Transformation to Cloud Computing
Outline

- Background on the course
- The approach to transformation
- Course Details
This Course is a Bit of a Horse of a Different Color

- This course it being taught by a team of IBM Researchers who are experts in their field
- There is no text book because “the book” is still being written ;(-)
Transformation to Cloud Computing

What is Cloud Computing?

…and why would anyone want to transform to it?
Examples of Cloud Computing

Utility Computing

Shared Resources

Computing as a Service

On Demand Provisioning

SaaS, PaaS, IaaS
Consider the Possibilities that Cloud Computing Opens Up?

“On the Internet, nobody knows you’re a dog.”

“On the Cloud, nobody knows you’re a small business!”

* Peter Steiner, The New Yorker, July 5, 1993
Cloud is... All of The Above

Application
- Monitoring
- Content
- Collaboration
- Communication
- Finance

Platform
- Object Storage
- Identity
- Runtime
- Queue
- Database

Infrastructure
- Compute
- Block Storage
- Network

Cloud Computing
Some Cloud Infrastructure Services
Some Cloud Platform Services

- Heroku
- IBM Bluemix
- Engine Yard
- Google App Engine
- AppScale
- OpenShift
- Docker
Some Cloud Software Services

- Workday
- Xero
- Marketo
- Salesforce
- Intacct
- NetSuite
- New Relic
- SugarCRM
What we mean when we say “Cloud Computing”

- A fundamental shift from physical infrastructure to virtual infrastructure
  - Seen as a major paradigm shift

- A rapid way of provisioning and later releasing computing services on the network

- Some important characteristics:
  - Rapid/automated provisioning and (later) release of services
  - Can be Pay-as-you-go
  - Appearance of infinite resources
  - Could be managed or unmanaged
  - and more…

- Types of Clouds:
  - Based on service:
    • Software as a Service (SaaS)
    • Platform as a Service (PaaS)
    • Infrastructure as a Service (IaaS)
  - Based on ownership:
    • Public Clouds
    • Private Clouds
    • Hybrid Clouds
Transformation

What is Transformation to Cloud?
Transformation is Migration

- Since the cloud is virtual you cannot “move” a “physical” computer into a cloud
  - But you can move the disk image into the cloud (which can be just as good)
    - …unless you had lots of “junk” on your computer because you might not want that on your new cloud server (note: we call this “your mess for less”)
  - Or you can build a new server in the cloud that looks just like the old server
    - When we build a new server we sometimes call this “workload” migration because we are migrating the “work” that the server is doing into another server in the cloud.

- What if the cloud doesn’t support your server’s OS platform?
  - Now you have to “re-platform” to a new OS which could get tricky
  - This is a lot like building a new server but what about all of the software? Will it still work?
### Types of Migration

- **Image Migration**
  - Capture an image of the server and reconstitute in the cloud
    - P2V (Physical-to-Virtual)
    - P2I (Physical-to-Image)

- **Application / Workload Migration**
  - Build a new server to run the workload in the cloud
    - Re-install
    - Re-platform
    - Consolidation
  - Build from a Template
    - IAAS
    - PAAS
  - Build via Specification Cloning
    - Use the physical server specs to build an exact duplicate virtual server
Types of Clouds

- **Unmanaged Clouds**
  - Do-It-Yourself from scratch
  - Possibly bring your own image
  - Anything goes but you fix it when it breaks

- **Managed Cloud**
  - Assistance in on-boarding
  - Only certain image infrastructure is allowed
  - Bring your own image may not be supported
    - Or image compliance must be adhered to
  - Steady state is managed
    - Patch management
    - Upgrade management
More Types of Clouds

- Clouds can be Public, Private, or Hybrid
  - Public to all on cloud provider’s infrastructure
  - Private to business on dedicated business infrastructure
  - Private to business on shared cloud provider’s infrastructure
A transformation example you may have seen

Switch 101
Migrate to Mac

Ready to begin? Just tell us what you want to know:

- **Welcome to Mac**
  This section shows you how to shed some of your old PC habits and do the same tasks on your Mac. We show you how to get around the Mac's interface, tell you where things are located and how things are done, and show you how to do the same tasks you're used to doing on a PC on a Mac.

- **Migrate your files**
  You can move many of your old PC files to your Mac. This section shows you what kinds of files you can bring right into the Mac platform, how to move everything into your new Mac home, and what you may need to do to make some things work.

- **Connect your peripherals**
  Got a treasure trove of digital devices? Find out how to connect your former Windows printer, modem, network, scanner, digital camera, DV camera, iPod, external drive, and more to your Mac.

- **Get me started on the software**
  Ready to email, surf Safari, groove to tunes, or get iLife? This section shows you how to use the Apple applications that come with your Mac. The link above transports you to "Mac 101: All Work and Play" (our special web series for new computer users).

- **Show me how to set up my Mac for me**
  Make your Mac work the way you want. Click the link above to visit "Mac 101: Customize My Mac," which shows you how to create multiple accounts, customize your Mac's look and feel, set preferences, adjust the sound volume, and more.

- **My Mac needs help**
  For those times when things don't go as planned, this link takes you to "Mac 101: Troubleshooting 101," which will help you troubleshoot common Mac issues and show you some maintenance tips to keep your Mac happy.

- **My Mac Cheat Sheet**
  Who wants to remember Internet settings, account information, computer specs, and other bits of important data when there's so much to explore on your Mac? With this helpful sheet, you won't need to. Jot down the information once, and you're good to go.

A transformation example you may have seen

Switch 101
Migrate to Mac

Ready to begin? Just tell us what you want to know:

- **Welcome to Mac**
- **Know your Target Platform**
  This section shows you how to shed some of your old PC habits and do the same tasks on your Mac. We show you how to get around the Mac’s interface, tell you where things are located and how things are done, and show you how to do the same tasks you’re used to doing on a PC on a Mac.

- **Migrate your files**
- **Migrate what you can**
  You can move many of your old PC files to your Mac. This section shows you what kinds of files you can bring right into the Mac platform, how to move everything into your new Mac home, and what you may need to do to make some things work.

- **Connect your peripherals**
  Got a treasure trove of digital devices? Find out how to connect your former Windows printer, modem, network, scanner, digital camera, DV camera, iPod, external drive, and more to your Mac.

- **Get me started on the software**
  Ready to email, surf Safari, groove to tunes, or get an iLife? This section shows you how to use the Apple applications that come with your Mac. The link above transports you to “Mac 101: All Work and Play” (our special web series for new computer users).

- **Show me how to set up my Mac for me**
  Make your Mac work the way you want. Click the link above to visit “Mac 101: Customize My Mac,” which shows you how to create multiple accounts, customize your Mac’s look and feel, set preferences, adjust the sound volume, and more.

- **My Mac needs help**
- **Test and fix Problems**
  For those times when things don’t go as planned, this link takes you to “Mac 101: Troubleshooting 101,” which will help you troubleshoot common Mac issues and show you some maintenance tips to keep your Mac happy.

- **My Mac Cheat Sheet**
  Who wants to remember Internet settings, account information, computer specs, and other bits of important data when there’s so much to explore on your Mac? With this helpful sheet, you won’t need to. Jot down the information once, and you’re good to go.

*Example from Apple  [http://www.apple.com/support/switch101/]
Why switch personal computer platforms?

- Will it save me money?
- Will I have fewer crashes?
- Will all my software work?
- Will the things work that I need?
- Will the service be better?
Why switch to cloud? A Business Perspective

- My machines, my OS
- My management tools, my management processes
- My delivery model

- Standardized OS and no worries about machines
- Standard set of tools, standardized processes
- Standard Cloud Delivery model

My mess for less

All good and cheaper in the Cloud
If costs will be significantly lower in Cloud offerings compared to current costs, will businesses tolerate running two models in parallel?

- Initially this may be the case
- The future of business computing environments is likely to trend towards sourcing from Cloud providers.
- How will IT service providers manage the desire from businesses to have cost benefits of standard delivery models while retaining some level of customization (some of which is driven by industry/geo specific regulation)
- The transition is challenging and businesses want to understand how to do this with a short time to payback
Corporate legacy has positive and negative sides and forms a legacy value stack

Legacy can be heritage or burden. Technologies can help customers to identify which legacy is heritage and which is burden, and help to take the appropriate actions to handle legacy.

Corporate legacy cuts across every aspect of the enterprise. Therefore, it can only be addressed effectively if it integrates Systems, People & Culture, and Processes around an agile business and information design.

Want to reduce, replace, control & get rid of it

“Bad” Legacy

Want to leverage & expand on it

“Good” Legacy

Legacy needs to be treated differently depending on the heritage/burden aspect. Any legacy related effort has higher value when targeting higher items in the legacy stack.

Business model legacy

Business process legacy

Software & data legacy

Infrastructure legacy

Increasing value
Transformation is Not Easy

- **Production workloads** are running and can’t be disrupted

- **System structure never fully known**
  - Personnel that knew the systems changes
  - Documentation gets out of date

- **Systems very heterogeneous**
  - Several generations of technology
  - Line-of-business governance for distributed systems
  - Mergers and acquisitions

- **Hence transformation cost** often exceeds the expected benefits, and important transformations are not undertaken.
  - **Big area for improvement!**
Outline

- Background on the course

- The approach to transformation

- Course Details
What is this Course About?

- **Enterprise IT needs constant changes:**
  - New business needs
  - Reduce cost by new technology

- **Examples:**
  - Servers consume about 1.2% of the electrical power produced in the US
  - Many servers have around 10% utilization – very inefficient
  - Technology often gets 10-15 years old because upgrade too risky

- **Gradual transformation** vs complete overhaul

- We present approaches for typical enterprise IT transformation problems

![Utilization of 9 servers in 24 hours (30-min slots), scale on the right](image)
From An ROI perspective – successful enterprise IT transformation reducing risk/cost of migration and increasing steady state benefit
Case Study for this Course
Case Study Details

- ACME wants to migrate some of their IT Services to the cloud
- They “think” they have about 2000 – 3000 Servers running a variety of:
  - Linux 64-bit, 32-bit
  - AIX
  - Sun Solaris
- Running middleware such as:
  - DB2
  - Oracle
  - MySQL
  - WebSphere Application Server
  - JBOSS
  - Tomcat
  - SAP
- In support of applications like:
  - Company Web Site
  - Human Resources
  - Manufacturing
  - Shipping and Logistics
  - Custom Written Departmental Applications
Conceptual Migration Workflow

1. Know your Target
2. Discover your Source
3. Analysis & Design
4. Provision & Configure
5. Migrate & Remediate
6. Test
7. Cut-over
Transformation Workflow Overview

**Discover**
- Collect the client technical, application, and financial data

**Analyze**
- Select migration candidates
- Create macro design(s), ROI, and plan with client

**Map**
- Create micro design for selected sources and targets, using discovered data as reference
- Create provisioning request for new or migrated servers

**Provision**
- Build, provision, and configure the target platform(s) environment and application components:
  - OS
  - Middleware
  - Filesystems
  - Users
  - Hardware
  - Network

**Migrate**
- Perform migration of source middleware configuration to target environment(s)

**Test**
- Leverage User transactions to automatically test and compare target servers to source
- Application and script transformation to target OS
Detailed Architecture for Enterprise IT Transformation

**Customer and infrastructure data collection** (manual and automated)
- Infrastructure data collection
- Organizational data (owners ...)
- Customer goals and plans

**Analytics, Design, Planning**
- Target options
- Technical compatibility
- Business constraints
- Placement optimization
- Wave planning
- ROI analysis

**Procurement and physical setup**
- Hardware and software ordering
- Setup of physical infrastructure if new

**Migrate, modify**
- Core migration methods:
  - Lift-and-shift
  - Copy
  - Provision and backup-restore
- Apply changes from design
- Start

**Test and remediate**
- Unit tests
- Comparison tests
- User acceptance tests
  If fails, back to “modify” or initial state

**Synchronize and cutover**
- Educate
- Resynchronize test system with source
- Switch operation over
- Registrations etc.

**Non-customer sources**
- External product descriptions
- Benchmarks

**Consolidated data repositories**
- Customer data
- Historic data
- General technical and financial data
- Models

**Migration Analytics**
- Operational improvement

**Project workflow and status visualization**
- Benchmark assessment
- Macro design
- Micro design
- Contracts

For large migrations in waves = groupings migrated at different times.
Possibly even micro-design and procurement in these waves
Possibly several optimization phases
Part 1

- Lecturer: Murthy Devarakonda, IBM Research, mdev@us.ibm.com
- Brief Introduction to Cloud Terms Used
- Cloud Economics: User perspective
- Cloud Economics: Provider perspective
- Reading:
Lecture: Discovery

- This has two dimensions: What data to collect, and how. The what is determined by the repository and by the project workflow. The how must suit the data and the customer.

Customer data collection

Infrastructure data collection
- Standard templates for early customer overviews
- Standard products brought by Services team
- Additional scripts for data not otherwise available
- Preexisting 3rd-party tools at customer
- Including application and data dependencies
- Including utilization discovery

Organizational data collection
- Roles, responsibilities, meeting data etc.
- Credential acquisition data (approval processes, status of asking, finally credentials)
- Business data for the infrastructure

Customer goals and plans
- Timelines, budgets
- Focus: ROI, space, power...
- Constraints: facilities, vendors, consolidation layers...

Adapter infrastructure
- Prebuilt adapters for services team’s tools
- .. and for standard APIs and typical tools present at customer
- Library for building more adapters

Data collection workflow and visualization
- What data to start / finish collecting when
- What tools to use, depending on customer inputs about goals, installed tools, approval processes
- Status tracking of credential acquisition and data collection

This part is automatable, but not fully automated in all phases at all customers

These parts also need standard templates

Consolidated data repositories
Lecture: Analytics, Design and Planning

- All the data used here are in the consolidated data repositories, or must be estimated based on those data.

### Analytics

**Benchmark assessments**
- Estimating gains and cost with few customer data, more historic data

**Technical compatibility**
- Depending on consolidation layer: SW-OS, OS-VM or OS-HW, cloud image options, software upgrade and change options (possibly with prices)
- Simple size constraints
- Migration costs for different scenarios

**Business constraint analysis**
- Workload-level performance (rough – no benchmarks for complex changes)
- Availability, backup, disaster recovery
- Security and compliance
- Other mgmt processes: Maintenance windows, change mgmt, ....

**Optimization (ultimately for cost)**
- Using resource utilization factors, for target systems from customer goals.
- Placement: Multi-dimensional bin packing: multiple utilization dimensions, and the technical and business constraints. Goal variable: typically cost, using the financial data. Might also be power or floor space.
- Rarer: storage and network usage optimization

**Wave planning**
- Groupings of servers or business application for joint migration

### Analytics, design and planning workflow

- Lots of reports and visualizations, as this is not fully automated yet
- ROI analysis may also include soft cost (licenses, server management ...).
- What-if-scenarios, storing important intermediate results, signoffs

![Consolidated data repositories](image)

Procurement and physical setup
Lecture: Automatic Migration

- Where ‘the business occurs’ the actual doing of the migration, after all the planning and procurement has concluded.

**Migrate, Modify**

**Core Cloud migration methods**
- Copy: Create an exact copy of the source servers, e.g. image copy. Copy this image between source and target directly or via intermediate. Live vs. non-live migrations
- Provision and backup-restore: Provision a new server based on details provided in design starting with OS installation. Introduce software packages in a phased approach. Initiate backup (source) and restore (target) once new system available

**Apply changes from design (sometimes in middle of migration)**
- Use-case driven modifications often needed.
- Ability for direct operator intervention
- Modification scope varies widely, and is package specific
- For complex scenarios, code change may be necessary

**Start**
- Either manual initiation or scheduled initiation.
- Need for real-time situation awareness
- New ideas: Provisioning to Cloud environments, image analysis.

**Migrate, modify workflow**
- Process constrained by schedule and resource availability per consolidated data repositories
- Requirement for exact data alignment between migration tooling and analysis
- Permit migration engineer overrides and in flight modification (constrained)
Lecture: Transformation and the Network

Networking Aspect

- Customer and infrastructure data collection
- Analytics, Design, Planning
- Procurement and physical setup
- Migrate and modify
- Test and remediate
- Synchronize and cutover
- Non-customer sources
- Consolidated data repositories
- Migration Analytics

Project workflow and status visualization
Lecture: Network Transformation

- Large scale changes to the Network Infrastructure of a company
- Key Objective
  - Maximize effectiveness of the enterprise network while keeping costs under control
- Example: Firewall Infrastructure Consolidation
  - Over time, the firewall infrastructure of an enterprise grows organically, eventually resulting in management, maintenance, and cost issues
  - Reduce the number of firewalls, while retaining flow control restrictions
Test and RemEDIATE

The point at which the ‘rubber meets the road’. Was the migration successful, if not, what are you going to do?

Test and Remediate

User Tests
- Test cases often developed during initial product development.
- For smaller systems, incremental improvements may have limited or inadequate test sets.
- For larger systems, full regression testing very costly.
- Risk, risk, risk. Remediation always ‘under the gun’ to complete
- Migration directed code coverage analysis tools provide value.

Comparison Tests
- Configuration comparison
- Running pre and post migration systems in parallel; very complex but provides high assurance of successful migration

User Acceptance Testing
- Essential to have clear UAT understanding before migrations start!
- Heavy reliance on strong client / provider relationship
- Area with greatest risk
- Observation: Most time consuming phase of the migration
- Observation: Perform on new dev test system, then promote
- New ideas: Integrated model based testing

Test and remediate workflow
- Iterative process to ensure that target behaves in same fashion as the source.
- Essentially involves exercising pre agreed test cases until such time as UAT passes
- Application specific SME often needed to assist in troubleshooting.
- Very difficult to ensure scripts etc. correctly migrated (often not originally part of test plan)
Synchronization and Cutover

- Finally, one can start using the new version of the system

### Synchronize and cut-over

#### Synchronize
- Except with lift-and-shift, source system typically keeps running during most of the prior phases
- So it’s now in a different state than the new / test system
- Resynchronize – typically using same copying tool instance as in migration

#### Cut-over
- If possible, only switch DNS to new IP addresses
- Else change clients

#### Registration and deregistration
- Enter new systems in asset management systems etc.
- Change status of old systems

#### User education
- If systems changed noticeably, teach users (probably started during test phase)

#### Decommissioning
- Typically old systems are kept for a while
- At some point, really decommission hardware (may be for reuse)
Outline

- Background on the course

- The approach to transformation

- Course Details
Course Evaluation

- 50% Assignments (3 total)
- 20% Mid-term Exam
- 20% Final Exam
- 10% Class Attendance
<table>
<thead>
<tr>
<th>Lecture Title</th>
<th>Lecturers</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Transformation To Cloud Computing: Course and Projects Overview</td>
<td>Nikolai Joukov, Murthy Devarakonda, Hari Ramasamy, John Rofrano</td>
<td>09/03</td>
<td>Introduction to cloud, IT transformation, and need for transformation in enterprise infrastructures. Description of course projects.</td>
</tr>
<tr>
<td>2. Clouds and Other Transformation Goals</td>
<td>Murthy Devarakonda</td>
<td>09/10</td>
<td>Economics of cloud, types of cloud</td>
</tr>
<tr>
<td>3. Enterprise IT Today, IT Discovery</td>
<td>Nikolai Joukov</td>
<td>09/17</td>
<td>Enterprise IT today is a mix of technologies from 80s, 90s, 00's, and state-of-the-art technologies.</td>
</tr>
<tr>
<td>4. Workload Placement: Analytics, Design, and Planning</td>
<td>John Rofrano</td>
<td>09/24</td>
<td>Analysis to identify which workloads are candidates for migration to cloud. Algorithms to optimize placement of such workloads on the target cloud platform.</td>
</tr>
<tr>
<td>5. Automatic migration</td>
<td>John Rofrano</td>
<td>10/01</td>
<td>Automation technologies for physical-to-virtual migration, re-installation, and re-platforming of OS instances and applications.</td>
</tr>
<tr>
<td>6. Student Assignment #1 Review</td>
<td></td>
<td>10/08</td>
<td>Students present and discuss the results of their 1st assignment</td>
</tr>
<tr>
<td>7. Enterprise Storage Systems, DevOps Technologies</td>
<td>Nikolai Joukov</td>
<td>10/15</td>
<td>Deep dive into Enterprise Data Storage Systems</td>
</tr>
<tr>
<td>8. Transformation and the Enterprise Network</td>
<td>Hari Ramasamy</td>
<td>10/22</td>
<td>Most transformation activities will involve changes to the networking infrastructure. We'll cover automation techniques for network reconfiguration during transformation to cloud.</td>
</tr>
<tr>
<td>9. Mid-term</td>
<td></td>
<td>10/29</td>
<td>Grades deadline is 11/03</td>
</tr>
</tbody>
</table>
## Schedule from Mid-term Exam to Final Exam

<table>
<thead>
<tr>
<th>Lecture Title</th>
<th>Lecturers</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. Student assignment #2 review</td>
<td></td>
<td>11/05</td>
<td>Students present and discuss the results of their 2&lt;sup&gt;nd&lt;/sup&gt; assignment</td>
</tr>
<tr>
<td>11. Experiences in Transformation to Hybrid Cloud: A Case Study for a Large Financial Enterprise</td>
<td>Hari Ramasamy</td>
<td>11/12</td>
<td>Nearly half of large enterprises will have hybrid cloud deployments by the end of 2017. We will describe a case study in hybrid cloud design spanning an on-premise private cloud, traditional IT infrastructure, and a public cloud.</td>
</tr>
<tr>
<td>12. Migration to Cloud Decision Support</td>
<td>Murthy Devarakonda</td>
<td>11/19</td>
<td>Framework tools for deciding what applications can and should be migrated to cloud</td>
</tr>
<tr>
<td>13. Student assignment #3 review</td>
<td></td>
<td>12/03</td>
<td>Students present and discuss the results of their 3&lt;sup&gt;rd&lt;/sup&gt; assignment</td>
</tr>
<tr>
<td>14. Final Exam</td>
<td></td>
<td>12/11</td>
<td></td>
</tr>
</tbody>
</table>
Cloud Migration Assignments (x3)

- The assignments are designed to build on each other.

- The end goal is to migrate your first application workload into a cloud.
  
  - First assignment is to analyze the application structure and understand it's run time behavior.

  - Second assignment is to estimate the size and number of VMs needed, and migrate the applications to VMs (application starts out as a non-virtualized code)

  - Third assignment is put it on a cloud, run it, and measure it.

- This course will give you all of the skills necessary to accomplish these tasks
Questions?