CLOUD COMPUTING AND ITS IMPACT ON THE CONSTRUCTION INDUSTRY

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Cloud computing is Internet-based computing that provides shared processing resources and data to computers and other devices on demand.

It is on-demand access to a shared pool of computing resources.

Cloud computing and storage allow customers to store and process their data in third-party data centers.

It enables sharing of resources to achieve economies of scale, similar to a utility (like the electricity grid) over a network.
Cloud computing allows companies to avoid upfront infrastructure costs, and focus on projects that differentiate their businesses instead of on infrastructure.

Cloud providers typically use a "pay as you go" model.

Companies can scale up as computing needs increase and then scale down again as demands decrease.

Customers focus on their core business.
WHAT CHANGED?

1. Availability of high-capacity networks and high-performance servers
2. Low-cost computers and storage devices
3. Widespread adoption of hardware virtualization
4. Cheap cost of services (CFO’s have taken notice!)
5. Scalability
6. Accessibility and availability.
• **Cloud clients**: Users access cloud computing using networked devices, such as desktop computers, laptops, tablets and smartphones.

• **Software as a service (SaaS)**: Customers access application software and databases. Cloud providers manage the infrastructure and platforms that run the applications. This eliminates the need to install and run the application on the cloud user's own computers. Reduces cost by outsourcing hardware and software maintenance and support to the cloud provider. SaaS is sometimes referred to as "on-demand software" and is usually priced on a pay-per-use basis or using a subscription fee. (Example: Microsoft Office 365)
• **Platform as a service (PaaS):** PaaS vendors offer a development environment to application developers (example: applications (Apps) for iPhone or iPad). Customers do not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but have control over the deployed applications and possibly configuration settings.

• **Infrastructure as a service (IaaS):** Customers lease Virtual Machines from the provider and install operating-system images and their application software on them. The cloud user patches and maintains the operating systems and the application software. Cloud providers typically bill the amount of resources allocated and consumed. (Example Advance 2000).
DEPLOYMENT MODELS

- **Private cloud**: cloud infrastructure operated solely for a single organization, whether managed internally or by a third-party, and hosted either internally or externally. Requires Virtualization (P to V) and self-run data centers which have a significant physical footprint, hardware, and environmental controls. These assets have to be refreshed periodically, resulting in additional capital expenditures. Users still buy, build, and manage them and thus do not benefit from less hands-on management and the cloud economic model.

- **Public cloud**: services are rendered over a network that is open for public use. Generally, public cloud service providers like Amazon AWS, Microsoft and Google own and operate the infrastructure at their data center and customers access it via the Internet. Private connections can be purchased as well.

- **Hybrid cloud**: cloud computing service that is composed of some combination of private, public and community cloud services, from different service providers. An organization can store sensitive client data in-house on a private cloud application, but interconnect to a business application provided on a public cloud as a software service. Also organizations can use public cloud computing resources to meet temporary capacity needs that cannot be met by their private cloud.
LIMITATIONS OF CLOUD COMPUTING

• Limited customization options.

• Cheaper because of economies of scale: the customer can only get what is offered. Fewer options at a cheaper price.

Security and Privacy
• The Cloud Provider can access the data that is in the cloud at any time.

• Risk of accidental or deliberate alteration or deletion of information.

• Release of information to law enforcement or court order. The Customers have very limited control.
WHO ARE THE LARGEST CLOUD PROVIDERS?

1. Amazon AWS
2. Microsoft 365, Dynamics, Azure
3. Google Apps
4. Apple
5. SalesForce
6. IBM Softlayer
7. Facebook
8. Verizon Terremark
9. AT&T
Network latency is the round trip delay that happens in data communication over a network. Measured in milliseconds.

Edge computing pushes applications, data and computing power away from centralized points to the logical extremes of a network.

Edge services decrease the data volume that must be moved, the consequent traffic, and the distance the data must go, thereby reducing transmission costs, shrinking latency, and improving quality of service (QoS).

Edge computing replicates information closer to the customer base and traffic between the source and the edge is primarily updates.
Agenda

• Data Center Demand Drivers

• General Market Trends

• Atlanta & North Carolina Trends

• What We’re Watching / Key Takeaways
SECTION I
Demand Drivers
Who Is Leasing Data Center Space?

The usual suspects grab the headlines....
Who Is Leasing Data Center Space?

...but it’s traditional industries too

Financial Services

Healthcare

Government

Insurance

Retail

Education

Law Firms

Oil & Gas

Manufacturing
Market Size Comparison

- Largest U.S. markets are comparable to country-size markets in other regions
- Market concentration at the top – consistent across regions
- M&A transforming landscape
- More sophisticated customers creating differentiation among providers
- Flexibility & scalability becoming increasingly more important

<table>
<thead>
<tr>
<th>Country/Region</th>
<th>Total Operational Square Feet (Millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States (Total)</td>
<td>37.9</td>
</tr>
<tr>
<td><strong>Northern Virginia (US)</strong></td>
<td>4.9</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>4.4</td>
</tr>
<tr>
<td><strong>New York/New Jersey (US)</strong></td>
<td>4.2</td>
</tr>
<tr>
<td><strong>Northern California (US)</strong></td>
<td>4.1</td>
</tr>
<tr>
<td>Japan</td>
<td>3.8</td>
</tr>
<tr>
<td>Germany</td>
<td>2.6</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>2.1</td>
</tr>
<tr>
<td>Singapore</td>
<td>2.1</td>
</tr>
<tr>
<td>Australia</td>
<td>2.0</td>
</tr>
<tr>
<td>Netherlands</td>
<td>1.3</td>
</tr>
<tr>
<td>Brazil</td>
<td>0.8</td>
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</table>

Source: 451 Research, 2014-15
## M&A Activity

<table>
<thead>
<tr>
<th>M&amp;A Activity</th>
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</thead>
<tbody>
<tr>
<td>Equinix</td>
<td>Telecity</td>
</tr>
<tr>
<td>Operator</td>
<td>Operator</td>
</tr>
<tr>
<td>ST Telemedia</td>
<td>Virtus</td>
</tr>
<tr>
<td>Investor</td>
<td>Operator</td>
</tr>
<tr>
<td>Digital Realty</td>
<td>Telx</td>
</tr>
<tr>
<td>Operator</td>
<td>Operator</td>
</tr>
<tr>
<td>NTT</td>
<td>E-shelter</td>
</tr>
<tr>
<td>Telco</td>
<td>Operator</td>
</tr>
<tr>
<td>QTS</td>
<td>Carpathia</td>
</tr>
<tr>
<td>Operator</td>
<td>Managed Hosting</td>
</tr>
<tr>
<td>NTT</td>
<td>RagingWire</td>
</tr>
<tr>
<td>Telco</td>
<td>Managed Hosting</td>
</tr>
<tr>
<td>Zayo</td>
<td>Latisys</td>
</tr>
<tr>
<td>Carrier</td>
<td>Managed Hosting</td>
</tr>
<tr>
<td>Telstra</td>
<td>Pacnet</td>
</tr>
<tr>
<td>Telco</td>
<td>Carrier</td>
</tr>
<tr>
<td>Shaw</td>
<td>ViaWest</td>
</tr>
<tr>
<td>Telco</td>
<td>Operator</td>
</tr>
</tbody>
</table>

- **Sector is at an all-time high for investment activity**
- **Acquisition prices at historically high levels**
- **High barriers to entry, capital intensive industry**
- **Appetite for investment remains high – more consolidation ahead**
SECTION II
GENERAL MARKET TRENDS
National Trends

- Banner year for demand in 2015
- Primary markets continue to capture majority of large requirements
- Recession proof demand?

- Enormous investor appetite, but not every asset a “diamond-in-the-rough”
- Enterprise users are ramping up strategies to monetize their data center assets

- Customer sophistication moving beyond core IT; TCO-centric markets benefit
- Multi-tenant market: lack of supply for variable resiliency requirements (N vs. 2N)

- Network/connectivity rapidly emerging as core attribute of “investment worthy” real estate
Data Center Market Maturity

Source: CBRE Research

MARKET GROWTH

HIGH

MODERATE

LOW

MARKET PROFILE

DEVELOPING/TERTIARY

EMERGING/SECONDARY

MATURE/PRIMARY

Northern VA
Silicon Valley
Dallas
Chicago

Minneapolis
Phoenix
Atlanta
NY/NJ

Nashville
North Carolina
Portland
Supply Trends

- There were 226 MW under construction in Primary markets at beginning of 2016
- 46% pre-leased
- 6 leases by large cloud providers account for 73% of pre-leasing
- 122 MW of speculative capacity being built

Pre-Leased - 104 MW

8 additional leases

- 28
- 12
- 15
- 10
- 9
- 22

6 cloud leases, 76 MW total
SECTION II
Atlanta & North Carolina
New CBRE report compares cost to build, own and operate a 5 MW enterprise data center across 30 U.S. markets.

Factors Considered:
- Taxes
- Incentives
- Power Costs
- Construction Costs
- Land Costs
- Labor

U.S. Enterprise Markets by Cost Segment (alphabetical order)

<table>
<thead>
<tr>
<th>LOW-COST</th>
<th>MODERATE COST</th>
<th>HIGH COST</th>
</tr>
</thead>
<tbody>
<tr>
<td>$227.5M - $248.3M</td>
<td>$252.9M - $275.8M</td>
<td>$276.6M - $368.4M</td>
</tr>
<tr>
<td>Atlanta, GA</td>
<td>Buffalo, NY</td>
<td>Boston, MA</td>
</tr>
<tr>
<td>Charlotte, NC</td>
<td>Cincinnati, OH</td>
<td>Chicago, IL</td>
</tr>
<tr>
<td>Cheyenne, WY</td>
<td>Denver, CO</td>
<td>Dallas, TX</td>
</tr>
<tr>
<td>Colorado Springs, CO</td>
<td>Jacksonville, FL</td>
<td>Houston, TX</td>
</tr>
<tr>
<td>Des Moines, IA</td>
<td>Kansas City, KS</td>
<td>Minneapolis, MN</td>
</tr>
<tr>
<td>Omaha, NE</td>
<td>Kansas City, MO</td>
<td>Northern New Jersey</td>
</tr>
<tr>
<td>Portland, OR</td>
<td>Las Vegas, NV</td>
<td>Philadelphia, PA</td>
</tr>
<tr>
<td>Quincy, WA</td>
<td>Nashville, TN</td>
<td>San Antonio, TX</td>
</tr>
<tr>
<td>Salt Lake City, UT</td>
<td>Northern Virginia</td>
<td>Silicon Valley, CA</td>
</tr>
<tr>
<td>Tulsa, OK</td>
<td>Phoenix, AZ</td>
<td>Southern California</td>
</tr>
</tbody>
</table>

Source: CBRE Research
Why North Carolina & Atlanta?

5 MW Enterprise Facility - Tax Burdens and Incentives
Savings by Market

Source: CBRE Research
Recent Absorption

![Recent Absorption Chart]

- **MegaWatts**
- **Locations**: Atlanta, North Carolina
Atlanta

- One of the 10 largest data center markets in the country with over 143 MW of multi-tenant capacity
- Existing vacancy currently near 15% with roughly 22 MW available
- Absorption has averaged roughly 10 MW per year over the last five years; QTS dominates market share
- While Georgia’s incentives score favorably, they have not been enough to attract large enterprise projects

### Pricing

<table>
<thead>
<tr>
<th></th>
<th>Retail ($US/kW/MO)</th>
<th>Wholesale ($US/kW/MO)</th>
<th>2015 Trend</th>
<th>2016 Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015 Trend</td>
<td>$225-$275 (Gross)</td>
<td>$125-$145 (+E)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016 Forecast</td>
<td></td>
<td></td>
<td></td>
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</tr>
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</table>

### Supply & Demand

<table>
<thead>
<tr>
<th>Available Supply</th>
<th>Balance</th>
<th>Tenant Demand</th>
<th>U/C Pipeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>~ 22 MW</td>
<td>OVER SUPPLY</td>
<td>EQUILIBRIUM</td>
<td>UNDER SUPPLY</td>
</tr>
</tbody>
</table>
Charlotte and Raleigh have a combined multi-tenant inventory of roughly 43 MW with 11 MW under construction.

- There are approximately 17 MW currently available.
- Sentinel entered the NC market in 2012 as the first multi-tenant wholesale provider, now building 2nd phase.
- T5 continues with their park in Kings Mountain.
- As new providers enter and expand in the market, North Carolina is transitioning from an user-owned hub into viable colocation/build-to-suit leasing market.
North Carolina: A Market In Transition?

![Graph showing Enterprise Data Center Investment and Multi-Tenant Absorption over years 2007-2016.]

<table>
<thead>
<tr>
<th>Year</th>
<th>Enterprise</th>
<th>Multi-Tenant</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007/8</td>
<td>Fidelity, Google, NetApp, IBM</td>
<td>Digital Realty, Windstream, Peak10</td>
</tr>
<tr>
<td>2009</td>
<td>Apple, EMC</td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>American Express, Wipro, Facebook</td>
<td>Digital Realty, Windstream, Peak10</td>
</tr>
<tr>
<td>2011</td>
<td>Disney, Time Warner Cable</td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>AT&amp;T, Bed Bath &amp; Beyond</td>
<td>Sentinel</td>
</tr>
<tr>
<td>2013</td>
<td></td>
<td>T5 Data Centers, DataChambers</td>
</tr>
<tr>
<td>2014-16</td>
<td>BB&amp;T, First Citizens Bank, Duke Energy</td>
<td>Peak10 (expansion), DC74, DataChambers, TierPoint, T5 Data Centers, Sentinel (expansion)</td>
</tr>
</tbody>
</table>
SECTION II
What We’re Watching / Key Takeaways
What We’re Watching

- Demand as strong as ever
- Adoption of the cloud model is occurring at a much higher pace than even providers expected
- Technology adoption, cost savings key demand drivers
- Down to pure real estate: it’s never been harder to find prime sites
- Infrastructure strains: in-fill, power, water, etc. in core markets
- Build new nodes or dark fiber links back to the old ones?
- Top-line enterprise companies looking to monetize their data centers more than ever before
- Proximity to end users = the race to “edge” has opened new demand channel
### RECENT DATA CENTER LEASE RENEWALS

<table>
<thead>
<tr>
<th>User/Client</th>
<th>Market</th>
<th>Transaction Size</th>
<th>Original Lease Date</th>
<th>Renewal Date</th>
<th>Renewal Cost Savings (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise</td>
<td>Amsterdam, NL</td>
<td>180 kW</td>
<td>2014</td>
<td>2015</td>
<td>37%</td>
</tr>
<tr>
<td>Enterprise</td>
<td>Los Angeles, CA</td>
<td>240 kW</td>
<td>2013</td>
<td>2015</td>
<td>24%</td>
</tr>
<tr>
<td>Enterprise</td>
<td>Frankfurt, DEU</td>
<td>206 kW</td>
<td>2012</td>
<td>2015</td>
<td>12%</td>
</tr>
<tr>
<td>Enterprise</td>
<td>Dallas, TX</td>
<td>1,200 kW</td>
<td>2005</td>
<td>2015</td>
<td>22%</td>
</tr>
<tr>
<td>Financial Services</td>
<td>Northern Virginia</td>
<td>50 kW</td>
<td>2010</td>
<td>2015</td>
<td>33%</td>
</tr>
<tr>
<td>Financial Services</td>
<td>Chicago, IL</td>
<td>25 kW</td>
<td>2010</td>
<td>2015</td>
<td>27%</td>
</tr>
<tr>
<td>Financial Services</td>
<td>Northern Virginia</td>
<td>80 kW</td>
<td>2010</td>
<td>2015</td>
<td>36%</td>
</tr>
<tr>
<td>Financial Services</td>
<td>Silicon Valley, CA</td>
<td>300 kW</td>
<td>2011</td>
<td>2015</td>
<td>27%</td>
</tr>
<tr>
<td>Healthcare</td>
<td>Pacific Northwest (WA)</td>
<td>100 kW</td>
<td>2010</td>
<td>2014</td>
<td>30%</td>
</tr>
<tr>
<td>Healthcare</td>
<td>Sacramento, CA</td>
<td>200 kW</td>
<td>2008</td>
<td>2015</td>
<td>59%</td>
</tr>
<tr>
<td>High Tech</td>
<td>Dallas, TX</td>
<td>2,500 kW</td>
<td>2007</td>
<td>2015</td>
<td>18%</td>
</tr>
<tr>
<td>Managed Hosting</td>
<td>Silicon Valley, CA</td>
<td>1,500 kW</td>
<td>2006</td>
<td>2016</td>
<td>22%</td>
</tr>
<tr>
<td>Retailer</td>
<td>Dallas, TX</td>
<td>250 kW</td>
<td>2010</td>
<td>2014</td>
<td>12%</td>
</tr>
<tr>
<td>Semiconductor</td>
<td>Boston, MA</td>
<td>80 kW</td>
<td>2010/11</td>
<td>2014</td>
<td>50%</td>
</tr>
<tr>
<td>Telecom</td>
<td>San Diego, CA</td>
<td>80 kW</td>
<td>2010/11</td>
<td>2014</td>
<td>35%</td>
</tr>
<tr>
<td>Telecom/Carrier</td>
<td>Tokyo, JPN</td>
<td>700 kW</td>
<td>2009</td>
<td>2015</td>
<td>25%</td>
</tr>
<tr>
<td>Telecom/Carrier</td>
<td>Tokyo, JPN</td>
<td>300 kW</td>
<td>2008</td>
<td>2015</td>
<td>39%</td>
</tr>
<tr>
<td>Telecom/Carrier</td>
<td>London &amp; Manchester, UK</td>
<td>1,500 kW</td>
<td>2008</td>
<td>2015</td>
<td>27%</td>
</tr>
</tbody>
</table>
Key Takeaways

• Data center market is expanding rapidly

• Atlanta & Carolinas are well-positioned

• A robust, competitive market is critical to growth

$70.3 billion
Investment in colocation by 2020

11.7%
Global colocation and outsourcing CAGR

Source: CBRE Research, Data Center Dynamics
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INDUSTRY TRENDS

Sam Westbrook
INDUSTRY TRENDS

• Design
• Construction
• End User
INDUSTRY TRENDS – DESIGN…

- Mechanical Cooling
- Density
- Redundancy
- Containment / Prefabrication
- Sustainability
- Cost to Operate
INDUSTRY TRENDS – CONSTRUCTION...

- Cost per MW Declining
- “Packaged” Design Build Approach
- Colocation Solutions
  - Adaptive Reuse
  - Site Strategies
- Speed to Market
INDUSTRY TRENDS – END USERS...

• Smart Technologies

• Software Driven Infrastructure

• Redundant Scalability

• Migration to the Cloud
WHAT IS NEXT?

FUTURE AHEAD