Aalto University
School of Science

T-110.5121 Mobile Cloud Computing
Business in Cloud Computing

Antero Juntunen
Aalto University, School of Science
Department of Computer Science and Engineering
Data Communications Software
3.10.2012

Contents

- Innovation in Mobile Clouds: Analysis of an Open Telco Application
- Mobile Computation Offloading – Factors Affecting Technology Evolution
- HTML5 in Mobile Devices – Drivers and Restraints
- Assignment - Business model

Innovation in Mobile Clouds: Analysis of an Open Telco Application

Antero Juntunen, Vesa Suikkola, Yrjo Raivio, Sakari Luukkainen
CLOSER 2011 - International Conference on Cloud Computing and Services Science

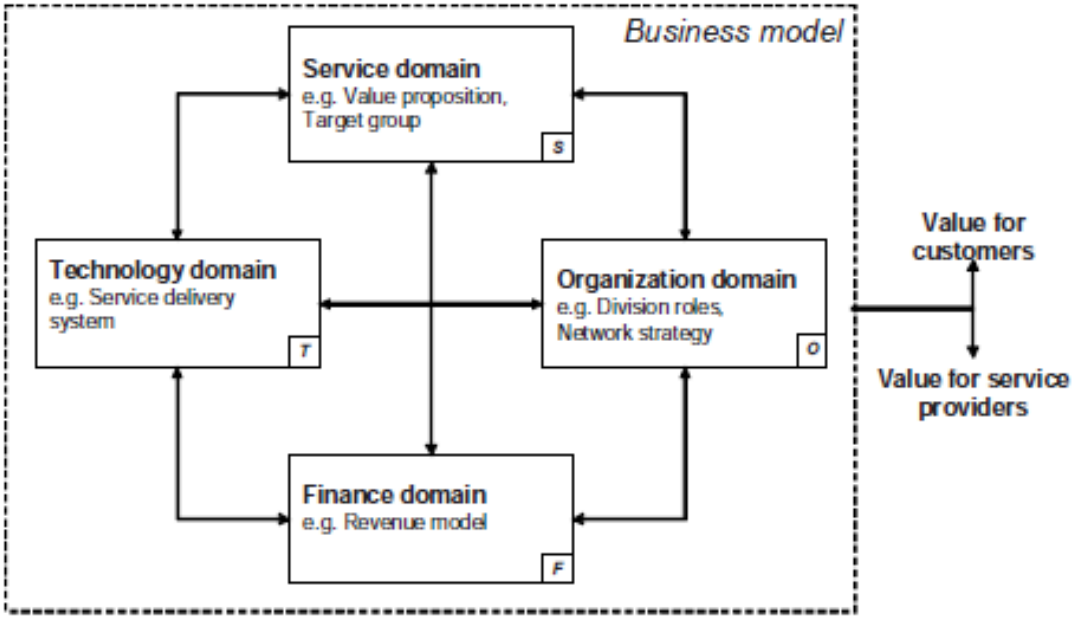
Aalto University
School of Science

Introduction: Open Telco

...NaaS (Network as a Service)

- Framework for open telecommunication-operator network inferfaces
  - Sample capabilities: location, messaging, and payment
- Enables telco mash-ups and Open Innovation in the telco domain → Long Tail of mobile services
- Current state: uncertainty and consequent lack of deployments
  - Need for revolutionary applications (”killer apps”) to drive the ecosystem forward

STOF Model



- STOF: Service, Technology, Organization, Finance
- A framework for analyzing business models

Source: Bouwman, De Vos, Haaker (Eds.), 2008.

Service Domain: Important concepts

- Value proposition
- Customer, End User, Market Segment
- Context
- Pricing
- Effort (ease of use)
- Bundling

Source: Bouwman et al., 2008

Technology Domain: Important concepts

- Technical Architecture
  - Applications
  - Devices
  - Service Platforms
  - Backbone Infrastructure
  - Access Networks
- Data
- Technical Functionality
- Security
- Quality of Service
- System Integration

Source: Bouwman et al., 2008

Organization Domain: Important concepts

- Actors
- Roles
- Value Network
- Interactions and Relations
- Strategies and Goals
- Resources and Capabilities
- Value Activities
- Organizational Arrangements

Source: Bouwman et al., 2008

Finance Domain: Important concepts

- Revenues and Revenue Sources
- Costs and Cost Sources
- Performance Indicators
- Capital and Investment Sources
- Risks and Risk Sources
- Financial Arrangements

Source: Bouwman et al., 2008

Event Experience Application

Alice and Bob find an interesting event on their favorite social networking site. They click to attend and notice the Event Experience service is available for this concert event. They order the service by specifying their mobile subscriptions to the application and receive admittance and complementary bus tickets by MMS and/or SMS. On the event day, Alice and Bob are heading to the venue well in advance as the service informs them a rush is expected. Their phones alert both at the same time – the concert organizer is guiding them to use Gate B as Gate A is crowded. They get in and find their seats in no time with the area map included in the service. Now it is time to read the latest comments by other visitors from the event wall, and see if any of their friends are located at the concert area. Alice and Bob are also invited to vote for the encore song of the concert. After the event, Bob orders a T-shirt through the Event Experience page; he can conveniently pay for the order by mobile.

Event Experience Analysis: Service Domain

- Complementary and supplementary services:
  - Information service on the event in which the users receive relevant information about the event, such as the event program, schedule, and seating chart.
  - Proactive crowding avoidance at the venue
  - An event specific blog and media feed through which the users can receive and send messages to other attendees
  - Polling and voting system, for example, for voting on the encore or rating the previous song at concerts.
  - Friend-presence service for checking if a friend is attending the event.
  - Public transportation ticket to the venue.
  - Event-store that offers, for example, video recording of the event, song downloads, event highlights media, or other event-related merchandise available for purchase and download or delivery through the event-store system.

Event Experience Analysis: Service Domain

- Integrated package of event-related services
  - Tickets and merchandise
  - Pre-, on- and post-event information
  - Social network services
    - Grouping, voting, chat, information sharing…
- Concerts, conferences, exhibitions, sports events, private parties, etc.
- Organizer and user application
- Browser-based application → low-effort adoption (no need to install an application)

Event Experience Analysis: Service Domain

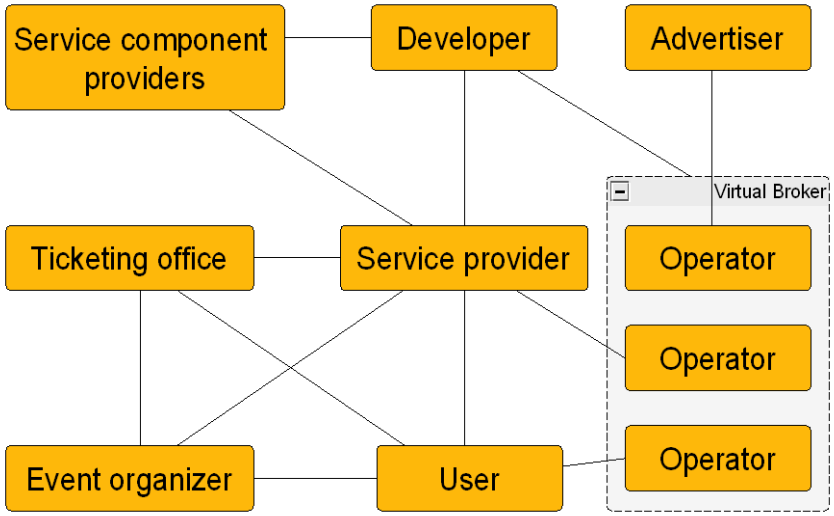
Feature / Benefit	Event Experience	Tiketti	YLE-Twitter	SMS-voting	Facebook
Mobile ticket distribution	X	X			
Mobile ticket purchase	X	X			
Ticket validation	X	X			
Context-specific messaging	X		X		X
Sharing context-specific media	X		X		X
Polling and voting	X			X	
Audience – organizer interaction	X		X	X	X

Event Experience Analysis: Technology Domain

- Application placed in the cloud
- Browser-based application
  - Decreased device requirements (processing, battery)
  - Decreased effect of OS fragmentation (accessible by mobile and desktop devices)
- Prototype implementation
  - Integration to Facebook events and social networks
    - Features: event wall, SMS/MMS messaging, ticketing and payment mock-ups
  - Telco messaging and payment (mock-up)
  - C.a. 500 hours of development time
  - Challenges:
    - Integration to external systems
    - Telco API limitations (payment not available, limited transactions)

Event Experience Analysis: Organization Domain

- Two-sided markets (for the service provider)
  - Organizers and users
- In addition to utilizing Open Telco APIs, developers can use other open APIs
  - APIs provided by service component providers
  - E.g. Facebook as the event/social network platform



Event Experience Analysis: Finance Domain

- Revenue streams
  - Users and organizers
  - (Advertisers)
- Utilization of cloud principles
  - Cloud hosting
  - Browser-based application
  - Open Telco capabilities

  → Only investment is the actual application development
  - Risk mitigation through modular architecture
    - Able to prioritize the core service features (ticketing, information, and social-networking features)
- Open Telco payment – 30% revenue share infeasible

Conclusion

- Event Experience success factors:
  - Bundling of services, enhanced user-experience
  - Organizers able to interact with users better, reduced costs
  - EE also suitable for smaller events
- MCC & OT benefits
  - Reduced investments, easy to scale up service
  - Less dependance on handset capabilities (browser required)
  - Applications easy to deploy
- Potential concerns:
  - Reliance on external APIs poses technical and business restrictions
  - Pricing of operator APIs

Mobile Computation Offloading - Factors Affecting Technology Evolution

Antero Juntunen, Matti Kemppainen, Sakari Luukkainen
ICMB 2012 – International Conference on Mobile Business

Aalto University
School of Science

Introduction

- Smartphones have become common in recent years, applications driving device adoption
- However:
  - Mobile device processing power still limited
  - Battery technology not keeping pace with energy consumption
- One solution: Mobile Cloud Computing
  - Definition: Using cloud-computing principles to deliver applications and services for mobile devices
  - Mobile applications can run in the browser, use cloud for intensive computation → Reduced software fragmentation
- Mobile Computation Offloading (MCO) can be seen as a subset of Mobile Cloud computing

Mobile Computation Offloading

- The processing of **native applications** is **dynamically** executed either in **surrogates** or on the mobile device
- Surrogate device = outside device performing the computation
  - Cloud, normal servers, desktop devices, etc.
- Not offloading user data (iCloud), nor communication
- Our research goal: identifying critical factors that affect the technology evolution of MCO

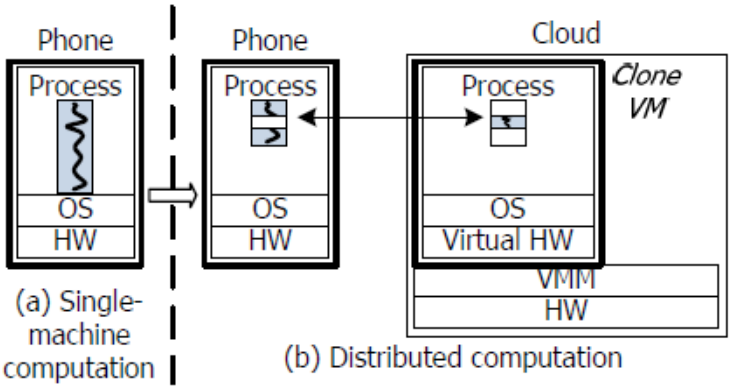


Figure source: Chun and Maniatis (2009). Augmented Smartphone Applications Through Clone Cloud Execution.

Methodology

- Literature review of MCO
- Analyzed using a framework derived from technology evolution literature
  - Added value
  - Ease of experimentation
  - Complementary technologies
  - Incumbent role
  - Security, privacy, trust

Added value

- Increased computing power
  - Enhanced funtionality (better AI in a game)
  - Better responsiveness (faster image recognition algorithm)
  - Potentially new applications
- Energy savings
  - Energy-draining computation performed outside mobile device
  - Communication a balancing factor
  - Offloading most suitable for applications that require significant energy in processing but limited energy in communication
- Subtle benefits such as reduced energy consumption difficult for end users to perceive

Ease of experimentation

- How easy is it for developers to move to MCO?
- Software modifications for offloading can be done quickly, but the result may be suboptimal
- Some current solutions aim to minimize developer involvement (CloneCloud, etc.)
  - Especially important low-margin, long-tail applications
- Other solutions automate part of the development process and integrate with development tools
- Feature vs. Method vs. System level offloading
- Developer involvement cannot be completely eliminated

Complementary technologies

- Mobile network technologies a key factor for MCO
- Wireless modem consumes more energy
  - the longer it remains active
  - the smoother the traffic pattern is
- High bandwidth can alleviate energy consumption
- Latency another key concern, especially for immersive applications
- Coverage a prerequisite for offloading
- New technologies such as LTE can increase the viability of MCO
- Another option: WLAN access points & local surrogates

Incumbent role

- Software companies
  - Increase performance of existing applications
  - Possible to develop new applications
  - Possible to target older mobile phones
- Device manufacturers & OS providers
  - Decreased hardware fragmentation
- Mobile Network Operators
  - Offloading infrastructure provider (cloud)
  - Leverage reputation to enhance user trust
  - Billing

Security, privacy, trust

- User trusts in
  - the computation performed on the surrogate
  - the privacy and integrity of the offloaded data
- Two basic methods:
  - Trust establishment
  - Reputation-based trust
- In MCO, security and privacy mechanisms have to be as energy-concious as possible

Conclusions

- Key benefits: energy savings & increased computation
- Technical solutions are still in a very early phase
- Offloading frameworks not available for wider use
- Evaluated test cases in MCO literature are typically tailor-made
  - The applicability of MCO for common use needs to be more throughly tested
- How to sell MCO to the end users?
- What about other options (web apps vs. native apps)?

HTML5 in Mobile Devices – Drivers and Restraints

Antero Juntunen, Eetu Jalonen, Sakari Luukkainen
HICSS 2013 – Hawaii International Conference on System Sciences

Aalto University
School of Science

Introduction

- Current issues for native applications:
  - Fragmentation, between and within OSes
  - Rigid revenue sharing models
- Web-based mobile applications may address these issues
- HTML5 is an evolution of the previous standards and provides certain features to the browser that are typically associated with desktop-style software
- Goal: identify drivers and restraints for HTML5 in mobile devices

Added value

- For the end users
  - No manual installation or update of an application
  - A unified user experience for multiple devices and platforms
  - HTML5 applications can better mimic the user experience of native applications
  - Offline data caching of HTML5
- For the developers
  - Cross-platform development
  - Web applications not tied to app stores: revenue sharing
  - More visibility for certain applications in web searches, etc.

Ease of experimentation

- How easy is it for developers to use HTML5 and how does HTML5 affect the software development process?
- HTML5 builds on existing knowledge of web technologies: easy transition for web developers
- Intrinsic advantages of running applications on the web:
  - Ease of deployment
  - Speed and ease of updating applications
  - Not tied to the approval processes of application stores
- On the other hand: Sufficient server hardware and bandwidth required (cloud one option)

Complementary technologies

- Adequate browser support a prerequisite for mobile HTML5 applications
- Platform vendors may control browser development

Feature	Safari on iOS	Android Browser	Google Chrome	Amazon Silk	BlackBerry Browser		Nokia Browser		Internet Explorer	Opera Mobile	Opera mini	Firefox	webOS Browser	
Platform	iPhone, iPad	Phones & Tablet	Android 4.0+	Kindle Fire	Phones	Tablet	MeeGo - N9	Symbian	Windows Phone 7.5	Android & Symbian	Java,iOS Android	Android, MeeGo	HP Phones	HP TouchPad
Versions tested	3.2 to 6.0	1.5 to 4.1	18	1.0	5.0 to 7.0	1.0 to 2.0	1.2	^3 to Belle	9	11 to 12	5 to 7	6 to 15	1.4 to 2.0	3.0
Application Cache W3C API Offline package installation.	✓	✓ 2.1+	✓	✓	✓ 6.0+	✓	✓			✓		✓	✓	✓
Web storage W3C API Persistent and session storage.	✓	✓ 2.0+	✓	✓	✓ 6.0+	✓	✓		✓	✓		✓	✓	✓
Web SQL storage W3C API (no active) Persistent SQLite storage.	✓	✓ 2.0+	✓	✓	✓ 6.0+	✓	✓			✓			✓	✓
Geolocation W3C API Geolocation & tracking using GPS, cells or Wi-Fi.	✓	✓ 2.0+	✓		✓ 6.0+	✓	✓	✓ Belle+	✓	✓		✓	✓	✓
Multimedia W3C API Video & Audio Players	✓	✓ 2.3+	✓	✓	✓ 7.0+	✓	✓	✓ Belle+	✓	✓		✓	✓	✓
Server-Sent Events W3C API EventSource pattern to mantain the connection to the server open	✓ 4.1+		✓			✓ 2.0+	✓			✓		✓		
Web Sockets W3C API Newbidireccional protocol over HTTP	✓ 4.2+		✓		✓ 6.1+	✓				✓		✓ 7+		✓ 3.0.5+

Figure source: mobilehtml5.org

Incumbent role

- Main incumbent players in the mobile application market: platform vendors (e.g. Google, Apple)
- Application store benefits:
  - Simplicity of monetizing applications
  - Visibility (potentially) through application store
  - Usability of native applications
- Web application benefits:
  - Not tied to application store policies
  - Flexible revenue models
  - Wide set of option for deployment (traditional website, cloud, deployed as an application)

Technological performance

- HTML5 still a work in progress
- Issues
  - Adapting the web application view to the conventions of a particular platform
  - Browser compatibility
  - Browser performance
- One solution: frameworks such as PhoneGap and Titanium SDK
  - Provide access to internal APIs of mobile platform but providing them in a platform-independent way

Conclusions

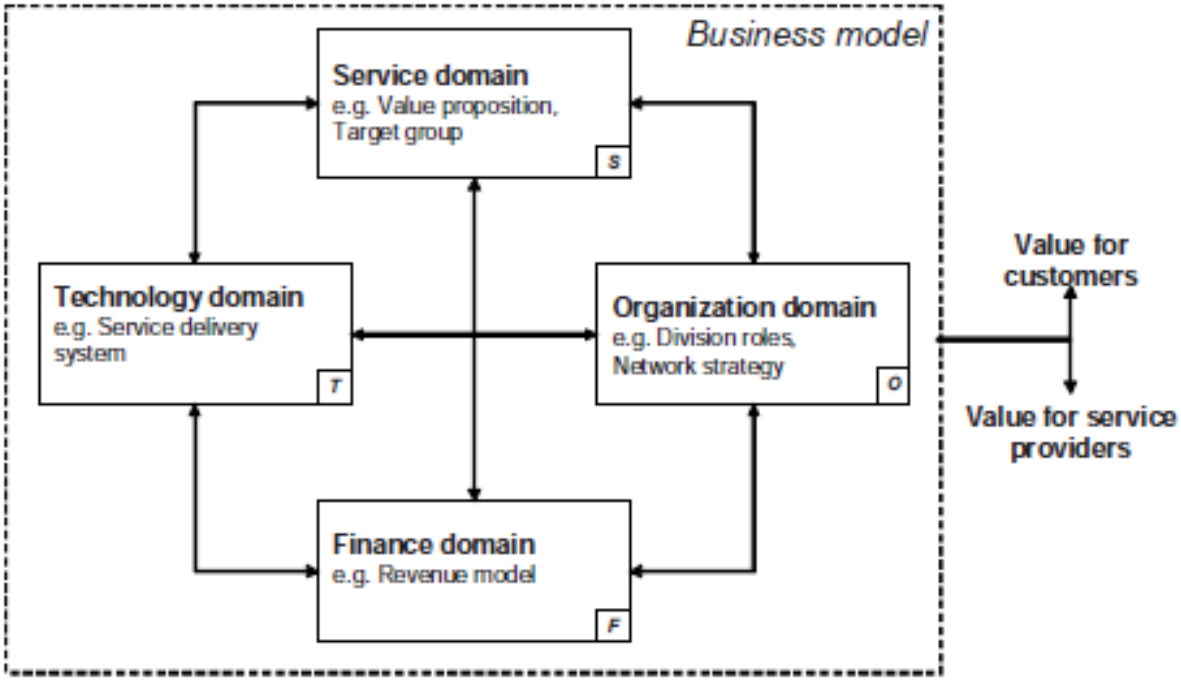
Dimension	Driver	Restraint
Added value	Cross-platform compatibility (D1)	User experience compared to native apps (R1)
Ease of experimentation	Cheaper, more flexible development and deployment (D2)	
Complementary technologies		Browser support (R2)
Incumbent role	No reliance on restrictive policies (D3) Flexible revenue models (D4)	Infrastructure and marketing expenses (R3)
Technological performance		Performance compared to native apps (R4)

Assignment - Business Model

Business Model

- **Make a business case for your service:**
  - Why would you or anyone else implement this service?
  - Who and how would you or anyone else generate value from your service?
  - What is the overall market like? Possible or likely partners? Competition? Alternatives?
- **This section should be around 1-2 page(s)**
- **One possibility: use an existing business model framework such as STOF or Business model canvas**

STOF Model


Business model
Service domain
e.g. Value proposition, Target group
S
Technology domain
e.g. Service delivery system
T
Organization domain
e.g. Division roles, Network strategy
O
Finance domain
e.g. Revenue model
F
Value for customers
Value for service providers

The Business Model Canvas

Designed for:

Designed by:

On: Day Month Year

Iteration: No.

Key Partners

Who are our Key Partners?
Who are our key suppliers?
Which Key Resources are we acquiring from partners?
Which Key Activities do partners perform?

MOTIVATIONS FOR PARTNERSHIPS:
Optimization and economy
Reduction of risk and uncertainty
Acquisition of particular resources and activities

Key Activities

What Key Activities do our Value Propositions require?
Our Distribution Channels?
Customer Relationships?
Revenue streams?

CATEGORIES
Production
Problem Solving
Platform/Network

Key Resources

What Key Resources do our Value Propositions require?
Our Distribution Channels? Customer Relationships?
Revenue Streams?

TYPES OF RESOURCES
Physical
Intellectual (brand patents, copyrights, data)
Human
Financial

Value Propositions

What value do we deliver to the customer?
Which one of our customer's problems are we helping to solve?
What bundles of products and services are we offering to each Customer Segment?
Which customer needs are we satisfying?

CHARACTERISTICS
Newness
Performance
Customization
"Getting the Job Done"
Design
Brand/Status
Price
Cost Reduction
Risk Reduction
Accessibility
Convenience/Usability

Customer Relationships

What type of relationship does each of our Customer Segments expect us to establish and maintain with them?
Which ones have we established?
How are they integrated with the rest of our business model?
How costly are they?

EXAMPLES
Personal assistance
Dedicated Personal Assistance
Self-Service
Automated Services
Communities
Co-creation

Customer Segments

For whom are we creating value?
Who are our most important customers?

Mass Market
Niche Market
Segmented
Diversified
Multi-sided Platform

Channels

Through which Channels do our Customer Segments want to be reached?
How are we reaching them now?
How are our Channels integrated?
Which ones work best?
Which ones are most cost-efficient?
How are we integrating them with customer routines?

CHANNEL PHASES
1. Awareness
How do we raise awareness about our company's products and services?
2. Evaluation
How do we help customers evaluate our organization's Value Proposition?
3. Purchase
How do we allow customers to purchase specific products and services?
4. Delivery
How do we deliver a Value Proposition to customers?
5. After sales
How do we provide post-purchase customer support?

Cost Structure

What are the most important costs inherent in our business model?
Which Key Resources are most expensive?
Which Key Activities are most expensive?

SAMPLE CHARACTERISTICS
Fixed Costs (salaries, rents, utilities)
Variable costs
Economies of scale
Economies of scope

Revenue Streams

For what value are our customers really willing to pay?
For what do they currently pay?
How are they currently paying?
How would they prefer to pay?
How much does each Revenue Stream contribute to overall revenues?

TYPES
Asset sale
Usage fee
Subscription Fees
Lending/Renting/Leasing
Licensing
Brokerage fees
Advertising

FIXED PRICING
List Price
Product feature dependent
Customer segment dependent
Volume dependent

DYNAMIC PRICING
Negotiation (bargaining)
Yield Management
Real-time-Market

www.businessmodelgeneration.com

References, links

- STOF Model: Bouwman et al. (eds.), 2008, Mobile Service Innovation and Business Models
- Business Model Canvas: www.businessmodelgeneration.com