft, Citrix, VMWare…
- Private datacenters and networks, external network or in the cloud
- Role-based for Instructors, Alumni and System Administrators
- Easy configuration and access



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Web-based OTS: Benefits

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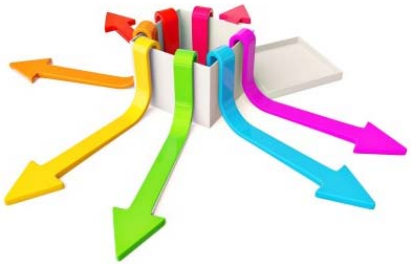
Distribution / Reach



- ***Ubiquitous access to training resources***
  - In time
  - In space
- Expanded use of training resources

Flexibility

- Internal and External users
- Classroom and self-training
- Portable (Off-site use)
- Cross-platform

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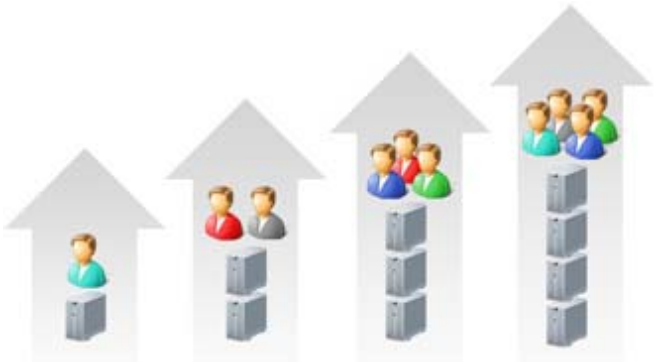

Scalability

- Content
- Users and Sessions On-Demand
- “Outsourceable”

Maintainability and Security

- Industry standard software components and technologies
- Streamlined maintenance
- Common framework for all deployments
- Security-centric: authentication, encryption, isolation

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E-LEARNING

SCORM
Shareable Content Object Reference Model

- The network browsing mechanisms allows the integration in a e-Learning Management System.
- E-Learning standards (such as SCORM or AICC) provide guidelines on packaging and deployment of web content to form a training module or a complete training programme.
- The OTS fits the deployment structure of these standards, allowing the access to the OTS from within the training modules themselves.
  - The student just activates the link embedded as part of the content of the training module (e.g. start up of the plant, 2nd day) and is redirected to the OTS interface for the present chapter.
  - The student executes the proposed exercise in the OTS and uses the results to answer questions in the training module.
  - Information generated by the execution of the exercise is stored under the student profile.

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SOME REAL CASES

- 2 real cases, with different degrees of complexity
  - Virtualized OTS system
  - Web based Training (ITOP & OTS)
- For both cases, description and reasoning, architecture and results / benefits

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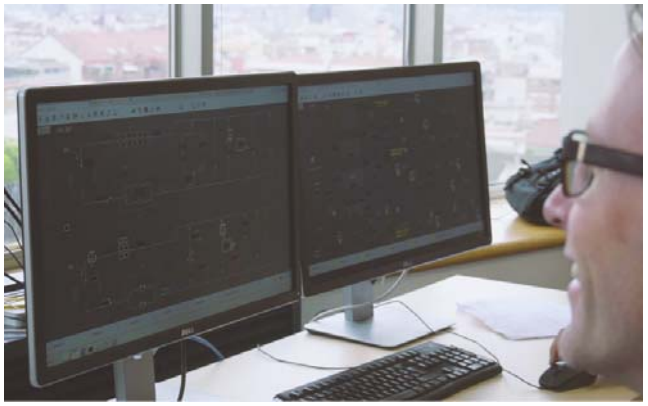
CASE 1: VIRTUALIZED OTS

- Refinery in Northern Europe, with an old OTS for one of its units, extensively used in training operators.
  - OTS was based on rigorous dynamic process simulation and native DCS software emulation
- Decision to add 2 additional, existing units to the training program (3 in total), but all in the same training room.
- Solution consisted in a virtualized architecture in which the different groups of VM's needed for each of the units can be launched on demand.
- OTS infrastructure in a separated sub-net.



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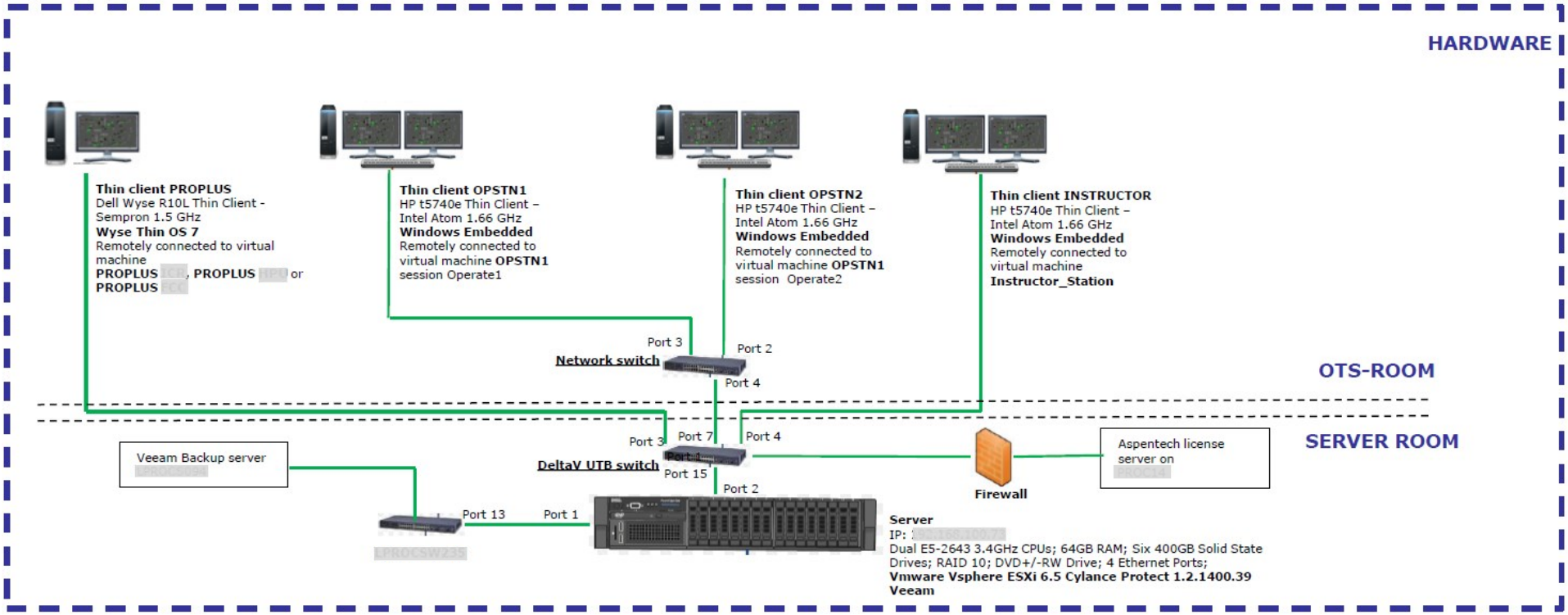
CASE 1: VIRTUALIZED OTS



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CASE 1: VIRTUALIZED OTS

Virtual PROPLUS running is dependant on training session, running them simultaneuosly is not possible.

VIRTUAL MACHINES in SERVER

PROPLUS 1

Windows 7 Professional
DeltaV version: 12.3.1
Cylance PROTECT
(version 1.2.1400.39)
VX2207S01: DeltaV SimulatePRO
VX2101S01: DeltaVSimulate PPN Networked Version 12

PROPLUS 2

Windows 7 Professional
DeltaV version: 12.3.1
Cylance PROTECT
(version 1.2.1400.39)
VX2207S01: DeltaV SimulatePRO
VX2101S01: DeltaVSimulate PPN Networked Version 12

PROPLUS 3

Windows 7 Professional
DeltaV version: 12.3.1
Cylance PROTECT
(version 1.2.1400.39)
VX2207S01: DeltaV SimulatePRO
VX2101S01: DeltaVSimulate PPN Networked Version 12

OPSTN1

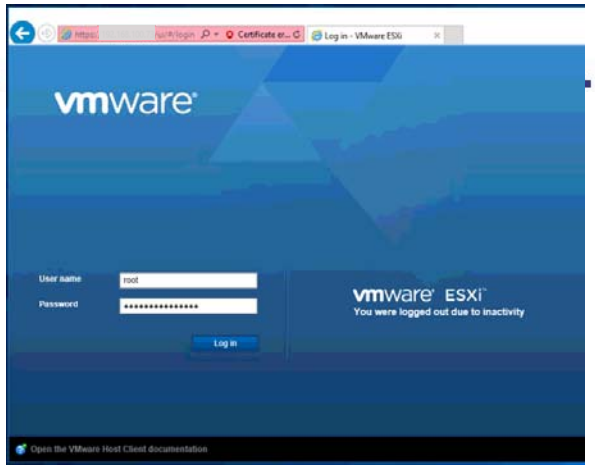
Windows server 2008 R2
DeltaV version: 12.3.1
Cylance PROTECT
(version 1.2.1400.39)
VX2104S01: DeltaV Simulate OSN

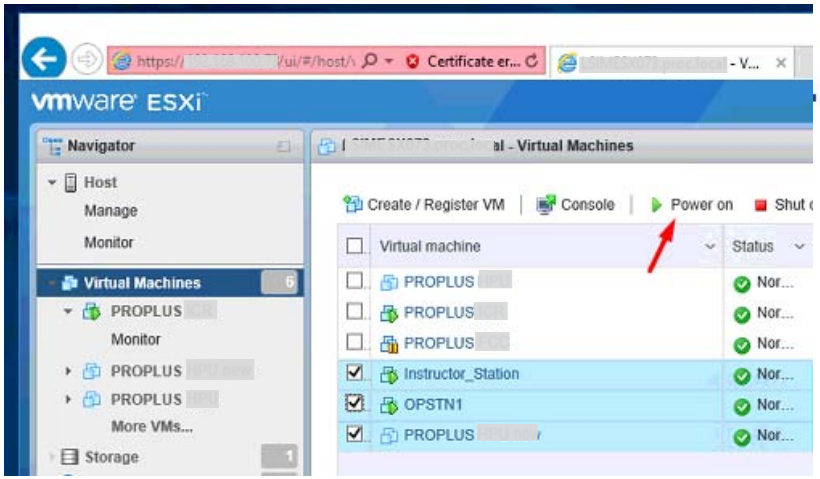
Session:
OPERATE1
VX2104S01: DeltaV Simulate OSN

Session:
OPERATE2
VX2104S01: DeltaV Simulate OSN

Instructor_Station

Windows server 2008 R2
Process Modelling (HYSYS) V9 patch2
Instructor Station (version 2.1.9)
Microsoft SQL Server 2008 R2 Native client (version 10.52.4000.0)
OPC remote (version 3.0.3)
OPC Core Components Redistributable (version 105.1)
Cylance PROTECT (version 1.2.1400.39)
Inprocess Instructor Station Perpetual Run-time and Editable license





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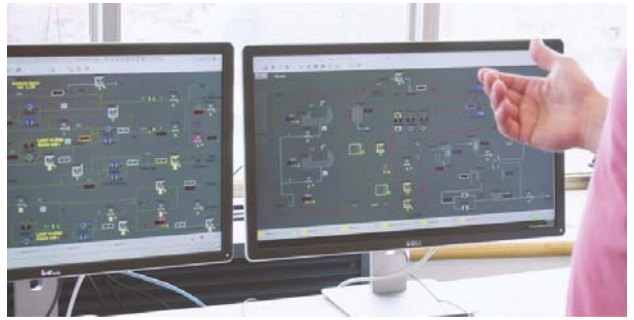
Case 1: Virtualized OTS



- Virtualization allowed for
  - Shared training room and resources for all OTS
  - A fast and easy switch between training sessions of different units (<5 min)
  - Saving training status between different training crews, and recovering later on
  - Scalability, allowing for increasing number of units, Operator Stations, or changing screens configuration.
  - Virtualization environment, backup strategies… defined by customer IT – happy!
- Successful results led to a deployment of another OTS for a 4th unit in the same infrastructure

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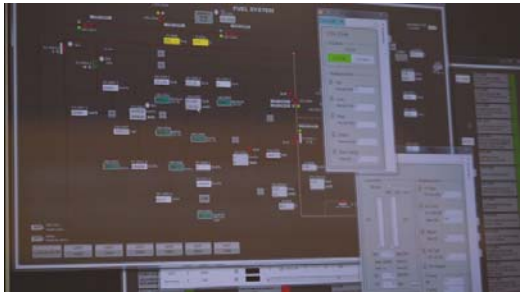
Case 2: Web Training (ITOP & OTS)



- European process licensor, with two training targets:
  - Support to start up of licensed plants
  - Training of Technical services personnel
- In order to address the two targets:
  - Development of a Generic OTS for one of their licenses, with rigorous dynamic simulation, and DCS emulation
  - Delivery of Inprocess ITOP libraries – Inprocess training material on “Unit Operations of Chemical Engineering”
- Deployment of a virtualized, web based environment so that training resources (ITOP and the OTS) are available to all world-wide employees

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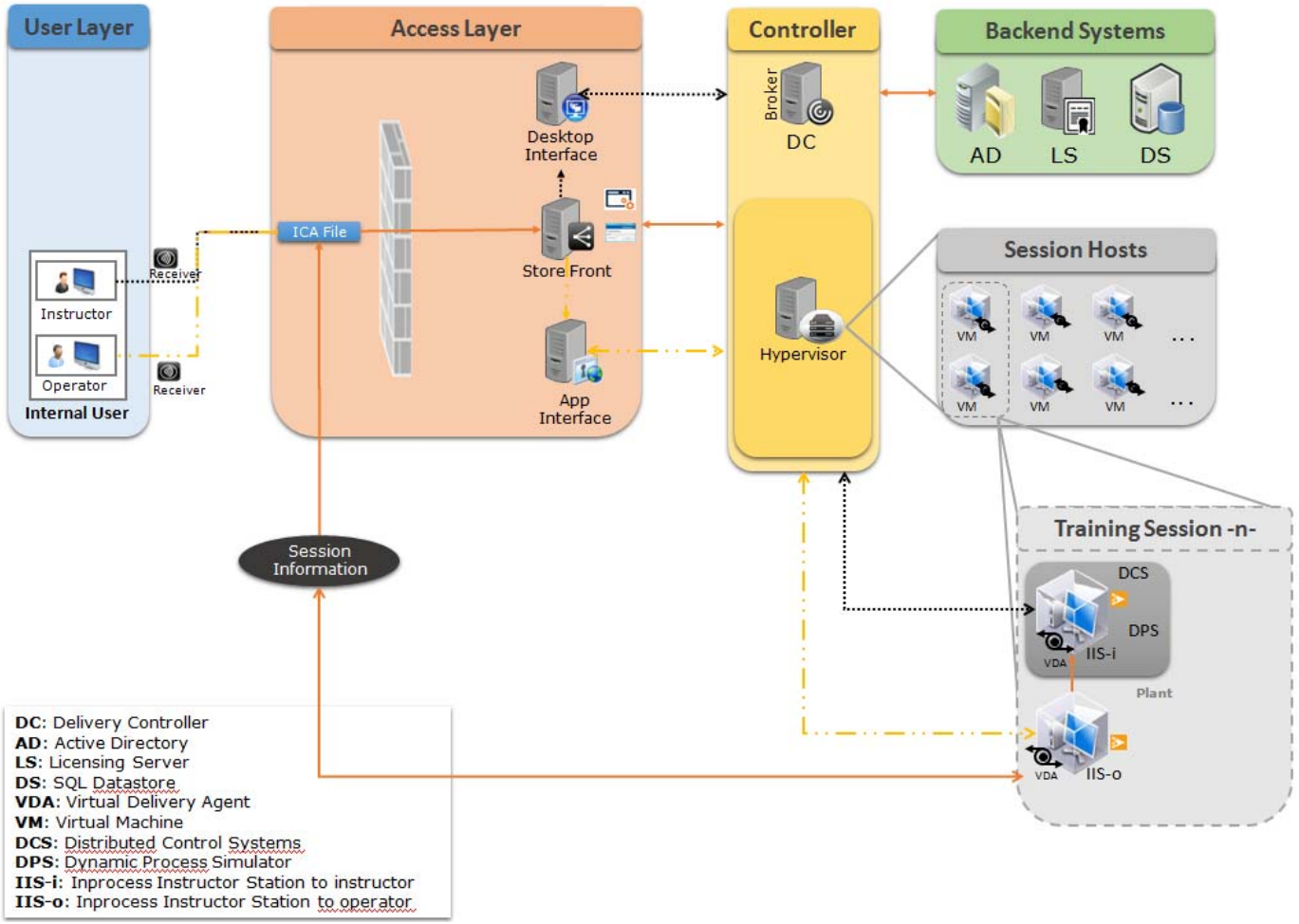
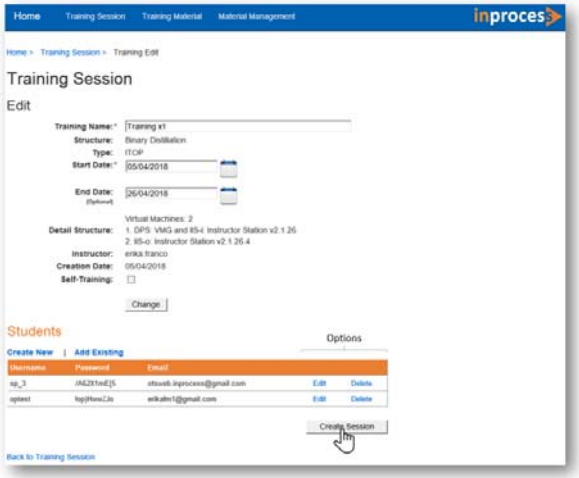
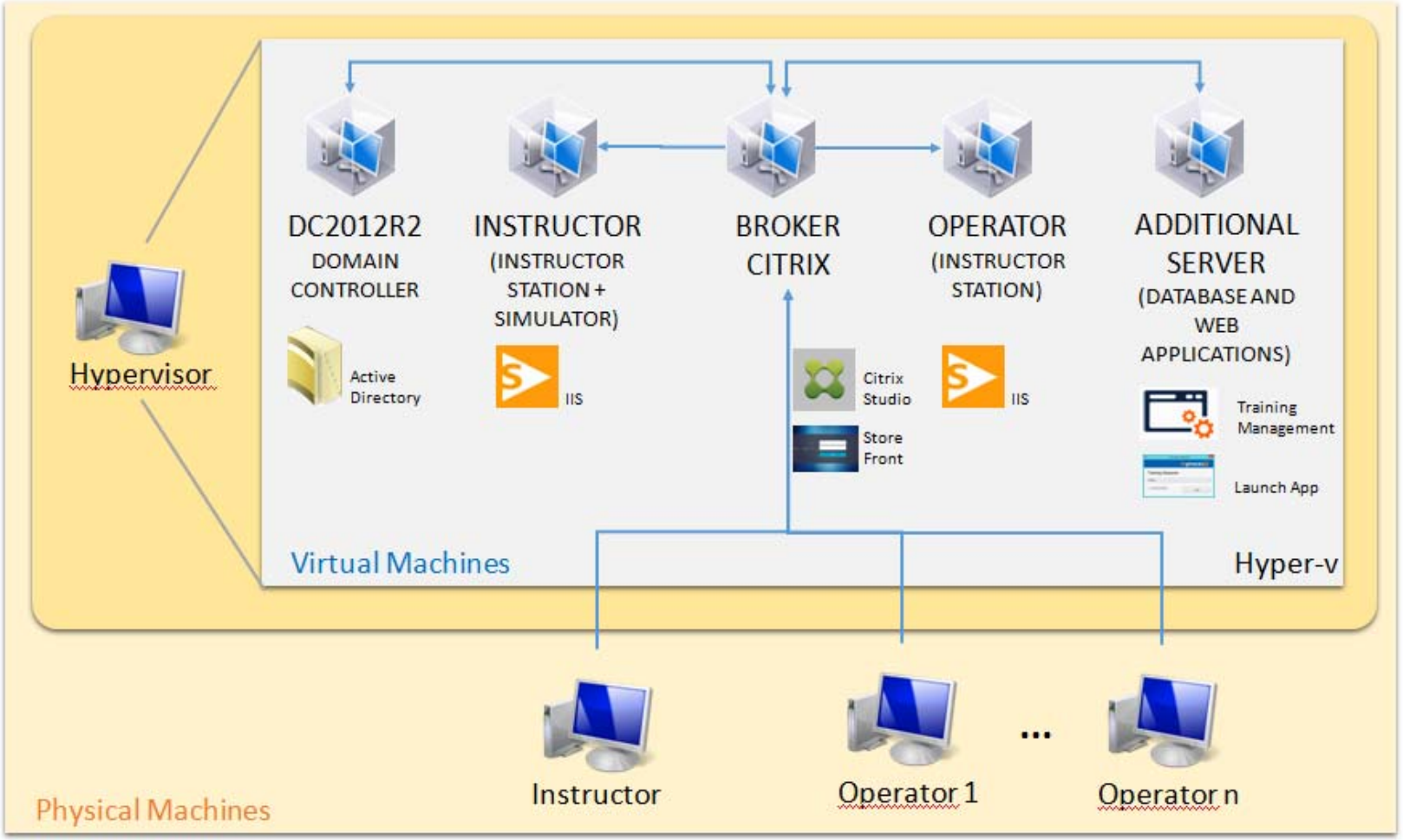
CASE 2: WEB TRAINING (ITOP & OTS)





CASE 2: WEB TRAINING (ITOP & OTS)



CASE 2: WEB TRAINING (ITOP & OTS)

DC2012R2

- Virtual Machine
- Domain Controller
- Windows Server 2012 R2
- SO: 64 Bit
- RAM: 2 GB
- Hard Disk: 60 GB

BROKER

- Virtual Machine
- Windows Server 2012 R2
- SO: 64 Bit
- RAM: 4 GB
- Hard Disk: 60 GB
- Applications:
  - Citrix Studio - Broker Machine

OPERATOR

- Virtual Machine
- Windows Server 2012 R2
- SO: 64 Bit
- RAM: 4 GB
- Hard Disk: 60 GB
- Applications:
  - Instructor Station
  - Citrix XennApp Xendesktop
  - Training Management
  - PS Tools
- Remote Desktop available

INSTRUCTOR V

- Virtual Machine
- Windows Server 2012 R2
- SO: 64 Bit
- RAM: 4 GB
- Hard Disk: 60 GB
- Applications:
  - Simulator Software
  - Microsoft Visio
  - Instructor Station
  - PS Tools
  - Citrix Xenapp XenDesktop
- Remote Desktop available

ADDITIONAL SERVER

- Virtual Machine
- Windows Server 2012 R2
- SO: 64 Bit
- RAM 4GB
- Hard Disk: 60 GB
- Applications:
  - SQL Server 2012
  - Launch App
  - Training Management
  - PS Tools

Hypervisor

- Physical Machine
- Windows Server 2012 R2
- Hyper-v
- RAM: 32GB
- Hard Disk: SSD 720 GB
- SO: 64 Bit

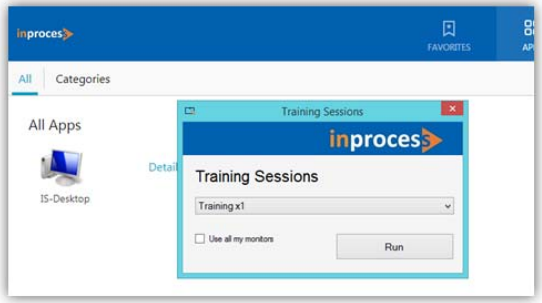
Operator Machine

- Physical Machine
- Windows 7
- RAM: 4 GB
- Hard Disk: 512GB
- SO: 64 Bit

Instructor Machine

- Physical Machine
- Windows 7
- RAM: 4 GB
- Hard Disk: 512GB
- SO: 64 Bit

Case 2: Web Training (ITOP & OTS)



- Benefits of virtualization also present
  - A fast and easy switch between training sessions of different units
  - Saving training status between different training crews, and recovering later on
  - Scalability, allowing for increasing number of units, Operator Stations, or changing screens configuration.
- Additionally, web based contents allowed for
  - Integration in customer data center – base technologies already used (IT happy!)
  - World wide access to resources (offices in different countries)
  - Possibility of multiple, parallel sessions; flexible number of students
  - Role-based access to material
- Ability to demonstrate process hands on to clients!

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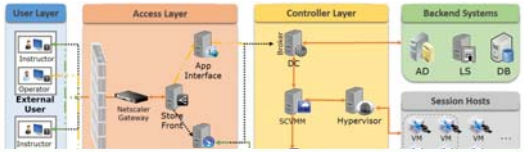

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