Leveraging Virtualization for Spacecraft Operations

GSAW 2012

Mr. Sen Yao

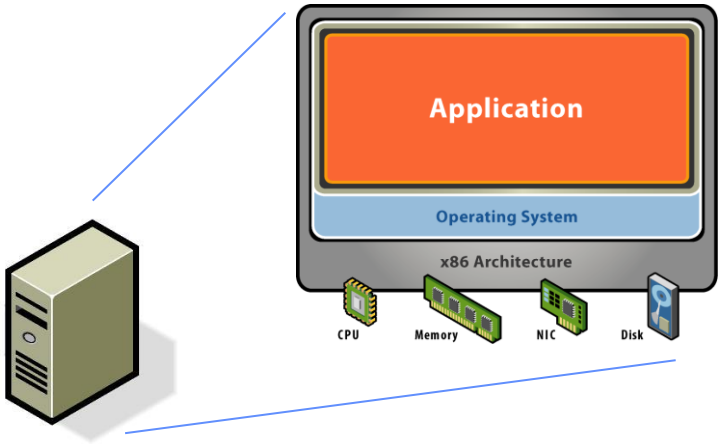
Non-ITAR Marking

Agenda

- Virtualization Overview
- Benefits of Virtualization
- Challenges and Solutions to Virtualization
- Finding the Right Virtual Solution
- Deploying Ground Systems with Virtualization
- Boeing Experience

Overview: Traditional Design

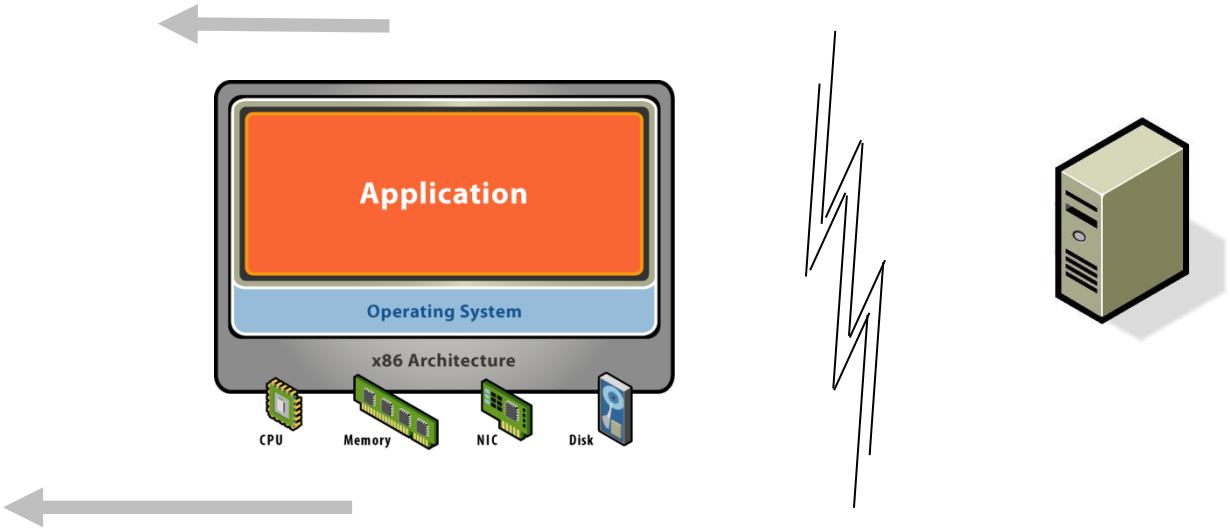
- **Traditional design without virtualization**
  - » **One physical hardware supports one operating system, with one set of applications**
    - – **Each system is individually built from the "ground up"**
  - » **Operating system and applications are tied to specific hardware**
  - » **Obsolescence eventually challenges maintenance**



Inefficient and outdated design model

Overview: Virtualization Design

- **Virtualization and the transition from traditional design**
  - » **Decoupling of hardware and software**
  - » **Encapsulate the operating system and applications into a Virtual Machine (VM)**
    - – **On-demand computing**
  - » **Reduces hardware obsolescence risks**



Design with flexibility to scale with business needs

Virtualization Overview

- **Computing industry has seen a tremendous shift recently towards technologies such as virtualization**
  - » **Virtualization is here to stay, benefits are proven**
  - » **Industry wide acceptance with more virtualized servers being deployed now than traditional servers**
  - » **Technology is stable, capable, and ready for mission critical environments**
- **Benefits are revolutionary**
  - » **Reduced time spent on IT administration and maintenance**
  - » **Improved data protection and backup**
  - » **Enhanced application availability**
  - » **Ability to respond to changing business needs quickly**

Benefits leveraged by computer industries can provide similar benefits to satellite operations

Benefits of Virtualization

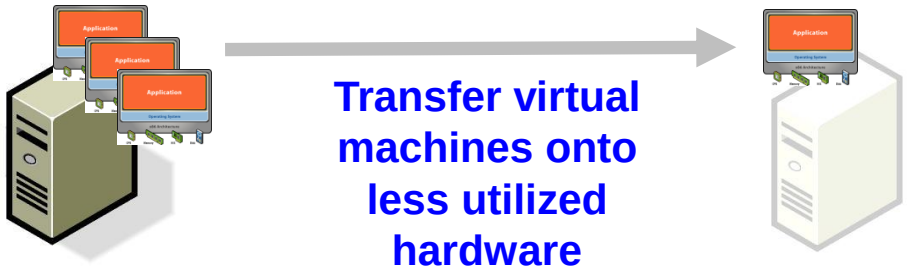
- **Server and Baseband Consolidation**
  - » **Reduce hardware requirements by factors of 10 or better***
  - » **Reduce operating costs with lower power consumption and space allocation ⇒ $ savings**
  - » **Reduce capital and maintenance costs, increase servers-to-admin ratio**
- **Decouple hardware from software**
  - » **Virtual machines run independently from underlying hardware**
  - » **Servers can host virtual machines of different operating systems on same hardware**
  - » **Move virtual machines from one hardware to another effortlessly**
  - » **Hardware as resource pools instead of machines dedicated to a particular function**
  - » **Hardware obsolescence does not equal software obsolescence**

***Source: Vmware.com**

Increase efficiency, flexibility, and responsiveness to ever changing business needs

Benefits of Virtualization (cont'd)

- **Virtual Machine (VM) Load Balancing**
  - » **Automatically optimize and load balance hardware usage on demand**

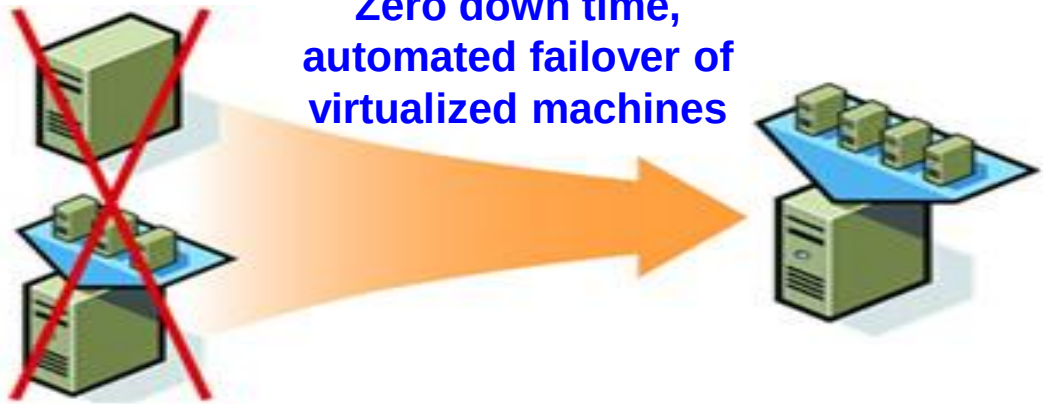


Transfer virtual machines onto less utilized hardware

Hardware at 100% utilization

Hardware on standby, ready for operations

- **Disaster Recovery and Business Continuity**
  - » **Eliminate downtime due to:**
    - » **Hardware failures**
    - » **Hardware maintenance**
  - » **Automate, simplify recovery**

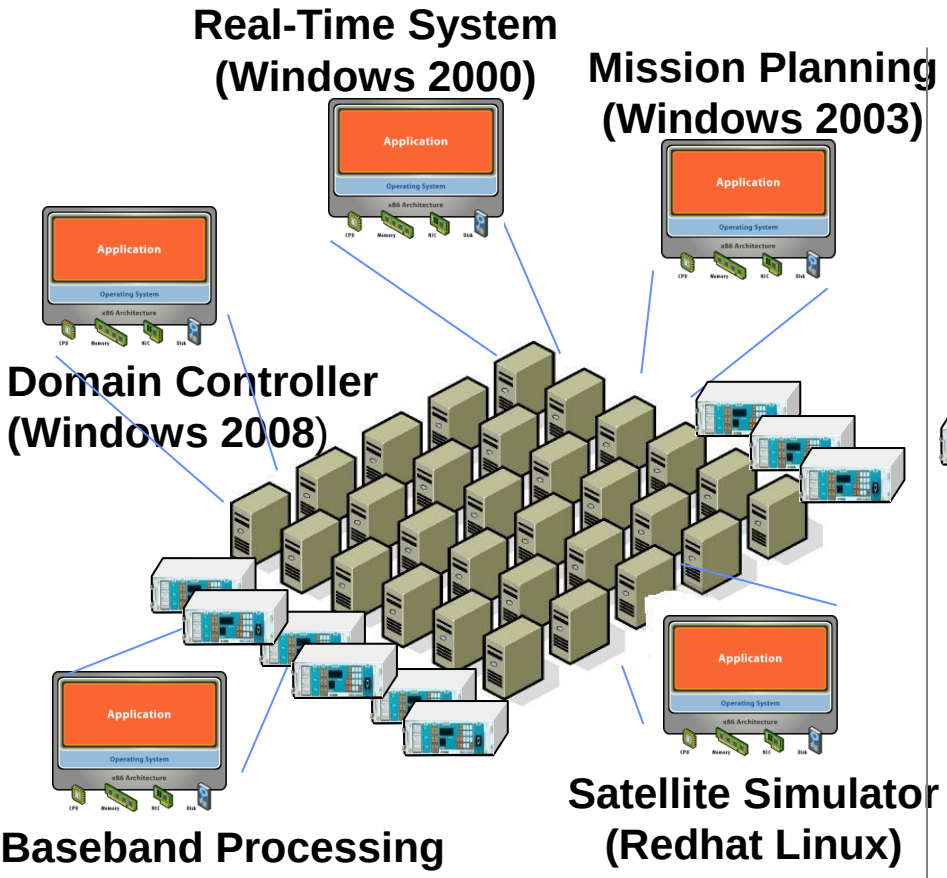


Zero down time, automated failover of virtualized machines

Improved availability, uptime, data protection and backup

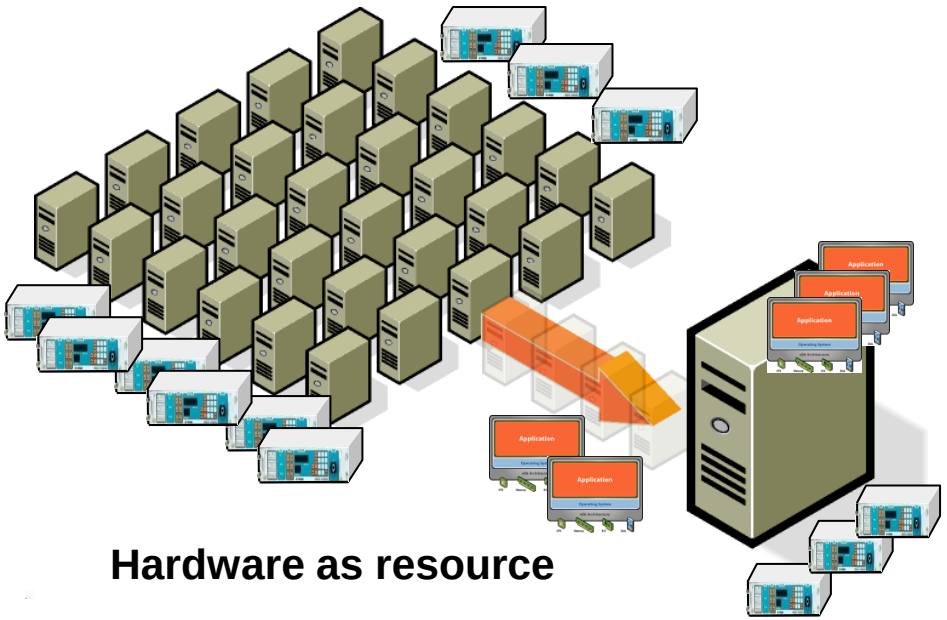
Deploying Ground Systems
Traditional vs. Virtualized Approach

Traditional Architecture



Inefficient, under-utilized, multi-layered platform

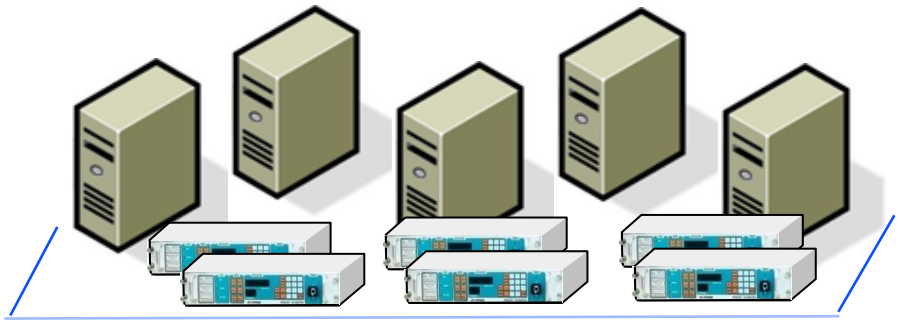
Virtualized Architecture



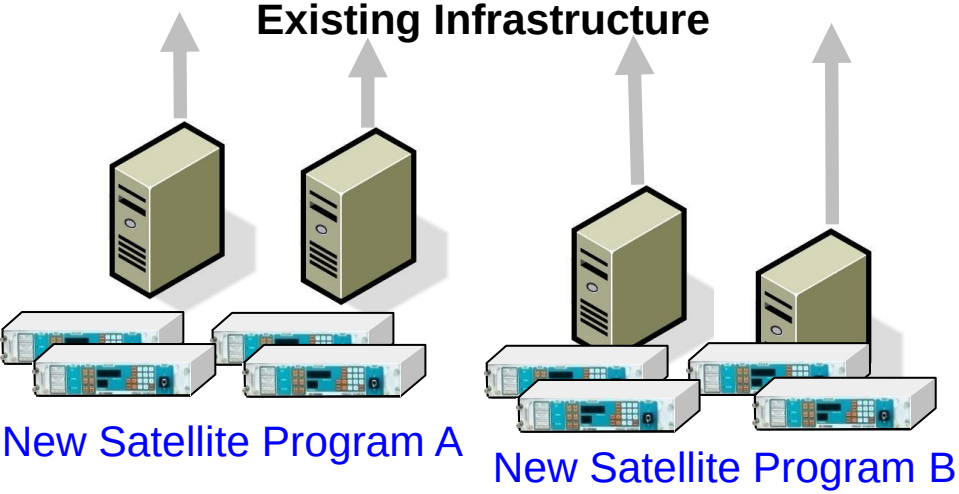
Virtualize, encapsulate, consolidate many platforms onto one

Deploying Ground Systems
Scale with Virtualization

Traditional Architecture



Existing Infrastructure

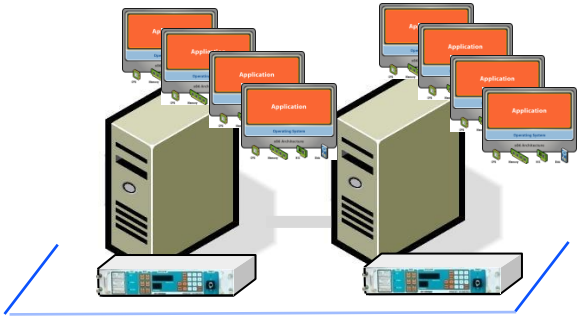


New Satellite Program A

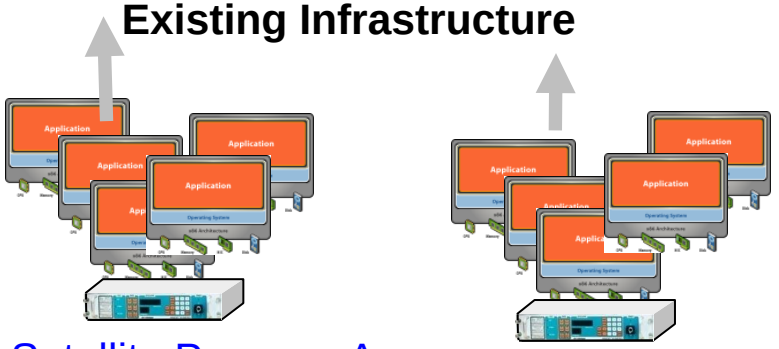
New Satellite Program B

Maximized physical footprint, while under utilizing hardware

Virtualized Architecture



Existing Infrastructure



New Satellite Program A

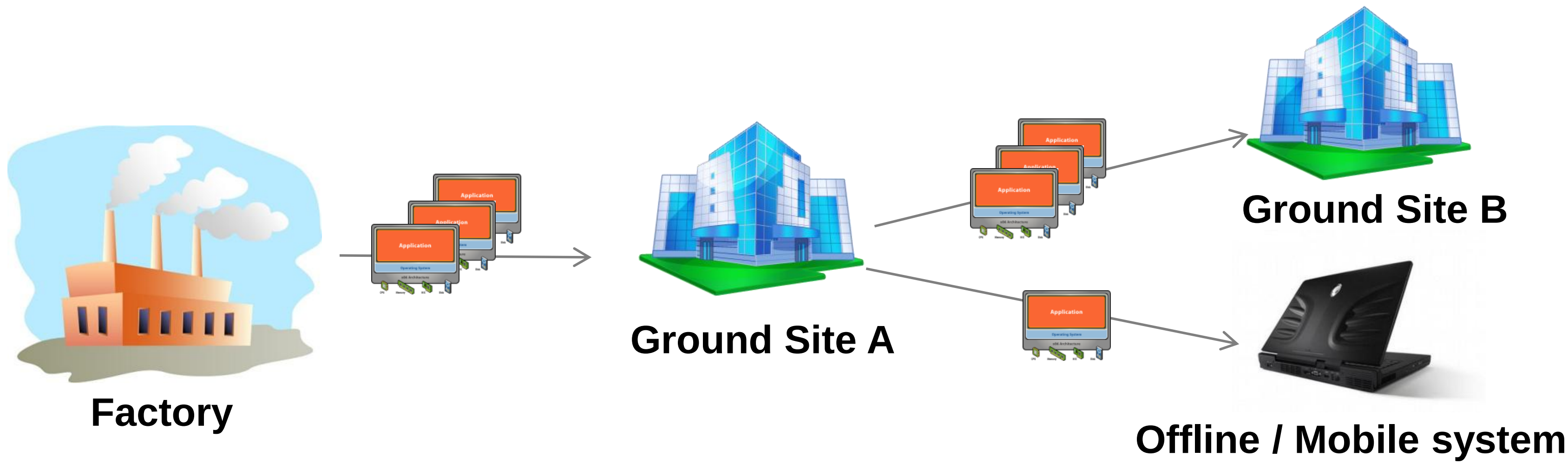
New Satellite Program B

Scale with Minimal Hardware

Maximize hardware utilization, minimize physical footprint

Deploying Ground Systems
Added capability / Flexibility of Operations

- **Software Deployment to Ground Sites**
  - » **Deploy to site quickly and easily <u>without repeated installations</u>**
  - » **Deploy VMs onto multiple test, training, and analysis environments**
  - » **Rollback different software versions with zero or minimum downtime**
  - » **<u>Snapshot</u> and ship deployed VMs back to the factory for analysis and troubleshooting support**



Deploy complete environments, not software components

Challenges to Virtualization

- **Software Application Licensing**
  - » **Software licensing traditionally tied to machine or socket**
  - » **Works in traditional model, not so in virtualized model where many VMs exist on a single physical host**
- **VM Sprawl / Management**
  - » **Ability to easily scale machines means more complexity in managing and tracking these machines over time**
- **Added Network / Storage Requirements**
  - » **Higher capacity storage needed for VMs, snapshots, data**
  - » **Higher demands for fast, reliable, redundant network**
- **Added Complexity to Information Assurance**
  - » **Protecting the hypervisor, the network, and the VMs from hacking is paramount!**

New technologies can present new challenges to overcome

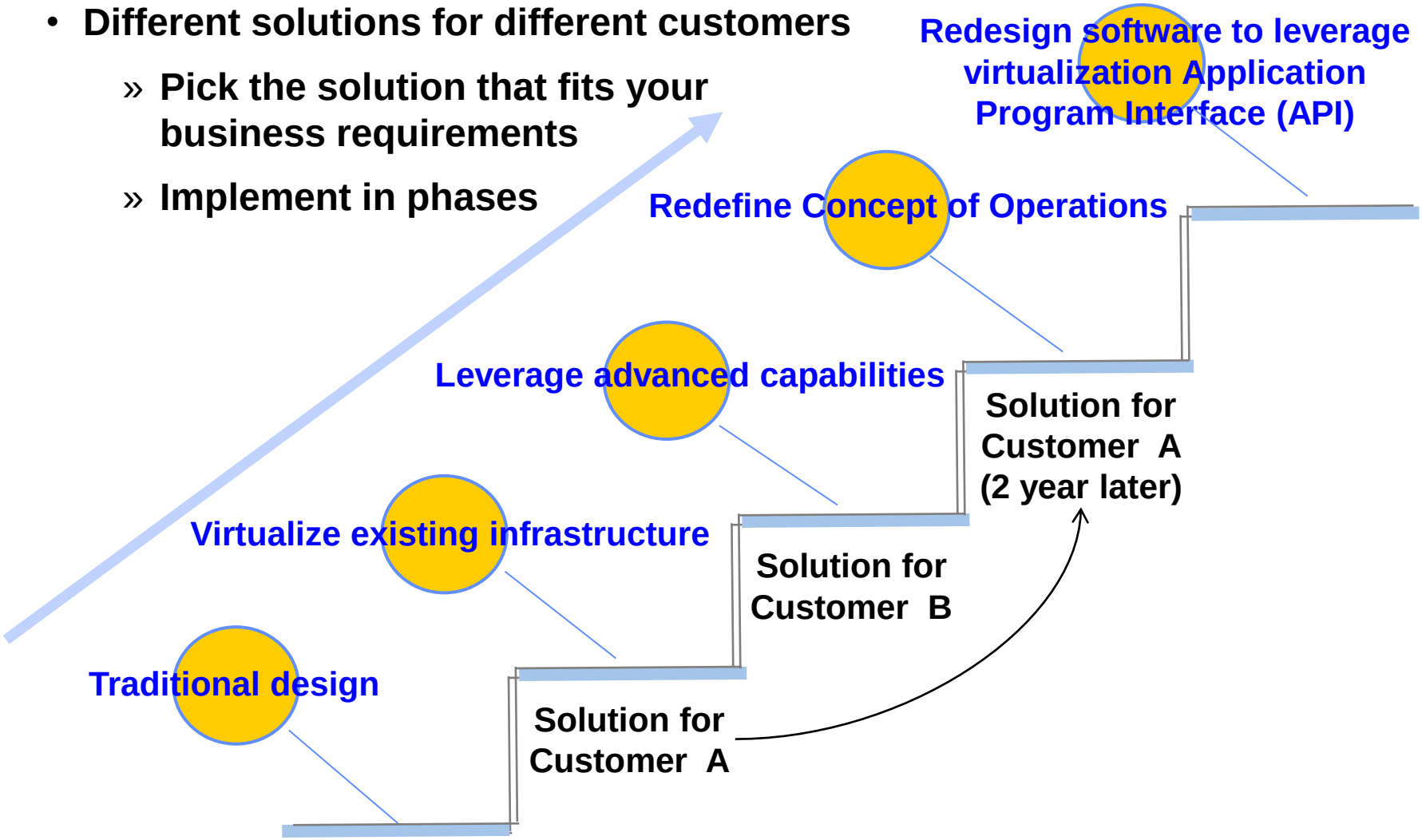
Solutions to Virtualization Challenges

- **Software Application Licensing**
  - » **Software companies have already begun adoption/transition to alternative licensing schemes**
  - » **Negotiate license agreements where possible**
- **VM Sprawl / Management**
  - » **Utilize VM management systems**
  - » **Implement VM best practices**
- **Added Network / Storage Requirements**
  - » **Design proper networks that support virtualization**
- **Added Complexity to Information Assurance**
  - » **Implement "lockdown" procedures from VM vendors**
  - » **Utilize security software designed for virtualization**

Proper planning and management is necessary to leverage virtualization successfully in the enterprise

Finding the Right Virtual Solution
Evolution Instead of Revolution

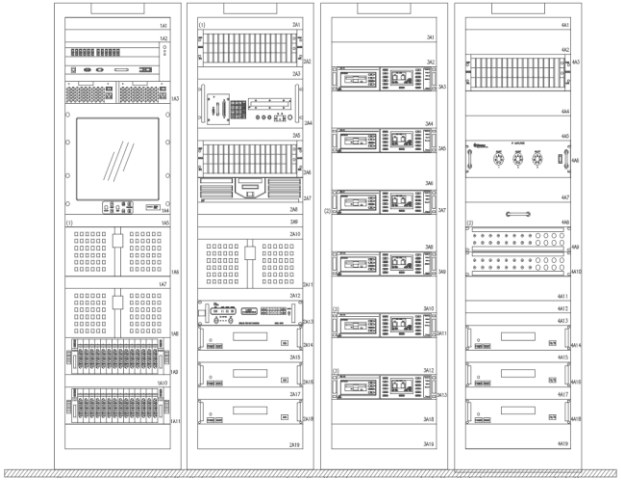
- Different solutions for different customers
  - » Pick the solution that fits your business requirements
  - » Implement in phases



Implement in steps, in accordance with business goals

Virtualization in Systems Operations

- **All-in-one mobile systems (telemetry & command, ground equipment control, and satellite simulators) for training and integration**
- **Ground system re-architecture from a 4-rack system supporting 3 satellites to a 3-rack system supporting 15 satellites**



Original System

Future SatOps System

Virtualization implements designs with realized cost savings

Boeing Experience

- **Boeing has utilized virtualization environments for several years**
  - » **Understand benefits/risks in bringing virtualization into satellite operations**
  - » **Defined software development, integration and test models in virtualized environment**
  - » **Performed factory spacecraft testing with virtualized versions of customer ground systems**
  - » **Partnered with vendors to virtualize servers and baseband processing units**
  - » **Designed, integrated and deployed operationally**
- **Roadmap to virtualization – Implement in Steps, evolution instead of revolution**
  - » **Internal Research and Development**
  - » **Internal use**
  - » **Customer use in training, validation, analysis**
  - » **Satellite operations**

Boeing is ready to help customers leverage virtualization to enhance capabilities and reduce operating costs

Contact Information

- **For inquiries:**

  Robert Winig
  310.416.6646
  robert.j.winig@boeing.com

- **For technical inquiries:**

  Sen Yao
  310.416.2273
  sen.yao@boeing.com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