Aalto University
School of Science
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Cloud Computing
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Agenda

- **Cloud Computing**
  - Motivation
  - Definition
  - Pros and cons
  - SaaS, PaaS, IaaS
  - Pricing
  - Security
  - Challenges and opportunities
- **Mobile cloud and Open Telco**
- **Hybrid cloud**
- **Cloud research in Finland & Europe**
- **Summary**

Traffic peaks are a severe problem

Hulluilla Päivillä kortit jumissa ja putkirikko

Maksukorttien käyttökatkos koski kaikkien pankkien kortteja

Stockmannin Hulluilla Päivillä riitti ongelmia avajaispäivänä keskiviikkona. Aamu alkoi huonosti, kun Visa- ja Master Card -korteilla ei voinut maksaa Stockmannin tavarataloissa. Lisäksi keskustan Stockmannilla kärsittiin putkirikosta.

Maksukorttivika johtui Luottokunnan ja Stockmannin välisestä tietoliikenneyhteydestä. Häiriö koski kaikkia Stockmannin tavarataloja ja kaikkien pankkien Visa- ja Mastercard -korteilla tehtyjä ostoksia, jotka edellyttävät varmennusta pankilta.

Esimerkiksi Itäkeskuksen Stockmannilla katkos aiheutti kymmenien metrien jonoja kassoille. Pitkiä jonoja syntyi myös pankkiautomaateille, kun asiakkaat lähtivät hakemaan käteistä.

Korttikaaoksen ratketessa keskustan Stockmannin Herkussa petti vesiputki kahdesta kohdasta puolen päivän aikaan. Vuotokohdat sijaitsivat ruokamyymälän valmisruokatiskin kohdalla.

"Ongelmat johtuivat linjan ylikuormittumisesta."

BJÖRN ULANDER

▸ Keskustan Herkussa vaalui lauhdevettä katon läpi. Alue rajattiin pois käytöstä vuoden ajaksi.

▸ Itäkeskuksen Stockmannilla korttien käyttökatkos aiheutti kymmenien metrien jonoja tiskeille.

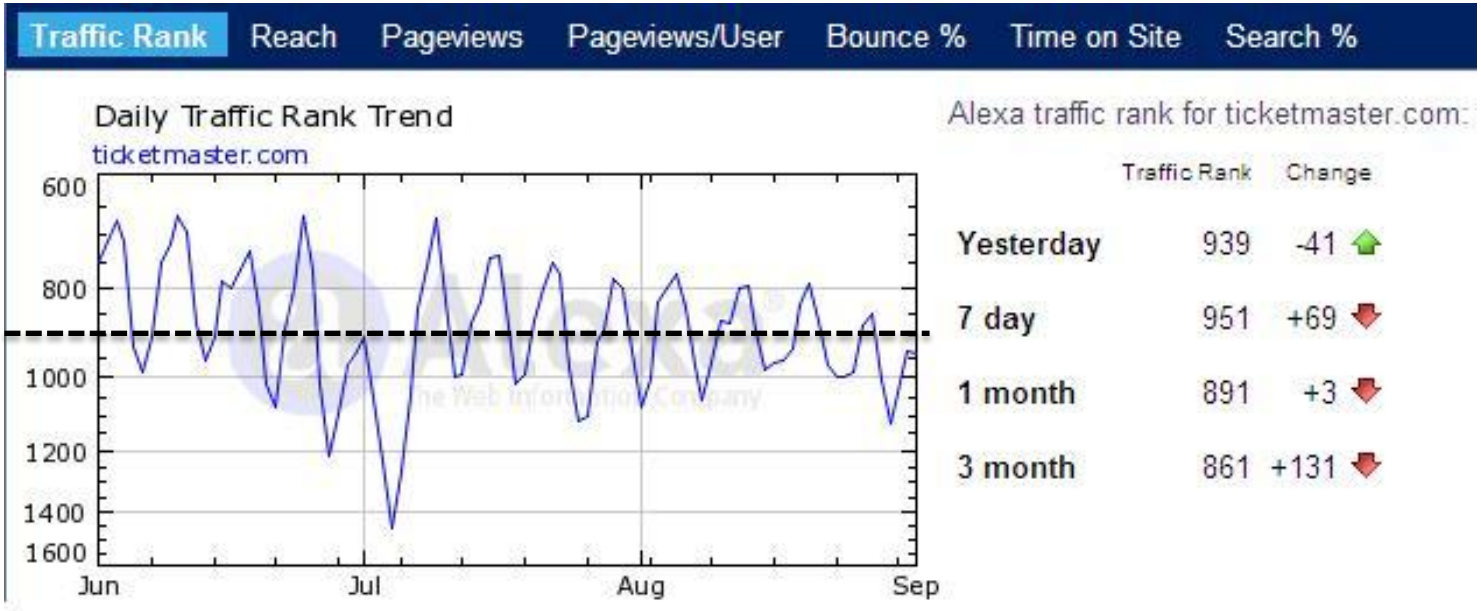
–Yhden jäähdytysputken sulku oli pettänyt ja lauhdevettä tuli katon läpi. Vedentulo loppui runsas vartti sitten, kommentoi tavaratalon johtaja Tuija Vänttinen hieman yhden jälkeen.

Vänttisen mukaan putkirikkoja tapahtuu silloin tällöin. Tällä kertaa vettä ehti valua joitakin, ehkä kymmeniäkin litroja.

Maksukorttiongelmien taustalla oli tietoliikenneyhteyden ylikuormittuminen, kertoo Luottokunnan kauppiaspalveluista vastaava johtaja Björn Ulander. Ulanderin mukaan Stockmannin tietojärjestelmätoimittaja Fujitsu Services vastaa tavaratalojen varmennusyhteyksistä Luottokuntaan.

–Kuormaa pystytään tasaamaan, ettei ongelmia tule jatkossa, Ulander vakuuttaa. STT-TT

Case Ticket sales



Source: http://www.alexa.com/siteinfo/ticketmaster.com#

Definition

– *"Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction."*

Source: P. Mell and T. Grance, The NIST Definition of Cloud Computing, July 2009

What is cloud computing

1. The illusion of infinite computing resources available on demand, thereby eliminating the need for Cloud Computing users to plan far ahead for provisioning.
2. The elimination of an up-front commitment by Cloud users, thereby allowing companies to start small and increase hardware resources only when there is an increase in their needs.
3. The ability to pay for use of computing resources on a short-term basis as needed (e.g., processors by the hour and storage by the day) and release them as needed, thereby rewarding conservation by letting machines and storage go when they are no longer useful.

Source: Ambrust et al, Above the Clouds: A Berkeley View of Cloud Computing, Feb 2009

Some skepticism

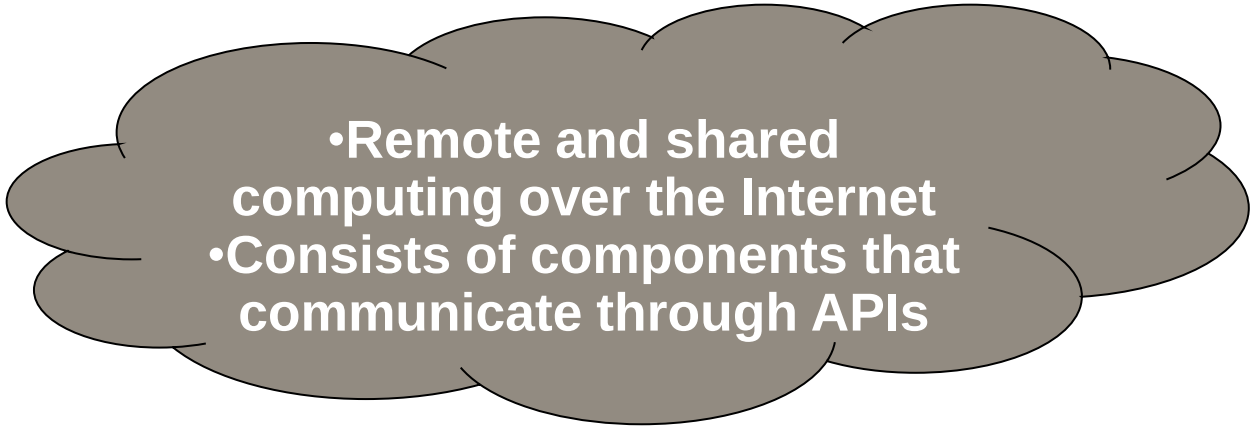
- ***The interesting thing about Cloud Computing is that we've redefined Cloud Computing to include everything that we already do. . . . I don't understand what we would do differently in the light of Cloud Computing other than change the wording of some of our ads.***

  Larry Ellison, quoted in the Wall Street Journal, September 26, 2008

- ***It's stupidity. It's worse than stupidity: it's a marketing hype campaign. Somebody is saying this is inevitable — and whenever you hear somebody saying that, it's very likely to be a set of businesses campaigning to make it true.***

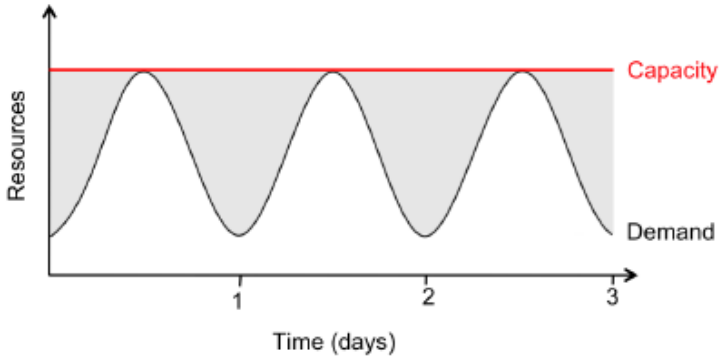
  Richard Stallman, quoted in The Guardian, September 29, 2008

Cloud computing pros and cons

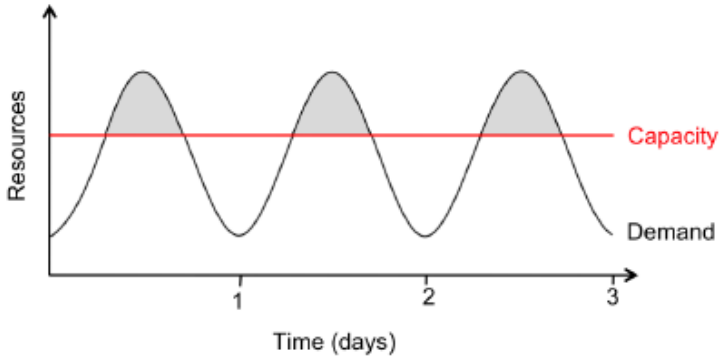


!	?
•Simple architecture	•Security & Privacy
•Efficient usage of CPU (>50%)	•High usage of certain CPUs
•Scalability	•Interoperability
•Load balancing	•Vendor lock-in
•Low capex	•High opex
•High availability	•SLA critical

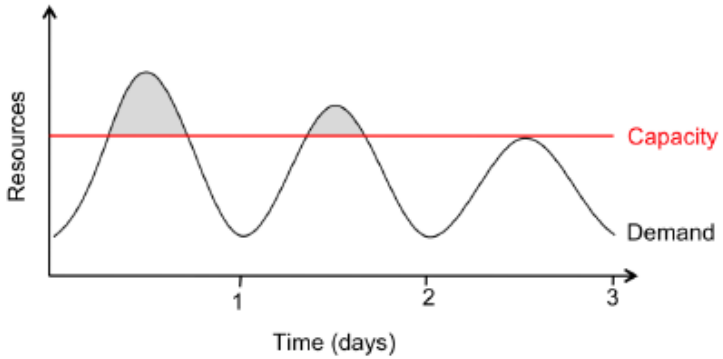
Resource planning



(a) Provisioning for peak load



(b) Underprovisioning 1



(c) Underprovisioning 2

Source: Ambrust et al, Above the Clouds: A Berkeley View of Cloud Computing, Feb 2009

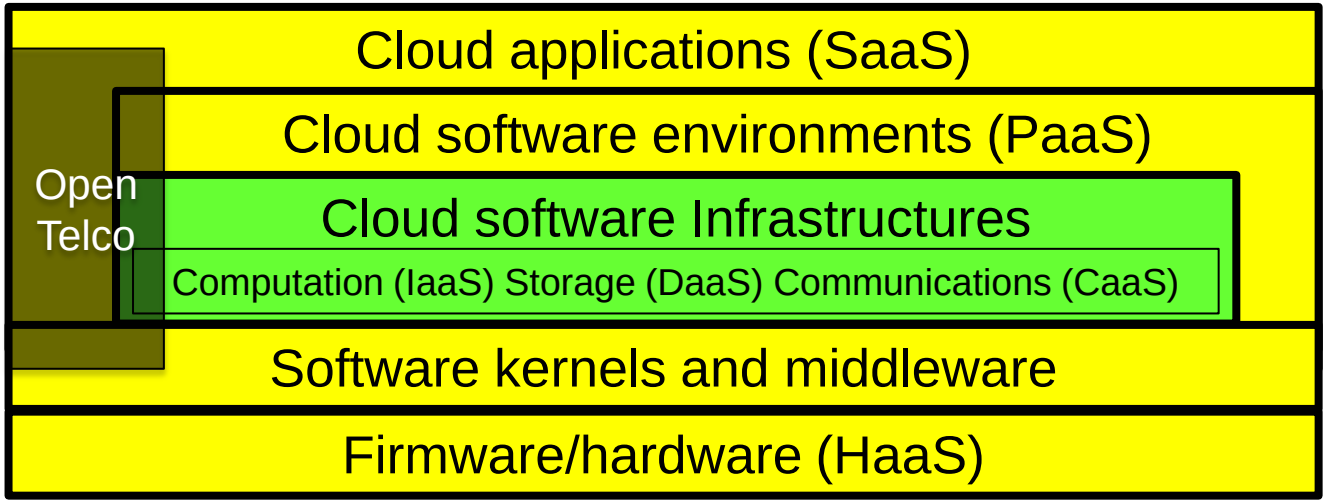
New opportunities

1. **New Technology Trends and Business Models**
2. **New Application Opportunities**

- **Mobile interactive applications**
- **Parallel batch processing**
- **The rise of analytics**
- **Extension of compute-intensive desktop applications**
- **“Earthbound” applications**

Source: Ambrust et al, Above the Clouds: A Berkeley View of Cloud Computing, Feb 2009

UCSB-IBM Cloud Computing Classification Model



Source: Syed A. Ahson and Mohammad Ilyas: Cloud Computing and Software Services (2011), CRC Press

Everything as a Service (XaaS)

SaaS (Software as a Service)

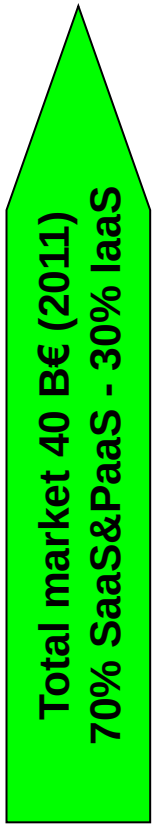
- Ready to deploy application
- Salesforce, Gmail, SMS, voice

PaaS (Platform as a Service)

- No system administration
- Simplified development
- Scaling is provided by the PaaS framework
- Google AppsEngine, Microsoft Azure

IaaS (Infrastructure as a Service)

- Computers owned by the cloud provider
- No hardware management issues
- Dynamic scaling of resources through virtualization
- Billing is calculated by usage only
- Amazon EC2



Amazon Elastic Compute Cloud (EC2) pricing parameters

- Zones
- Instance size
- Storage size
- Reserved instances
- Spot instances
- Data transfer
- Elastic IP address
- Monitoring services
- Elastic load balancing
- VPN

Source: http://aws.amazon.com/ec2/pricing/

MapReduce (1/2)

- **Numbers*:***
  - Facebook with 10 billion photos (x4: 40 billion files), one peta byte in total; 2-3 tera are added every day
  - The Web: 100 billion web pages -> 400-500 terabytes compressed (duplicated across several clusters)
  - eBay has 6.5 PB of user data + 50 TB/day bytes are added every day
- **Bottleneck in data transfer speeds (reads/writes from/to disks)**
- **Unlike disk capacity, improves linearly**

Source: Denis Shestakov, Cloud Computing seminar 24.9.2010

MapReduce (2/2)

- **Solution: read parallel from multiple disks**
- **However, programming challenging**
- **Google introduced MapReduce 2003/2004**
- **Hides from a programmer complexity of parallelization, fault-tolerance, data distribution and load-balancing**
- **Principle**
  - Iterate over a large number of records
  - Extract something of interest from each (MAP)
  - Shuffle and sort intermediate results
  - Aggregate intermediate results (REDUCE)
  - Generate final output

Source: Denis Shestakov, Cloud Computing seminar 24.9.2010

Security challenges by Cloud Security Alliance (CSA)

Architectural	Cloud Computing Architectural Framework (cloud deployment, taxonomy…)
Legal & Management	• Governance and Enterprise Risk Management • Compliance & Audit • General Legal • E-discovery • Portability & Interoperatibility • Information Lifecycle Management
Operational	•"Traditional" Security impact • Data Center Operations • Storage • Virtualization • Encryption and Key Mgmt. • Identity and Access Mgmt. • Application Security

Source: CSA, Security Guidance for Critical Areas of Focus in Cloud Computing V2.1, December 2009

Top security threats in Cloud computing

Threat	Description	Target
Abuse and Nefarious Use of Cloud Computing	Abusing anonymity for spamming, malicous code launch etc.	IaaS, PaaS
Insecure Interfaces and APIs	Anonymous logging, miuse of resources	All
Malicious Insiders	Misuse of internal information	All
Shared Technology Issues	Misuse of computation resources	IaaS
Data Loss or Leakage	Misuse of data	All
Account or Service Hijacking	Eavesdrop business	All
Unknown Risk Profile	Lack of control	All

Source: CSA, Top Threats to Cloud Computing V1.0, March 2010

Challenges and opportunities

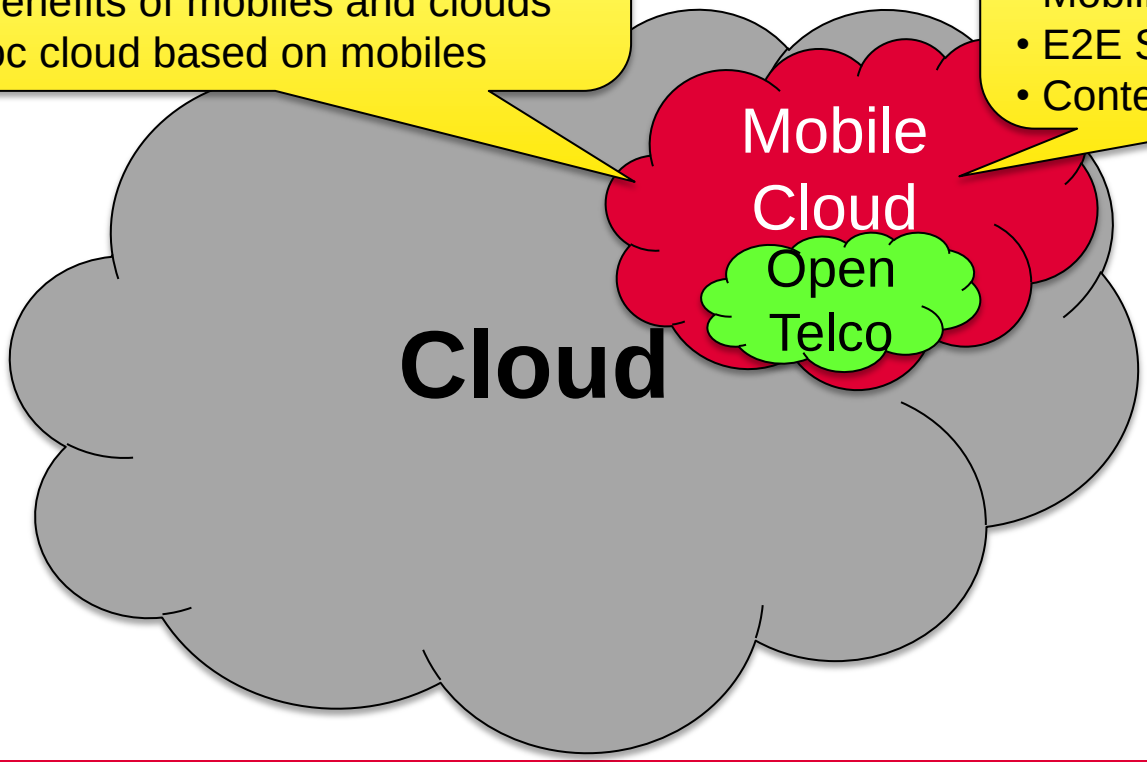
#	Challenge	Opportunity
1	Availability of Service	Use Multiple Cloud Providers
2	Data Lock-In	API standardization
3	Data Confidentiality and Auditability	Deploy Encryption, VLANs, and Firewalls
4	Data Transfer Bottlenecks	Higher Bandwidth LAN Switches
5	Performance Unpredictability	Flash Memory
6	Scalable Storage	Invent Scalable Store
7	Bugs in Large-Scale Distributed Systems	Invent Debugger that relies on Distributed VMs
8	Scaling Quickly	Invent Auto-Scaler
9	Reputation Fate Sharing	Offer reputation-guarding services
10	Software Licensing	Pay-for-use licenses

Source: Ambrust et al, Above the Clouds: A Berkeley View of Cloud Computing, Feb 2009

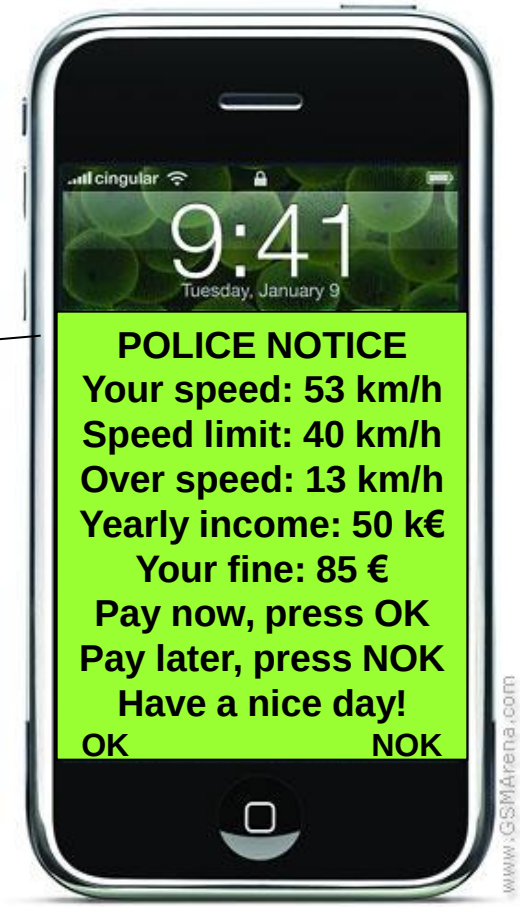
What is Mobile Cloud

Tekes Signal Session 11.5.2010:
1. Mobile access to fixed cloud
2. Enabler for new services utilizing the benefits of mobiles and clouds
3. Adhoc cloud based on mobiles

Telecom Forum, Pekka Markkula (TeliaSonera) 21.9.2010:
- Mobility
- E2E Security
- Context awareness



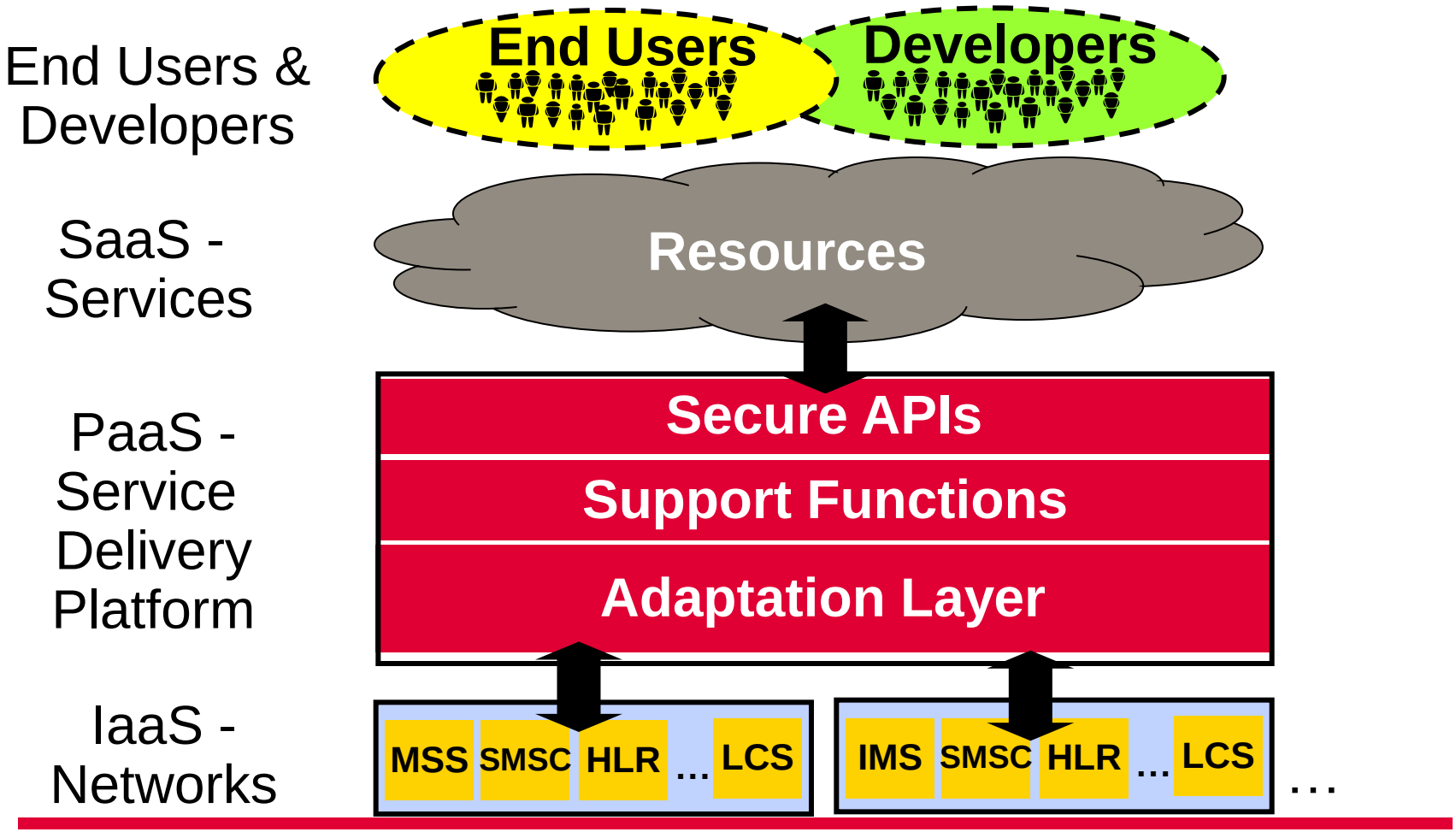
Open Telco enables new innovation



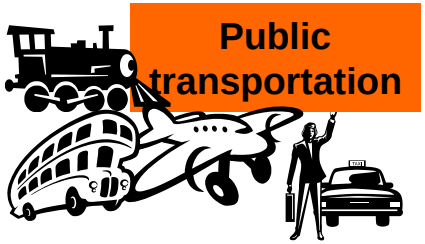
Open Telco in a nutshell

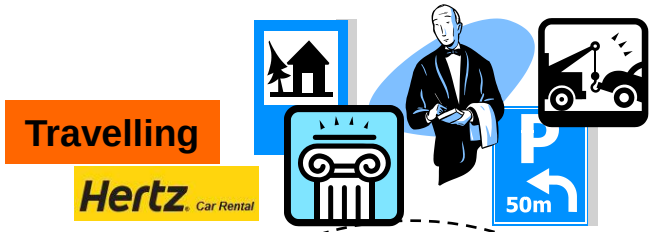
- **The current approach: closed model where services created in a controlled environment**
- **The target: hybrid model where Open APIs provide data for a service machinery located (partly) in a cloud**
- **Open APIs can be utilized by operators, partners and developers**
- **Privacy challenge must be solved, end user in control**
- **Cloud Software/Open Telco core targets**
  - Reviewing theoretical literature and frameworks
  - Report on secure & open APIs and middleware solutions in cloud
  - Analyzing business models and value networks
  - Developing a demonstration system with real APIs in multi-operator & -vendor networks

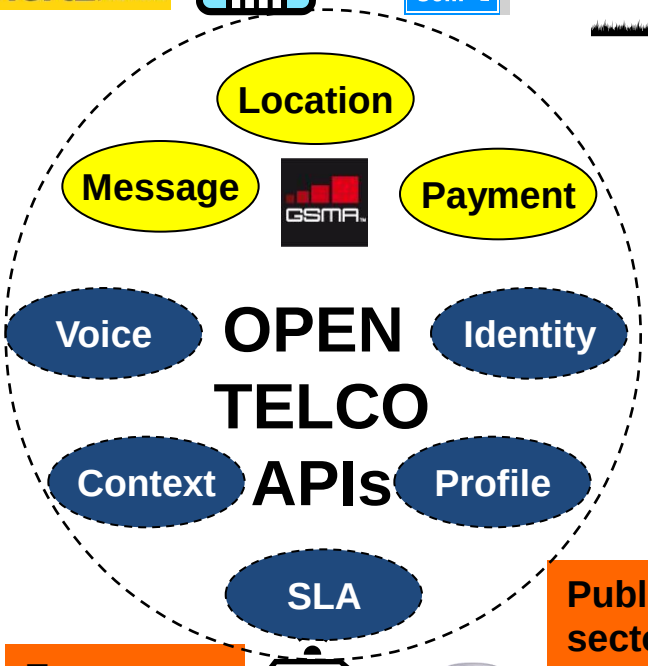
Architecture



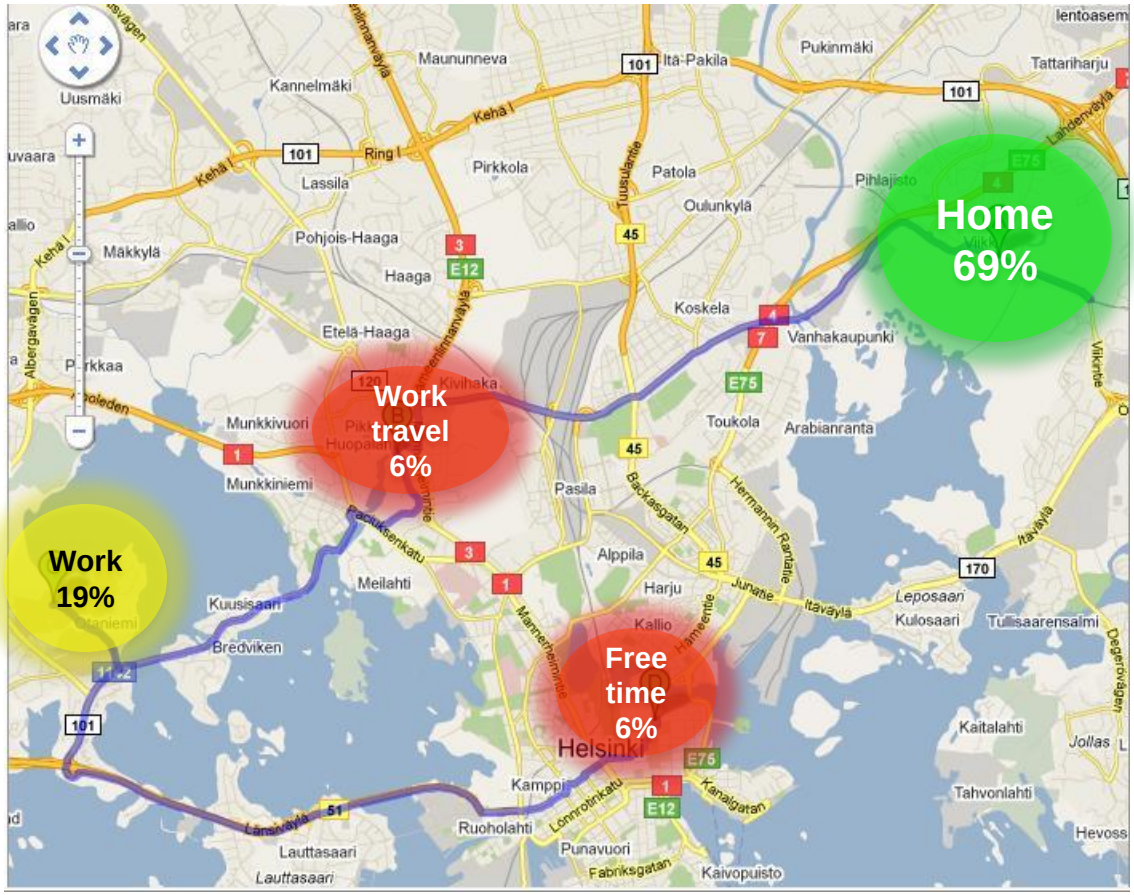
Open APIs exist everywhere



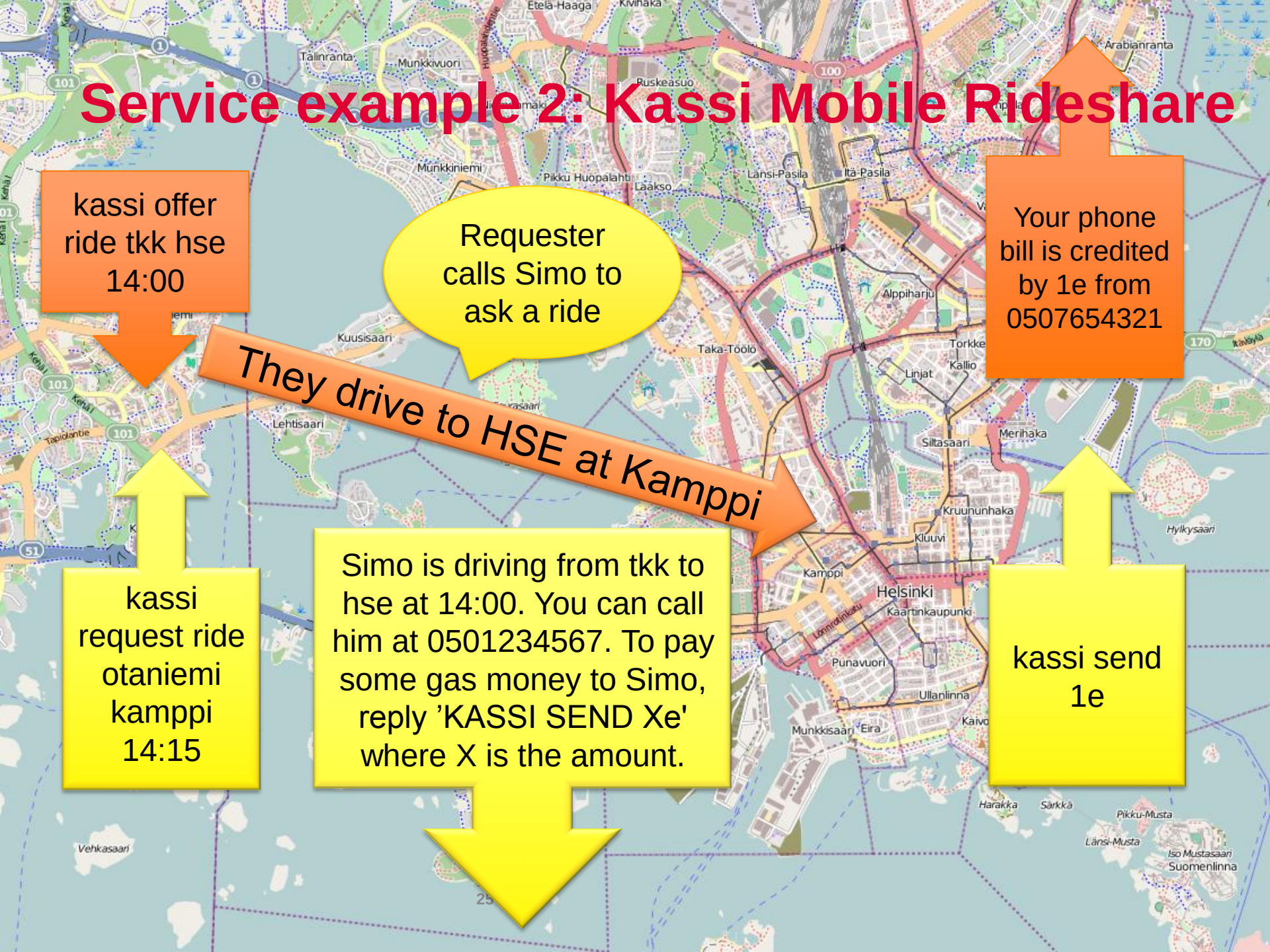




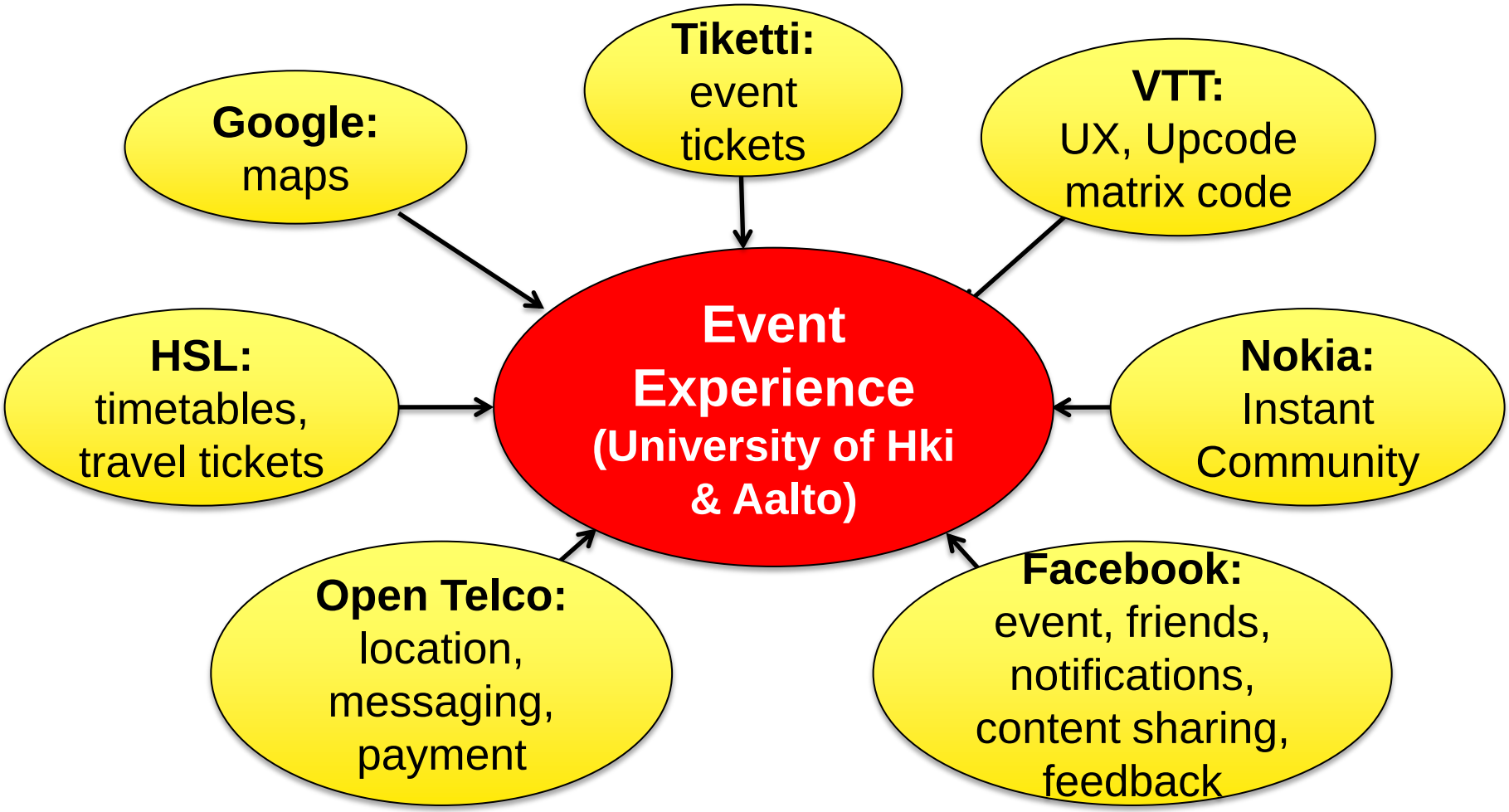
Service example 1: Location tracing



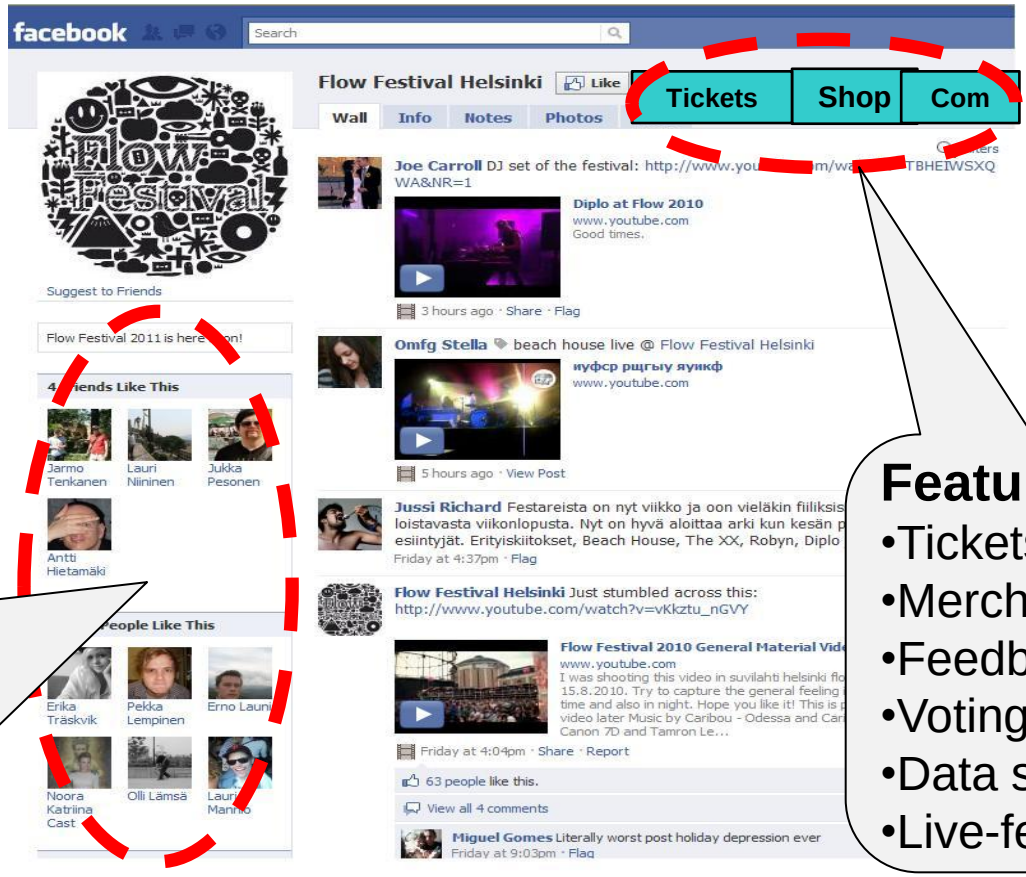
Service example 2: Kassi Mobile Rideshare



Service example 3: Event Experience



Facebook view



Presence

- Who will attend?
- Who are at the event venue right now?
- Who have visited the event venue?

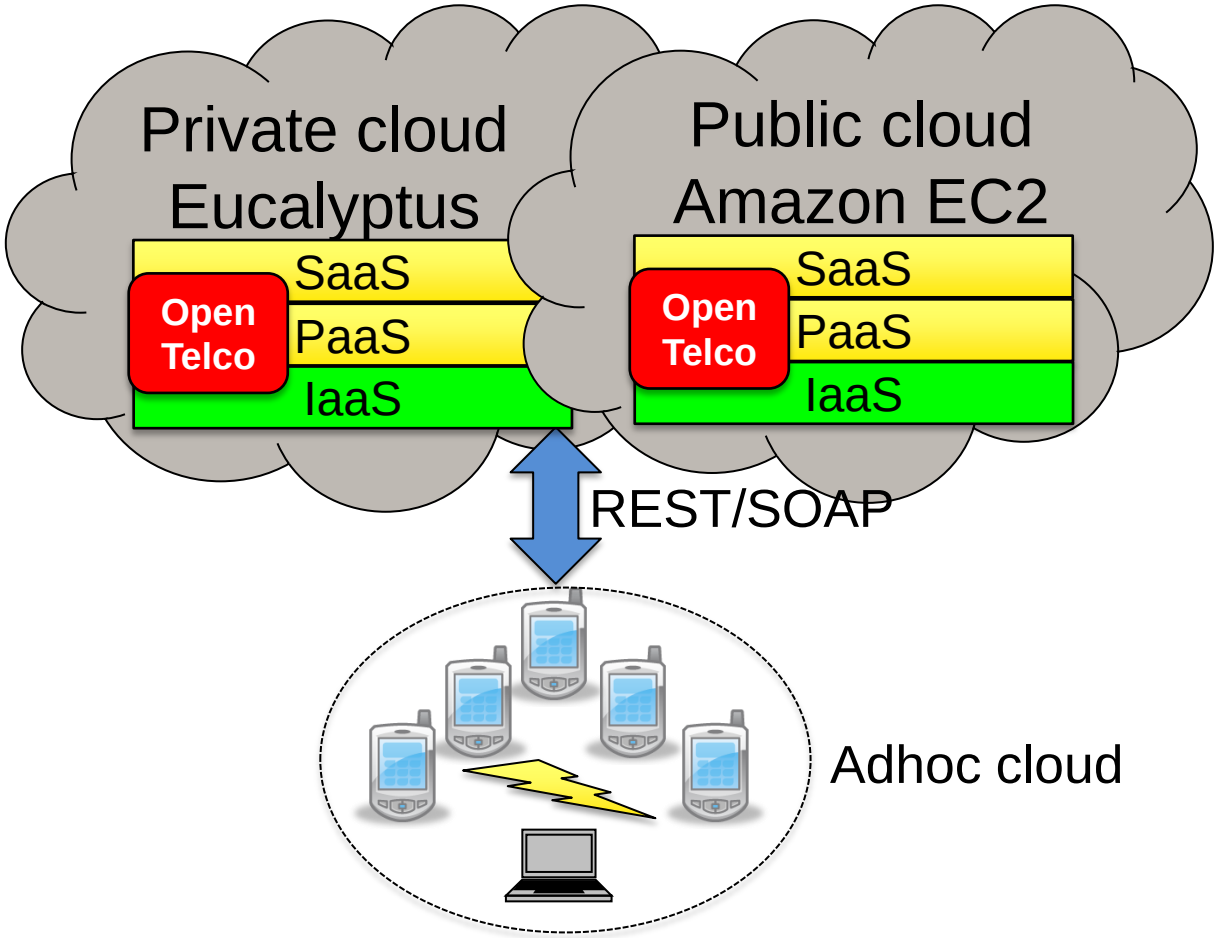
Feature sheets

- Tickets
- Merchandise
- Feedback
- Voting, polls
- Data sharing
- Live-feed

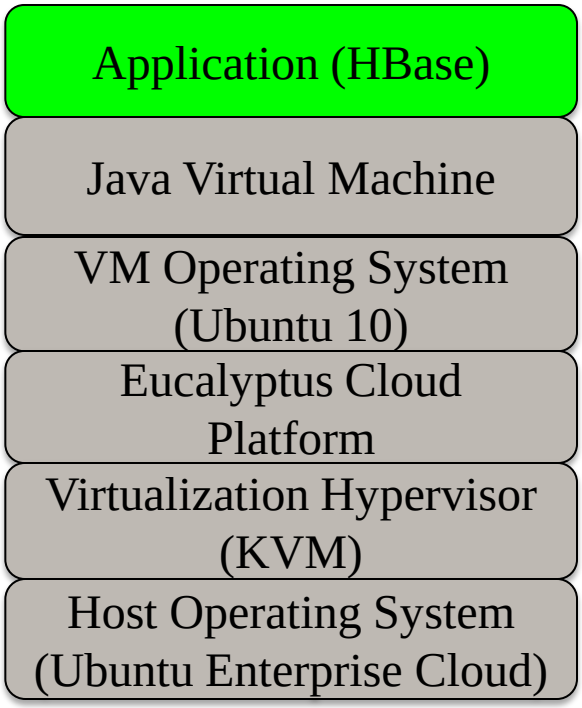
Mobile view

- A new business innovation
- Combines social networks and open APIs to provide a unified event experience
- Event and travel tickets
- Merchandise
- Pre-, on- and post event information
- Social network services, such as voting, mode, chat and grouping

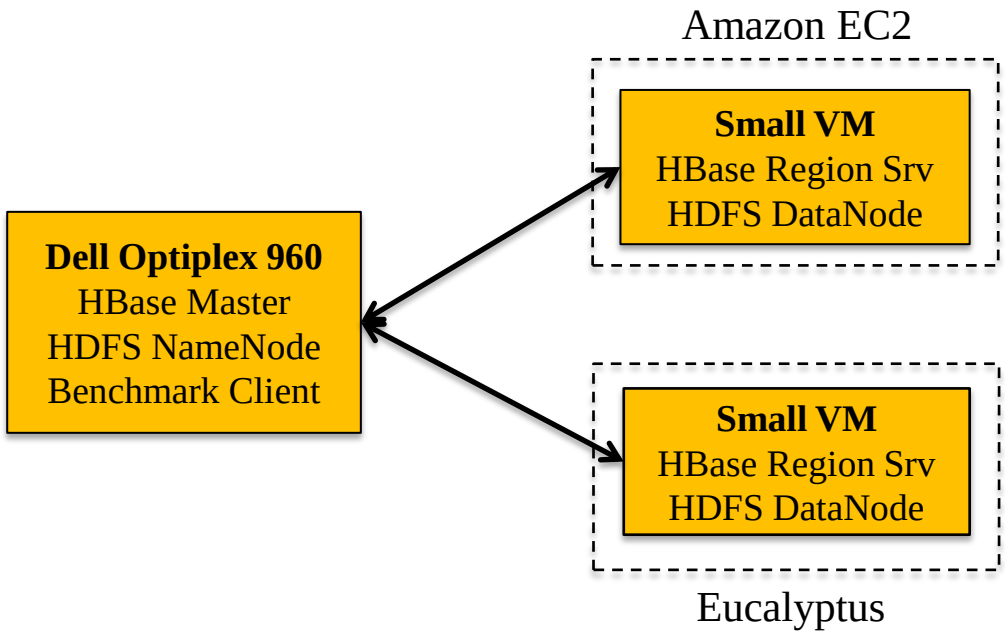
Mobile Cloud project



Cloud stack for Eucalyptus

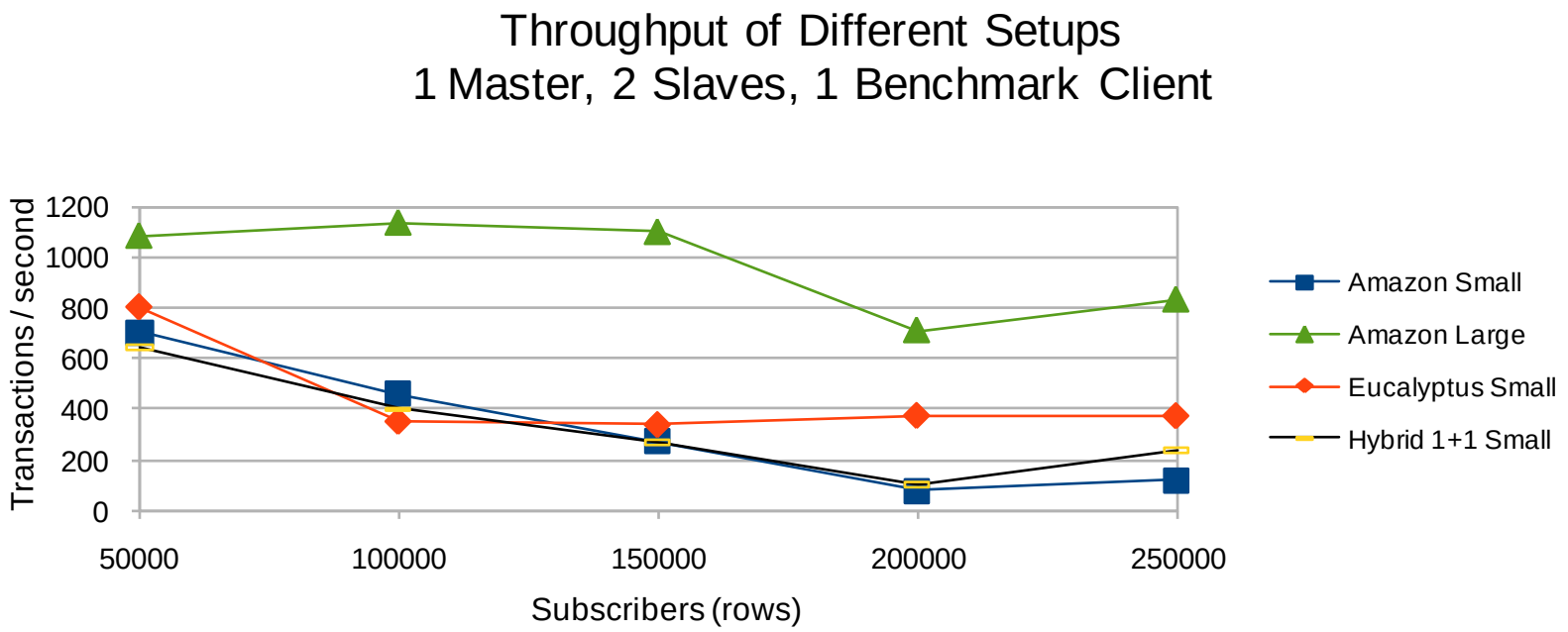


Hybrid Cloud 1x1 HBase benchmark with single client

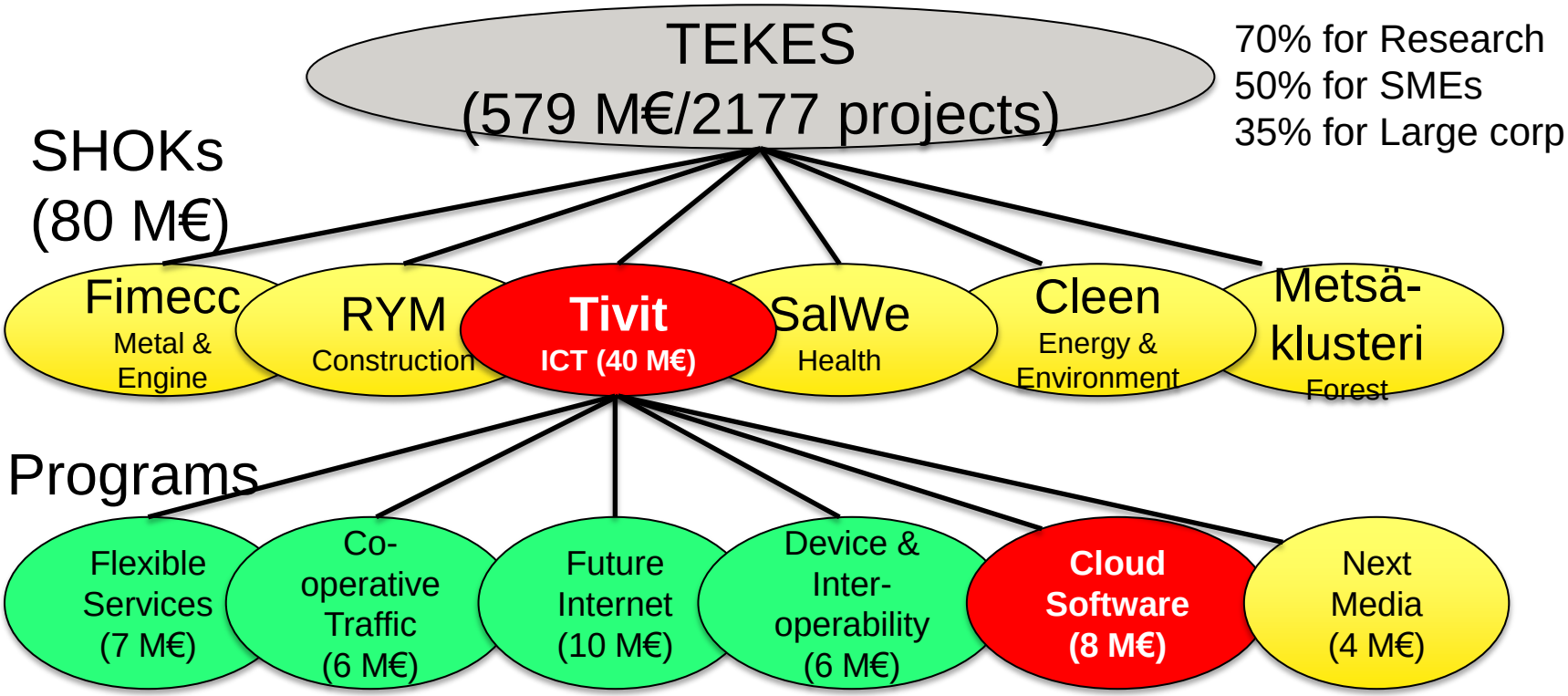


•Amazon: 1.7 GB memory, Ubuntu Lucid 10.04 32 bit server
•Eucalyptus: 1.7 GB memory, Ubuntu Lucid 64 bit desktop
- HW: 100 Mbps LAN, PC with Intel Core 2 Duo processor and 8 GB memory

Throughput results with 1 master, 2 slaves and 1 benchmark client



Tekes, Tivit and Cloud Software



Participating companies and universities

- Total budget 2010
  - 16,3 M€
    - Industry: 10,5 M€ (64%)
    - Research: 5,8 M€ (36%)
      - Aalto: 1,375 M€
  - 1469 pm
    - Industry: 926 pm (63%)
    - Research: 543 pm (37%)
      - Aalto: 120 pm
        - DCS: 28 pm
- Similar budget for 2011-2013

Industry	Research
Digia	Aalto Uni
Elektrobit	Tampere Uni
Ericsson	Åbo Uni
F-Secure	Helsinki Uni
Ixonos	Jyväskylä Uni
NetHawk Oyj	Oulu Uni
Nokia	VTT
NSN	
TeliaSonera	
Tieto	
CSC	
& 8 SMEs	

Cloud Software breakthrough targets

1. **The competitive position, volume and profitability of the Finnish software and software intensive industry in global markets improve significantly.**

2. **The Finnish software and software intensive industry introduce significant amount of globally competitive new or improved product and service concepts.**

3. **Leading ecosystems in the field of Cloud Software are established.**

EU FP7 ICT Calls 2011-2012

	Budget	GC, EEB, FoF PPP 2011	Future Internet PPP 2011	EU-Russia coord. Call	EU-Brazil coord. Call	FET Flags. Initiat.	Call 7	SME Initiat.	Call 8	GC, EEB, FoF PPP 2012	Call 9	Future Internet PPP 2012	FET Open
Date of publication		20/7/10	20/7/10	20/7/10	28/9/10	20/7/10	28/9/10	1/2/11	26/7/11	30/7/11	18/1/12	18/5/12	20/7/10
Call deadline		2/12/10	2/12/10	14/9/10	18/1/11	2/12/10	18/1/11	28/4/11 (short) 28/9/11 (full)	17/1/12	2/12/11	17/4/12	29/10/12	Cont. to 31/12/12
1. Pervasive and Trusted Network and Service Infrastructure	625												
1.1 Future Networks	160								160				
1.2 Cloud Computing, Internet of Services and Advanced Software Engineering	70								70				
1.3 Internet-connected Objects	30						30						
1.4 Trustworthy ICT	80								80				
1.5 Networked Media & Search Systems	70						70						
1.6 Future Internet Research and Experimentation (FIRE)	45						20		25				
1.7 PPP FI: Technology foundation - Future Internet Core Platform	41		41										
1.8 PPP FI: Use Case scenarios and early trials	107.5		40									67.5	
1.9 PPP FI: Capacity Building and Infrastructure Support	15.5		3									12.5	
1.10 PPP FI: Programme Facilitation and Support	6		6										
2. Cognitive Systems and Robotics	155												
2.1 Cognitive Systems and Robotics	155						73				82		
3. Alternative Paths to Components and Systems	402												
3.1 Very advanced nanoelectronic components: design, engineering, technology and manufacturability	60								60				

Cloud computing summary

- Cloud computing enables new business innovations
- Mobile cloud could be the Finnish advantage
- Also ”Stored in Finland”?
- Open APIs will emerge, companies can still be closed (Twitter)
- Still a lot of challenges => opportunities for us!

References

1. Syed A. Ahson and Mohammad Ilyas: Cloud Computing and Software Services (2011), CRC Press
2. Amazon Elastic Compute Cloud, Pricing, http://aws.amazon.com/ec2/pricing/
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