Gottfried Vossen
University of Münster, Germany &
University of Waikato, New Zealand

Breathing in the Clouds:
Thin Air or Bad Atmosphere?
Breathing in the Clouds:
Thin Air or Bad Atmosphere?
1. A Few Quick Facts
2. Bright Spots in the Cloud
3. What Makes the Air Thin
4. What Makes the Atmosphere Bad
5. What the cloud enables
6. A Forecast

“Cloud computing is using the Internet to access someone else’s software running on someone else’s hardware in someone else’s data center”
Lewis Cunningham, Oracle
Who believes he or she is not in the [consumer] cloud yet?
My question:
What makes it hard for non-IT SMEs to move to the cloud and what can we do about it?
1. A Few Quick Facts
Cloud Sourcing: Five Properties

1. Resource Pooling
2. Rapid Elasticity
3. On-demand Self-service
4. Broad Network Access
5. Measured Service

Immediate adaptability to changing demands in resources
Comprehensive network access
Pay-per-use
Common usage of physical resources
Three Main Service Models

Technical overview:

- **User Layer**
  - Software-as-a-Service
  - Platform-as-a-Service
  - Infrastructure-as-a-Service

- Virtualization Layer

- Hardware Infrastructure
Examples

GoGrid Cloud Hosting

CLOUD HOSTING
The simplest way to deploy complex infrastructure.

DEDICATED HOSTING
Innovative options to power flexible dedicated cloud architectures.

PRIVATE CLOUD
Leverage the benefits of cloud computing plus physical resource separation.

See for Yourself

WE MAKE CLOUD INFRASTRUCTURE EASY. REALLY EASY.

Cloud Hosting
- Public, private, and hybrid clouds
- Based on OpenStack for no lock-in
- Pay-as-you-go pricing available

IN THE NEWS
Cloud Block Storage Now In Unlimited Availability

IN THE NEWS
Cloud Block Storage Now In Unlimited Availability
SpotCloud is the World's First Global Market for Cloud Capacity
Buy and sell computing capacity globally based on price, location, and quality, on a fast and secure platform.

Buy Capacity
Find the best providers at the best price
SpotCloud is the world's best place to buy cloud servers. Instantly get the broadest choice of precise geo-targeted capacity at the best price.

Sell Capacity
Sell Your Data Center Capacity Globally
SpotCloud provides a powerful channel to increase utilization and drive new revenue. Easily sell idle server capacity with instant access to global markets.

Browse the SpotCloud Market (Free Signup)
Request To Become a Capacity Provider
CompatibleOne: the first real Open Cloud Broker

CompatibleOne offers a simple and unique interface allowing for the description of user cloud computing needs, in terms of resources, and their subsequent provisioning on the most appropriate cloud provider.

Resource descriptions may cover the complete cloud computing paradigm ranging from complete applications (SaaS), through development platforms (PaaS) down to low level compute and storage defined infrastructure (IaaS).

CompatibleOne provides a unique language for the description and management of an unlimited number of cloud service providers.

The immediate benefits are:
- Centralized description of all your cloud computing needs in terms of resources
- Rapid selection of the most appropriate provider
- Full automation of the provisioning and the migration process of your resources
- Elimination of any form of vendor lock-in and permit full interoperability
- Monitor and control the service delivery quality of your cloud providers

"Since the IT industry is rapidly adopting service based business models, there is a substantial and growing need for solutions that can reduce the complexity involved in delivering federated business services and can handle the challenges of managing a distributed infrastructure. This is where I believe CompatibleOne cloud service broker provides a unique value - their solutions' ability to address both needs paves the way for building a new generation of IT infrastructure." - Praveen Pabari, Principal Architect, Intel Corporation.

More
Three Main Service Models

Technical overview:

- User Layer
- Software-as-a-Service
- Platform-as-a-Service
- Infrastructure-as-a-Service

Virtualization Layer

Hardware Infrastructure
G. Vossen: Breathing in the Clouds

Examples

Reinventing application development

IBM’s platform as a service (PaaS), IBM SmartCloud Application Services, is included with, runs on and automatically deploys virtual resources to IBM SmartCloud Enterprise (IaaS). SmartCloud Application Services delivers a secure, collaborative, integrated cloud environment that supports the full lifecycle of accelerated application development, deployment and delivery.

Deploy a new app during lunch hour and still have time for lunch

- Get web applications to market faster
- Enjoy middleware as a service
- Develop and test application patterns

IBM SmartCloud Services Trial. No charge. End-to-end cloud application development just got a whole lot easier. Experience the power of IBM public cloud infrastructure and platform services with this 90-day trial.

Sign Up Today
Three Main Service Models

Technical overview:

User Layer

- Software-as-a-Service
- Platform-as-a-Service
- Infrastructure-as-a-Service

Virtualization Layer

Hardware Infrastructure
The “Cloud Washing” Problem

Research proves that cloud confusion is causing storms in the IT sector

- **What is PaaS?**
  - 22%
  - Think that Platform as a Service (PaaS) was a new philosophy in railway management

- **What is IaaS?**
  - 12%
  - Think that Infrastructure as a Service (IaaS) was a new road project

- **16%**
  - Think that cloud computing is a free WiFi service for Internet access in public places
Four Modes of Cloud Operation

1. Private Cloud
2. Public Cloud
3. Community Cloud
4. Hybrid Cloud

Company 1
Company 2
Company 3
Company 4
Company 5
Company 6
Cloud Benefits

- Economies of scale w.r.t. hardware and software
- Easy accommodation of demand fluctuations
- No local installations w/ upgrades, patches, service packs, etc.
- End of inefficient utilization of server resources
- No big upfront investments
- Extensive technical support
- Continuous participation in technological advances
- “Pay-as-you-go” business model (as known from other commodities, e.g., water, electricity)
So what makes it so popular for individuals?

- No manual backups
- Automatic service maintenance
- Alerts about almost anything (if you want)
- Cheap pricing (e.g., for music)
- Better selectivity (e.g., for albums)
2. Bright Spots in the Cloud

Source: http://images.computerwoche.de/images/computerwoche/bdb/1817240/890.jpg
NASA JPL – Landing of Mars Rover “Curiosity”

- Landing in August 2012
  - Broadcast via live stream
  - 3+ M viewers

- Based on Adobe as well as AWS products for
  - Streaming
  - Monitoring & provisioning of additional infrastructure
  - Content delivery & load balancing
Netflix: “Watch TV shows & movies anytime, anywhere. For one low monthly price.”
- Runs movie rental and on-demand streaming to 30+ M customers
- In 2011 responsible for approx. 1/3 of the entire US downstream traffic
- Data centers still not their core competency
- Therefore moved to AWS in 2008

Why Amazon? Can provide the power and scalability that Netflix requires

What is done in the cloud?
- Transcoding (2009), Streaming (2010)
- Own products as PaaS based on AWS
Stock exchange info for replay and analysis, allowing users to view consolidated quote and trade data
- Replay data is available intraday as soon as 15 min after it occurs
- 1+ PB of compressed trading data, adding 50+ GB every day

Storage is using Amazon S3
- Each object contains 10 min of trading data per share
- Access application is based on Adobe AIR using Data-on-Demand API

Advantages achieved by cloud exploitation
- Cost reduction
- Shorter Time-to-Market (1/3 of what it was before)
Customers include

- KLM Royal Dutch Airlines
- Well Fargo Bank
- Spotify
- OpenTable
- Hire A Hubby
- Chipotle Mexican Grill
- Caesar’s Entertainment
- Vodafone

Wheelz example:

- Australian company connecting people that need to use a car to car owners who are willing to lend theirs for an hourly rate

Wheelz uses Desk.com

- to manage new leads, existing customer relationships, and strategic initiatives, and
- to track every customer touch point from initial sign up to the most recent rental experience
A startup from the University of Münster, winner of the ERCIS Launch Pad 2010

An intelligent, personal assistant for the automatic management of all paper-based as well as digital documents in a single system

Complete and digital file cabinet

https://www.fileee.com/
3. What Makes the Air Thin

Source: http://coakley-baker.com/downdn/a/part8/images/intoThinAir.jpg
SMEs cannot afford a private cloud, so they need to go public

Yet they are insufficiently prepared

They are afraid of (among others)
  - Preparation overhead
  - Storing data in the cloud
  - Trusting the CSP
  - Provider lock-in
  - Complexity of migration
Tedious Service & Provider Selection

High up-front selection overhead, e.g.:
- Identify viable cloud services
- Scrutinize services and providers
- Find optimal implementation
Lack of Trust in the Cloud

- Where is data stored?
- Who has control?
- Who has access?
- How trust CSP if no insight and control?

SMEs lack trust in cloud services:
- Lack of trust in technical security of CSPs
- Lack of trust in governance over CSPs
- Lack of trust in legal framework for cloud usage

G. Vossen: Breathing in the Clouds
<table>
<thead>
<tr>
<th>Rank</th>
<th>Prerequisites for using SaaS</th>
<th>$\bar{r}$</th>
<th>$N$</th>
<th>$SE_{\bar{r}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Confidentiality of data with respect to 3rd parties</td>
<td>4.95</td>
<td>40</td>
<td>.03</td>
</tr>
<tr>
<td>2</td>
<td>Permanent availability of the software</td>
<td>4.63</td>
<td>40</td>
<td>.11</td>
</tr>
<tr>
<td>3</td>
<td>Confidentiality of data with respect to CSP</td>
<td>4.50</td>
<td>40</td>
<td>.16</td>
</tr>
<tr>
<td>4</td>
<td>CSP has clearly defined backup strategy</td>
<td>4.40</td>
<td>40</td>
<td>.15</td>
</tr>
<tr>
<td>5</td>
<td>Performance of the software (no latency during use)</td>
<td>4.38</td>
<td>40</td>
<td>.13</td>
</tr>
<tr>
<td>6</td>
<td>Stable prices for service usage</td>
<td>4.10</td>
<td>40</td>
<td>.14</td>
</tr>
<tr>
<td>7</td>
<td>Usability resembles traditional desktop applications</td>
<td>4.03</td>
<td>40</td>
<td>.19</td>
</tr>
<tr>
<td>8</td>
<td>Possibility of complete data export (e.g., database dump)</td>
<td>3.97</td>
<td>39</td>
<td>.18</td>
</tr>
<tr>
<td>9</td>
<td>Guaranteed geographical limits for cloud service</td>
<td>3.51</td>
<td>37</td>
<td>.28</td>
</tr>
<tr>
<td>10</td>
<td>Possible integration into existing non-SaaS software</td>
<td>3.42</td>
<td>38</td>
<td>.23</td>
</tr>
<tr>
<td>11</td>
<td>Possibility of changing the CSP</td>
<td>3.37</td>
<td>38</td>
<td>.23</td>
</tr>
<tr>
<td>12</td>
<td>Custom SLAs</td>
<td>3.28</td>
<td>39</td>
<td>.18</td>
</tr>
<tr>
<td>13</td>
<td>CSP is located in Germany</td>
<td>2.97</td>
<td>37</td>
<td>.23</td>
</tr>
<tr>
<td>14</td>
<td>Possible integration into other SaaS software</td>
<td>2.88</td>
<td>40</td>
<td>.21</td>
</tr>
<tr>
<td>15</td>
<td>Possibility of local installation of the SaaS software</td>
<td>2.87</td>
<td>39</td>
<td>.23</td>
</tr>
<tr>
<td>16</td>
<td>CSP is located in the EU</td>
<td>2.62</td>
<td>34</td>
<td>.25</td>
</tr>
<tr>
<td>17</td>
<td>CSP has the Safe Harbor seal</td>
<td>2.41</td>
<td>27</td>
<td>.26</td>
</tr>
<tr>
<td>18</td>
<td>CSP has the PrivacyMark seal</td>
<td>2.36</td>
<td>25</td>
<td>.29</td>
</tr>
<tr>
<td>19</td>
<td>CSP is certified according to ISO/IEC 27001</td>
<td>2.26</td>
<td>31</td>
<td>.27</td>
</tr>
<tr>
<td>20</td>
<td>CSP is certified according to SAS 70</td>
<td>1.80</td>
<td>30</td>
<td>.26</td>
</tr>
<tr>
<td>Rank</td>
<td>Reason for not using SaaS</td>
<td>$\bar{x}$</td>
<td>N</td>
<td>SE $\bar{x}$</td>
</tr>
<tr>
<td>------</td>
<td>------------------------------------------------------------------------------------------</td>
<td>----------</td>
<td>----</td>
<td>--------------</td>
</tr>
<tr>
<td>1</td>
<td>SaaS does not work well with other software</td>
<td>3.63</td>
<td>38</td>
<td>.20</td>
</tr>
<tr>
<td>2</td>
<td>Loss of control over access to data</td>
<td>3.59</td>
<td>39</td>
<td>.23</td>
</tr>
<tr>
<td>3</td>
<td>Data Migration from existing application too tedious</td>
<td>3.56</td>
<td>39</td>
<td>.23</td>
</tr>
<tr>
<td>4</td>
<td>High latency when using software (page loads)</td>
<td>3.44</td>
<td>39</td>
<td>.25</td>
</tr>
<tr>
<td>5</td>
<td>Less control over backups of data</td>
<td>3.41</td>
<td>39</td>
<td>.22</td>
</tr>
<tr>
<td>6</td>
<td>SaaS software lacks some desired features</td>
<td>2.97</td>
<td>35</td>
<td>.25</td>
</tr>
<tr>
<td>7</td>
<td>Permanent broadband Internet connection required</td>
<td>2.92</td>
<td>38</td>
<td>.29</td>
</tr>
<tr>
<td>8</td>
<td>Usability of web application worse than desktop application</td>
<td>2.63</td>
<td>38</td>
<td>.26</td>
</tr>
<tr>
<td>9</td>
<td>Lack of acceptance among employees</td>
<td>2.58</td>
<td>38</td>
<td>.25</td>
</tr>
<tr>
<td>10</td>
<td>Pay-per-use is not attractive</td>
<td>2.49</td>
<td>35</td>
<td>.25</td>
</tr>
<tr>
<td>11</td>
<td>Technical implementation too much effort</td>
<td>2.15</td>
<td>39</td>
<td>.23</td>
</tr>
<tr>
<td>12</td>
<td>Restrictions from existing contracts</td>
<td>2.14</td>
<td>37</td>
<td>.21</td>
</tr>
<tr>
<td>13</td>
<td>Benefits of SaaS are not seen</td>
<td>2.03</td>
<td>37</td>
<td>.26</td>
</tr>
<tr>
<td>14</td>
<td>Previous CAPEX has to be amortized first</td>
<td>1.97</td>
<td>38</td>
<td>.23</td>
</tr>
</tbody>
</table>

in Proc. 12th Int. Conf. on Web Information System Engineering (WISE), October 2011, Sydney, AU
The Good News: SMEs, you’re not alone!

- Check the provider’s reputation
- Check which SLAs can be specified
- Check the price models offered
- Check the controlling options
The Cloud is not reversible, so what can we do?

- Strategy development considering four major dimensions
- Structured provider selection
- Cloud intermediaries
- CCO introduction
- Employ monitoring tools such as CloudSleuth or CloudHarmony
- Service-level agreements (SLAs)
The Four Dimensions

- Economic Dimension
- Technical Dimension
- Legal Dimension
- Organizational Dimension

Cloud Computing
Strategy

Preparation & Planning

Provider Selection

Contract Negotiation & Detailed Planning

Implementation & Migration

Operation
For Step 1: EVACS Method

1. Sanity Check
   - Make sure cloud paradigm is basically adequate

2. Preparatory Analysis
   - Using rules of thumb, roughly estimate the business value of a cloud sourcing project

3. In-depth Analysis
   - Build a detailed business case using the proposed guidelines on cost factors and benefits

Cloud sourcing candidates

Profitable projects

EVACS = Economic Value Assessment of Cloud Sourcing → CloudAsia 2013
The New CCO Role

Chief Cloud Officer

- Cloud-Strategie
- Cloud-Controlling
- Cloud-Sicherheitsmanagement

  - Demand-Management
  - Supplier-Relationship-Management
4. What Makes the Atmosphere Bad

A survey by Six Degrees Group has found that

- 45% of **IT decision makers** feel that ‘cloud-washing’ by marketing departments at technology brands is an increasing problem;
- 83% feel that cloud service providers could do more to demystify the cloud;
- 82% of IT decision makers say that their cloud-computing provider is not listening to them;
- 51% of **business decision makers** believe that technology companies are guilty of using too much jargon, compared to 24% for Government, 16% for bankers and only 9% for lawyers.
Aberdeen Group study, February 2013: data losses reported by SaaS users:
A hacker stole the names, birthdates and possibly credit-card numbers for 77 M people who play online videogames through Sony's PlayStation console, April 2011

Online shoe store Zappos hacked, January 2012, exposing the names, e-mail addresses, addresses, phone numbers and partial credit card numbers of 24 M customers

Data leakage at LinkedIn and Last.fm, Summer 2012; passwords easily computable due to simple hashes

Data leakage at Dropbox, July 2012 customer data stolen from the dropbox of an employee
61% of users reuse passwords across multiple services and 44% of consumers change their password at most once a year (CSID Consumer Survey 2012)

90+ % of user-generated passwords are vulnerable to hacking, according to a Deloitte report, January 2013
Applicable laws vary from one country to the next

In Germany alone, cloud users and CSPs need to consider
- Telekommunikationsgesetz (TKG)
- Bundesdatenschutzgesetz (BDSG)
- Strafgesetzbuch (StGB)
- Abgabenordnung (AO)
- Versicherungsaufsichtsrecht (VAG)
- Betriebsverfassungsgesetz (BetrVG)

Most critical: protection of personal data

What is the CSP willing to sign a contract about?
5. What the Cloud Enables
Crowdsourcing, crowdfunding
Health care – big time
Public security – Boston Marathon example
Traffic management
Energy management
Smart homes
Marketplaces for data

... to mention just a few areas and applications
Crowdsourcing, crowdfunding

- New ways of working, developing ideas, funding projects
If you think crowdsourcing isn’t serious business …

- Projects exploring the potential of hybrid human/computer systems for database query processing:
  - CrowdDB (UC Berkeley)
  - Qurk (MIT)
  - sCOOP (UC Santa Cruz)

- Idea is that human workers can perform query operations such as subjective comparisons, fuzzy matching for predicates and joins, entity resolution, etc. These extensions can greatly extend the usefulness of a query processing system.
Clouds Against Disease computational platform run by Molplex, Newcastle University, and Microsoft Research

<table>
<thead>
<tr>
<th>Indication</th>
<th>Target</th>
<th>Partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infectious Mononucleosis</td>
<td>Epstein-Barr Virus</td>
<td>Internal</td>
</tr>
<tr>
<td>Androgenic Alopecia</td>
<td>undisclosed</td>
<td>Internal</td>
</tr>
<tr>
<td>Gram Positive Antibiotics</td>
<td>gram-positive bacteria</td>
<td>Imperial College London, Sunderland University</td>
</tr>
<tr>
<td>Dengue Fever</td>
<td>Dengue virus DENV &amp; DENV+</td>
<td>Institute for Medical Research, Malaysia</td>
</tr>
<tr>
<td>Filariasis</td>
<td>Wuchereria bancrofti</td>
<td>Institute for Medical Research, Malaysia</td>
</tr>
<tr>
<td>Malaria</td>
<td>Plasmodium falciparum</td>
<td>Institute for Medical Research, Malaysia</td>
</tr>
</tbody>
</table>

Across the globe, Molplex is helping scientists reduce the time and cost of screening large data sets of chemical compounds to identify potential drugs. Researchers are using automated tools in a cloud-based environment to speed up the drug discovery process.

G. Vossen: Breathing in the Clouds
Singapore trials a traffic management system that could improve the monitoring of the city-state’s roads by using geo-location data captured from drivers’ smart phones.
Cloud-Assisted Design for Autonomous Driving
Smart Homes

- Heating is controlled according to time of day
- Electrical appliances are switched on and off
- Lighting is coordinated and switched on/off
- Remote control even possible from your smartphone
- Central control and configuration via PC

Source: www.alsoactebis.com/ec/cms2/de/1010/content/solutions/smarthome_2/smarthome_3.jsp
Data Marketplace Outline

Source: Muschalle, Stahl, Löser, Vossen: Pricing Approaches for Data Markets; Proc. BIRTE 2012

G. Vossen: Breathing in the Clouds
Other Developments

- ERTICO – Intelligent Transport Systems and Services for Europe
- E-Health (23andme, Fitbit)
- Big data processing in social media (e.g., Twitter index)
- Germany’s energy u-turn, i.e., the decision to phase out nuclear power by 2022
6. A Forecast
What Happens in an **Internet Minute?**

- **639,800 GB of global IP data transferred**
- **20** New victims of identity theft
- **47,000** App downloads
- **583,000** In sales
- **204 million** Emails sent
- **100+** New LinkedIn accounts
- **1,300** New mobile users
- **135** Botnet infections
- **277,000** Logins
- **61,141** Hours of music
- **20 million** Photo views
- **320+** New Twitter accounts
- **3,000** Photo uploads
- **100,000** New tweets

**And Future Growth is Staggering**

- **Today**, the number of networked devices = the global population
- **By 2015**, the number of networked devices = 2x the global population
- **In 2015**, it would take you 5 years to view all video crossing IP networks each second
G. Vossen: Breathing in the Clouds

Sales Volume of Cloud Computing in Germany

Forecast

- Business Cloud
- Consumer Cloud

<table>
<thead>
<tr>
<th>Year</th>
<th>Business Cloud</th>
<th>Consumer Cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1.9</td>
<td>3.6</td>
</tr>
<tr>
<td>2012</td>
<td>3.0</td>
<td>5.3</td>
</tr>
<tr>
<td>2013</td>
<td>4.7</td>
<td>7.9</td>
</tr>
<tr>
<td>2014</td>
<td>5.1</td>
<td>6.9</td>
</tr>
<tr>
<td>2015</td>
<td>14.0</td>
<td>10.8</td>
</tr>
<tr>
<td>2016</td>
<td>17.1</td>
<td>10.7</td>
</tr>
</tbody>
</table>
What else is happening

- **Heavy investing by public funding agencies**
  - BMWi’s Trusted Cloud Program: www.trusted-cloud.de/
  - TRESOR, CLOUDwerker, SensorCloud, cloud4health in Germany
  - Cloud Control in Sweden
  - VERDIKT in Norway
  - Andromède in France
  - NSF, USA

- **Government initiatives such New Zealand’s Cloud First Strategy**, an all-of-government approach to cloud computing (similar to the G-Cloud in the UK)
The personal cloud, where business and leisure meet, will get bigger thanks to BYOD and COPE

- Cloud interoperability, portability
- Cloud standards for configuration, management, security, storage, communication

<table>
<thead>
<tr>
<th>Data Portability</th>
<th>Standards</th>
<th>Ease of Migration &amp; Deployment</th>
<th>Developer Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>How can I keep control over my data?</td>
<td>What technology standards are important for Cloud Platforms?</td>
<td>Will your Cloud Platforms help me migrate my existing technology investments to the cloud?</td>
<td>How can I leverage my developers’ and IT professionals’ skills in the cloud?</td>
</tr>
<tr>
<td>Customers own their data and Cloud Platforms should make it easy and efficient to securely move customers data in and out.</td>
<td>Cloud Platforms should reuse existing and commonly used standards when appropriate and may lead to the creation of new standards where existing standards are not sufficient.</td>
<td>Cloud Platforms should provide, for existing technologies that are appropriate to the cloud, a migration path that preserves, in a secure way, existing investments in applications and IT resources.</td>
<td>Cloud Platforms should enable developer choice in tools, languages and runtimes.</td>
</tr>
</tbody>
</table>
A Warning from CEET in Australia

Wireless networks are the biggest threat to the sustainability of cloud services, not data centres.

By 2015 wireless cloud energy is expected to compare to 30 megatonnes of CO2 compared to 6 megatonnes in 2012.

Energy consumption of wireless networks = 9% = 4.9 million new cars.
"Cloud computing might be more accurately described as 'sky computing,' with many isolated clouds of services which IT customers must plug into individually. ... the idea of loosely coupled services running on an agile, scalable infrastructure should eventually make every enterprise a node in the cloud. It's a long-running trend with a far-out horizon. " Gruman & Knorr, Infoworld

"Wilber is probably taking this Cloud computing too seriously."
http://www.crowdsourcing.org
“the industry website”

Acatech’s Future Business Cloud Initiative:
http://www.acatech.de/de/projekte/laufende-projekte/future-business-clouds.html