The Internet of Things – all connected!
And the role of Cloud and Fog Computing

Claus Schaale
WW  Cloud business development

JULY, 2015
Role of Cloud and Fog Computing in IoT

Purpose

• To establish a common taxonomy and definition for M2M, IoT and IoE
• To review the current market trends and opportunities in IoT
• To present high level overview of architectures
• To present the Cloud and Fog computing role in IoT solutions
• To understand security and compliance components
What’s going on with Cloud according to the analysts

IDC – The Third Platform

IOE/IOT: Sensors, Applications, Network, Cloud

Velocity, Variety Volume, Value

Social Business Not just Social Media
Battle of the buzzwords: M2M v IoT v IoE

**Machine to Machine (M2M)**

A device... that captures an event... transmits it over a network... to an application... that translates it into meaningful information.

**Internet of Things (IoT)**

A network of uniquely identifiable "things" that communicate without human interaction using IP connectivity.

**Internet of Everything (IoE)**

Bringing together the people, process, data & things to make networked connections more relevant by turning information into actions.

Source: IDC Telecom Practice
Internet of Everything

People + People + Machine + Machine

People

Process

Intelligent Network

Things

Data

People-to-People + People-to-Machine + Machine-to-Machine
IoT Is Here Now – and Growing!

50 Billion
“Smart Objects”

Rapid Adoption
Rate of Digital Infrastructure:

The New Essential Infrastructure

Source: Cisco IBSG, 2011
IoT Transforms Data into Wisdom

Wisdom (Scenario Planning)

Knowledge

Information

Data

More Important

Business Benefit

Less Important

Big Data becomes Open Data for Customers, Consumers to Use
How Big Is the Potential Market?

“Trying to determine the market size for the Internet of Things is like trying to calculate the market for plastics, circa 1940. At that time, it was difficult to imagine that plastics could be in everything.”

Prof. Michael Nelson
Georgetown University
Sizing the Opportunity

$19.0* Trillion

VALUE AT STAKE

14.4 Trillion PRIVATE SECTOR
Includes Both Industry-specific and Horizontal Use Cases:
- Customer experience
- Innovation
- Employee productivity
- Supply chain
- Asset utilization

4.6 Trillion PUBLIC SECTOR
Includes Cities, Agencies, and Verticals Such as Healthcare, Education, Defense:
- Increased revenue
- Reduced cost
- Employee productivity
- Connected militarized defense
- Citizen experience

Estimate Is Based on Bottom-up Analysis of 61 Use Cases, Including 21 for Private Sector and 40 in Public Sector (*2013-2022)
## IoE Consists of M2M, M2P, and P2P Connections

<table>
<thead>
<tr>
<th>CONNECTION TYPE</th>
<th>IoE VALUE (2013-2022)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MACHINE-TO-MACHINE (M2M)</strong></td>
<td>$7.4 TRILLION</td>
</tr>
<tr>
<td>- Data sent / received from one machine (thing) to another</td>
<td></td>
</tr>
<tr>
<td>- Often called the “Internet of Things”</td>
<td></td>
</tr>
<tr>
<td><strong>MACHINE-TO-PERSON (M2P)</strong></td>
<td>$4.6 TRILLION</td>
</tr>
<tr>
<td>- Data sent / received from a machine (thing) to a person</td>
<td></td>
</tr>
<tr>
<td>- Often called “data and analytics”</td>
<td></td>
</tr>
<tr>
<td><strong>PERSON-TO-PERSON (P2P)</strong></td>
<td>$7.0 TRILLION</td>
</tr>
<tr>
<td>- Data sent / received from one person to another</td>
<td></td>
</tr>
<tr>
<td>- Often called “collaboration”</td>
<td></td>
</tr>
</tbody>
</table>
The Investment in IoT Starts With One “Killer App”… But Can Quickly Lead to Additional Efficiencies

**MANUFACTURING**
- Operational Efficiency

**SMART CITIES**
- New Revenue

**TRANSPORTATION**
- Regulatory Compliance

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IoE für Städte: “High Level” Architektur

Sensoren/Maschinen
Infrastrukturen
Open Data

Daten der Stadt

“Digital Footprint”
Soziale Medien
“CrowdSourcing”

Daten von Bürgern

z.B.

Parken
Wasser
Gebäude
Licht
Müll

Offenes Innovations-Ecosystem

Apps/Dienste für Bürger
Smart City Architektur

Partner Applikationen und Städtische Dienste
- Transport Management
- Park Management
- Beleuchtungs Management
- Abfall Management
- Stadtumfeld
- Sicherheit & Gefahrenabwehr
- Verkehrs Management
- Monitoring/Command/Control Centers

Bürger Dienste
- Apps
- Portal

Internet
- Cloud Dienste

Data/Event Virtualisierung/Aggregation

City Infrastruktur Management

Public/Private WAN
- Wireless WAN (2G/3G/4G/Wimax)
- DSRC/LMR

City WiFi Netzwerk

Fahrzeuge
- Fahrzeuge
- Privat
- Industrie
- Öffentlich

Gebäude
- Wasser
- Parken
- Straßen Beleuchtung
- Abfall
- Stadtumfeld
- Menschen
- Einrichtung
- Sicher Gefahrenabwehr
- Verkehr

Straße

Schicht 1
Schicht 2
Schicht 3
Schicht 4
Intelligentes Parkraum-Management

Bürger bekommen Echtzeit-Informationen über Verfügbarkeit von Parkplätzen
Reduzierung von kreisendem Verkehr, Umweltbelastung und Verkehrsstörungen

Intelligente Verkehrssteuerung

Beobachtung und Management von Verkehrseereignissen
Reduzierung von Staus und Erhöhung der Lebensqualität in der Stadt

Sicherheit in der Stadt

Automatische Erkennung von Sicherheitsereignissen
Verkürzung von Reaktionszeiten
Datenanalyse zur Reduzierung der Kriminalität

Intelligente Lokalisierungsdienste

Sichtbarkeit von Menschenströmen zur Unterstützung der Planung und Beeinflussung von Kontextbezogenen Inhalten und Werbung

Intelligente Stadtbeleuchtung

Management der Straßenbeleuchtung zur Einsparung von Energie und Wartungs-Kosten
Verfügbarkeit von zusätzlichen Diensten (Hotspot, Analytics, Überwachung, Parkraummanagement usw.)
Beispiel: Die Straßenbeleuchtung als Multi-Sensor-Knoten

1. Unterschiedliche Sensoren erfassen die gegenwärtigen städtischen Zustände und führen eine FOG Analytics durch.
2. Die gesammelten Daten werden über das sichere Wireless Netzwerk zur Cloud geschickt.
3. Die gewonnenen Daten werden aggregiert, normiert und für eine übergreifende Analyse vorbereitet.
4. Anwendungen nutzen die Daten, um den städtischen Betrieb zu optimieren.

Lösungs-Komponenten:
- LED-Leuchten Halterung
- Multi-Sensor Knoten
- Video Kamera / Video Sensorik
- Wireless Netzwerk
- Cloud-Lösung

Daten-Fluss:
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Städtische Betriebsanwendungen:
- Licht Steuerung
- Kenntnis zur aktuellen Situation
- Städtische Luft-/Lärmpegel-/Umweltbelastungs-Karten
- Energie-Berichte
- Parkraumbewirtschaftung
- Erkennen von Ereignissen
- Städtische Sicherheit

Bürger-Dienste:
- Öffentliches WLAN
- Verfügbarkeit von Parkraum
- Verkehrs-Alarme

Dezentrale Analyse (FOG Analytics)

Wi-Fi Mesh

Datenspeicher in der Cloud mit API’s für Zugriff
Convergence of networks
IoT Communications & Devices

- Devices are independent & distributed
- Multiple protocols
- Device network handoff involve multiple protocols
- Communications involve complex Networking and Addressing
- One size does not fit all

Wireless Protocols for IoT

- IEEE 802.11
- Bluetooth/Bluetooth Smart
- ZigBee/ZigBee Smart Energy 2.0
- IEEE 802.15.6-2012: Body Area Networking
- Wireless HART (Highway Addressable Remote Transducer Protocol)
- International Society of Automation (ISA) 100.11a
- Z-Wave
- MiWi (Microchip Technology Wireless)
- ANT+
- Wireless MBIU
Converged Operational and IT processes

Operational Technology
- Traffic Control
- Telemetry
- Passenger Wi-fi
- Passenger Safety
- Trains
- Machine Parts
- Access Points
- Video Cameras

Information Technology
- ERP
- CRM
- VOIP
- Video
- PCs
- Smartphones
- Datacenter
- Branch Offices

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Convergence Delivers Control Over IP

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Convergence Delivers Control Over IP

Operational Technology
- Traffic Control
- Passenger Wi-fi
- Video
- ERP
- CRM
- Passenger Safety

IoT
- Project Mgmt.
- Asset Tracking
- Fleet Operations
- Sensor Network
- Email
- HRMS

Information Technology
- PCs
- Smartphones
- Data-centers
- Branch Offices
- Sensors
IoT Requires Distributed Computing

Traditional Computing Model
(Terminal/Mainframe, Client-Server, Web)

Data Center/Cloud

Endpoint
IoT Requires Distributed Computing

IoT Computing Model

Scalability
Security
Privacy and compliance

Information standardization
Information filtering
Local decisions

Data Center/Cloud

Enterprise
Community
Public

Fog

Device
What are the different Cloud scenarios?

- **DC/Private Clouds**
  - FlexPod
  - BLOCk

- **Regional/Niche Clouds**

- **Public Clouds**
  - SoftLayer
  - Amazon Web Services
  - Microsoft Azure
  - BT
Executing on IoE Architecture

Vertical
- IoE Services/Applications
- IoT Middleware
- Core Network
- Manufacturing
- Transportation
- ...

Horizontal
- Public Internet
- Private Network
- IoT GW
- App
- Analytic Systems
- Business Applications
- IoE PaaS Platforms
- Legacy protocols
- IP
- Machine/Sensor nodes

IoT GW
- Services
- App

IoE Middleware
- App
- Analytic Systems
- Business Applications
- IoE PaaS Platforms
- Public Internet
- Private Network

IoE Services/Applications
- Manufacturing
- Transportation
- ...

Cisco Confidential
5 Requirements for Successful IoT Implementations

- Converged, Managed Network
- Resilience at Scale
- Security & Privacy
- Distributed Intelligence
- Application Enablement
Last but not least...Privacy and compliance

IoT will reach and produce information that is or will be subject to privacy or compliance regulation

Privacy by design allows us to keep getting the value of IoT and Cloud while taking into consideration these factors
In summary

- Internet of Things as the next big digital revolution, Convergence of operational technologies and information technologies
- Cloud as IoT enabler/IoT foundation
- Fog is needed for scale and real-time apps
- Privacy by design as emerging need

**IoT is a US$19 trillion Opportunity!**
Vielen Dank!
Additional information

http://internetofeverything.cisco.com/

http://clausoncloud.blogspot.com/

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