Green Software Services
From requirements to Business Models

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### Computing Models

<table>
<thead>
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<th>Machine-based Computing</th>
<th>Human-based Computing</th>
<th>Things-based computing</th>
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<td>Processing Unit</td>
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<td>Architecture</td>
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<td>Grid</td>
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<td>Ad hoc networks</td>
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<tr>
<td>Comm.</td>
<td>TCP/IP</td>
<td>Web of things</td>
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Autonomic Nervous System
Organic System – Everything connected
More than 7 billion devices and sensors exist for M2M application.

IoT and Cloud Computing enable smart services ecosystem and collaboration opportunities.

Managed City Governance Service Oriented Architecture

Ubiquitous Managed Services Solution Across Business Verticals

Numerous Forms Of Smart Services..

Managed Services
- Portfolio management
- Event management
- Analytics

Provisioning
- Services
- SIM profile configuration
- Network configuration

Controls
- Activation
- Deactivation
- Privacy
- Security

Transaction Mgmt.
- Visibility
- Billing
- Reporting

Integration framework
- Algorithm engine
- Chart builder
- Predictive modeling
- Incidents manager
- Expert rule engine
- FDD Service Mgmt

Storage policies
- Database manager
- Operations manager

Managed City Governance Service Oriented Architecture

Ubiquitous Managed Services Solution Across Business Verticals

Numerous Forms Of Smart Services..

IoT and Cloud Computing enable smart services ecosystem and collaboration opportunities.

More than 7 billion devices and sensors exist for M2M application.
ICT for energy savings in buildings

Command Control Center

- SMEs
- Dashboards
- User interfaces
- Reports
- Carbon footprint measurement
- Benchmarking
- Remote monitoring
- Engineers

Villas
- Fire
- Safety & security
- Energy
- HVAC
- CCTV
- Carbon footprint

Factories
- Fire
- Lift
- Safety & security
- Energy
- Chiller / HVAC
- CCTV
- Carbon footprint

Schools
- Fire
- Lift
- Safety & security
- Energy
- Chiller / HVAC
- CCTV
- Carbon footprint

Commercial & residential buildings
- Fire
- Lift
- Safety & security
- Energy
- Chiller / HVAC
- CCTV
- Carbon footprint

Utilities
- Sewage pumps
- Water treatment plants
- Irrigation

Hospitals
- Fire
- Lift
- Safety & security
- Energy
- Chiller / HVAC
- CCTV
- Carbon footprint

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ICT enabled Security Services

Command Control Center

Shopping malls

Airports

Schools

Factories

Hospitals
ICT enabled Telematics

Command Control Center

Vehicle tracking system

Logistics Management
ICT enabled services for food storage and delivery

Command Control Center

Freezer rooms

Food display cabinets

Cold storage system
ICT enabled services for health care

Command Control Center

Hospital operations management

Hospital equipments monitoring

Hospital security systems
ICT enabled smart education systems

- Command Control Center
- Campus infrastructure
- Smart classrooms
- Smart Universities
- SMEs
- Dashboards
- User interfaces
- Reports
- Carbon footprint measurement
- Benchmarking
- Remote monitoring
- Engineers

*Smart classrooms*

*Smart Universities*

*Campus infrastructure*
Monitoring

Galaxy

- SMEs
- Dashboards
- User interfaces
- Reports
- Carbon footprint measurement
- Benchmarking
- Remote monitoring
- Engineers

Measurement & Verification

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Command Control Center for Managed Services
Smart City Stakeholders

- Auditors
- Customers
- Governments

Business Service providers

OEMs
GSS providers
GSS developers
Core Stakeholders

- **Business Service Providers**
  - Operate business utilizing GSS
  - Common objectives e.g., maximizing sustainability of their business -> impacting their business financials

- **OEMs**
  - Produce equipment (source of energy consumption)
  - Their efforts have significant impact on savings (e.g., via energy saving capabilities)
• **GSS providers**
  – Provide services to Business service providers
  – GSS retain service interfaces
  – Establish direct business relationships with customers who need GSS

• **GSS developers**
  – Implement business logic and optimization methods -> significant impact
  – Domain knowledge required
Supporting Stakeholders

- **Governments**
  - Are responsible for large scale sustainability activities and information providers
  - Policy making and enforcement, legislation, standards

- **Auditors**
  - Systematically assess GSS
  - Provide baseline for comparing (future) GSS
  - Standardized evaluation methods

- **Service Consumers**
  - Currently “passive“, however, behavior patterns help to get data and improve GSS
Service delivery platform for Smart Cities
Service delivery workflows
1. **Identifying Core Services**
   - Collecting/Preparing data from target systems (access & acquire raw+higher level data)
   - Customizing for different target systems
   - Accommodating various scales -> Elasticity
Elasticity ≠ Scaleability

Resource elasticity
Software / human-based computing elements, multiple clouds

Quality elasticity
Non-functional parameters e.g., performance, quality of data, service availability, human trust

Costs & Benefit elasticity
rewards, incentives
Some GSS Requirements /2

2. Supporting Process optimization & analytics
   – Data modeling & simulation, Context-aware controls, agent based systems

3. Supporting of sustainability policies
   – Modeling & understanding policies of target systems
   – Finding efficient ways for meeting goals

4. Ensuring Privacy & Security
   – Securing controls for privacy & security

5. Supporting stakeholder collaborations
   – Building interfaces and marketplaces for collaborations
Business Models

[Diagram showing the components of a business model, including Infrastructure, Value Proposition, and Customer, with Key Partners, Key Activities, Key Resources, Value Proposition, Customer Relationship, Customer Segments, Channel, Financials, Cost Structure, and Revenue Structure.]
Platform Services

Infrastructure

- Accessing Data, Processing Data, Device integration, Application development
- Infrastructure services, data services, Domain knowledge

Value proposition

- Business logic implementation, Optimization methods implementations, Fast time-to-market, Low upfront costs

Customer

- Self-service
- Business Service Providers, OEMs, GSS developers

Financials

- Device integration cost, Platform running and maintenance cost
- License fee, Subscription fee
Data Services

Infrastructure

- Business service providers, OEMs, GSS providers, Government
- Accessing data, Processing data, Securing Data
  - Data storage, data processing

Value proposition

- Knowledge discovery, Data Analytics

Customer

- Self service
- PaaS

Financials

- Data Storage, Sensing Data, Data processing
- Data volume, free
3rd party applications

**Infrastructure**
- OEMs, GSS providers, GSS developers
  - Business logic implementation, Optimization
  - Data, Infrastructure, and core Services

**Value proposition**
- Novel applications

**Customer**
- Self-service
  - Business service providers, GSS Developers
- GSS

**Financials**
- Data Storage, platform services, hosting 3rd-party application
- Subscription, licensing
Analytics as a Service

Infrastructure:
- Business service providers, GSS developers,
  - Data analytics, Data visualization, Process
  - Data storage, Data access

Value proposition:
- Hidden knowledge in data

Customer:
- Self service, data provisioning
- Business service providers, Government, Auditors
  - GSS
  - Business service providers

Financials:
- Data Storage, data provisioning
- Reports, data volume
First Conclusions

• GSS require tight integration from Requirements, Design & Implementation, to the Business Models

• Understanding & Support for Stakeholders needed (Data, Elasticity, collaboration models)

• Cloud service models and GSS collaboration models needed
Some Research Challenges

• Virtual Verticals
  – Dynamic number of devices
  – Various (amounts of) real-time data
  – Ad hoc application usage on Clouds

• Cross-layer planning methodologies needed
  – Providing an isolated environment per tenant
  – Dynamic resources (Elasticity)

• Coherent model for scheduling/predicting resource usage
  – Impact on Elasticity
Some Research Challenges /2

• **Programing Model**
  – Inherent in PaaS
  – Decoupling applications from device specifics
  – Control logic often executed in Gateways -> standardization issues

• **Quality-aware real-time data**
  – Data quality is highly volatile
  – Data quality assurance is needed -> methods e.g. statistical, selective data sources, etc.

• **Metering, Billing, and SLA**
  – Needs support for all resources and various contexts
  – Metering & Billing for all stakeholders -> Configurability
Thanks for your attention

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Forthcoming paper:
IEEE Internet Computing 2013

Web-Scale Service Delivery for Smart Cities

Fei Li, Michael Vogler, Sanjin Sehic, Soheil Qanbari, Stefan Nastic, Hong-Linh Truong, and Schahram Dustdar • Vienna University of Technology

Smart cities encompass services in diverse business and technological domains. Presently, most of these services are delivered through domain-specific, tightly coupled systems, which entail limited scalability and extensibility. The authors propose Web-scale service delivery that addresses these limitations and encourage the creation of novel services based on a domain-independent, cloud-based service-delivery platform.

Current smart-city services are typically provided in single domains — for example, building management, transportation, and so on. With such services, domain-specific application requirements drive all system component design and determine most technical solutions, increasing issues with service and smart city interoperability.

Two Motivating Services
We first analyze two representative smart-city services and examine the limitations of the existing service-delivery model.

Building Energy Management

Open the attached file