Fog Computing: Current Research and Future Challenges

Julien Gedeon, Jens Heuschkel, Lin Wang, Max Mühlhäuser
Smart Urban Networks (SUN) Group
Telecooperation (TK) Lab

KuVS FCC@Darmstadt
08.03.2018
The evolution of computing paradigms

<table>
<thead>
<tr>
<th>Paradigm</th>
<th>Evolution Focus</th>
<th>Not so important?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Device Ubiquity</td>
<td>Resource Sharing</td>
</tr>
<tr>
<td>Mainframe/Terminal</td>
<td>✘</td>
<td>✓</td>
</tr>
<tr>
<td>PC</td>
<td>✓</td>
<td>✘</td>
</tr>
<tr>
<td>Cloud/Mobile</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Mobile applications of the near future

Real-time big data processing requires both *HIGH* bandwidth *and* *LOW* latency
The solution – fog computing
Current research

- Computation offloading

Orleans [SoCC11]        MAUI [MobiSys10]
ThinkAir [INFOCOM12]    Odessa [MobiSys11]
TONO [INFOCOM13]        Comet [OSDI12]
Current research (contd.)

- Fog computing infrastructure

OpenFog

ETSI
Our vision

Fog Computing as a Utility

Challenges:
- Lightweight virtualization/migration
- System management at scale
- Resource optimization
- Comm. channel selection
Lightweight virtualization

sharing vs. isolation
System management

SDN

Cloud

NFV

Edge
System management (contd.)

▪ **A general framework that**
  • Provides hardware abstraction for application development
  • Handles common tasks such as resource management

▪ **Requirements**
  • Loose coupling between the device and edge infrastructure
  • Highly-responsive in interaction loops
  • Resource efficient to fully utilize the resources
System management (contd.)

- **Fog computing framework**
  - Execution subsystem: event-based microservices
  - Control subsystem: admission control, resource allocation, mobility management
Holistic resource allocation

The fog is real; the cloud is abstract.
Mobility-agnostic online resource allocation

- Mixed integer program
- Competitive analysis (constant competitive ratio)

Service entity placement for VR/AR

- Social communication between service entities, resource contention at the edge/fog node

- Graph-cut-based optimal placement algorithm

Future challenges

- **Data/application migration**
  - Highly mobile scenarios
  - Proactively migration based on predicted mobility

- **Seamless interplay between fog and cloud**

- **Business models**
  - Incentives for telco and service providers, business impact

- **Security and privacy**
  - Fog can help to improve privacy, but how?
  - Movement traces of users
In closing...

“Edge/fog computing is transformative. It enables new applications. It is truly disruptive. It is here!”

- Mahadev Satyanarayanan
Thank You
Questions?