From Smart Devices to Ambient Communication

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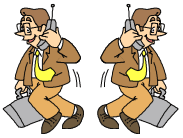
From Smart Devices to Ambient Communication

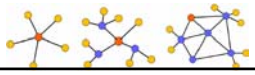
- France Telecom R&D has been a pioneer in promoting the new era of "smart devices", opening up, way beyond present-day handsets, a whole new world of "machine to machine" (M2M) telecom services supported by the generalized networking of embedded devices through "capillary" networks.
- Smart devices cover a wide complexity spectrum and are not merely information processing and storage devices : they do actually get their renewed and much-vaunted "smartness" from being networked *and* augmented with physical interaction capabilities through sensors, and possibly actuators. As such, they make up a large-scale & fine-grain distributed "internet of things", providing as yet unforeseen capabilities by leveraging local and remote interaction with users, peer devices and distributed software .
- In addition to "user-out-of-the-loop" M2M services, pervasive devices may also provide the backplane for a quantum leap in human interfaces for pre-existing ICT applications. An evolutionary, short-term perspective draws from the multiplicity of smart interface devices to support an enriched, multimodal and spatially distributed interaction repertoire. In a more radical and long-term perspective, smart devices may disappear practically and subjectively, if not physically. They disappear as a mandatory impersonation of telecom services and as the locus of exclusive user's attention and interaction, getting integrated into "smart spaces". Ambient communication, embedded in these smart surroundings, may become an entirely different user experience, interlaced unobtrusively with the user's familiar activities, adapting to these activities rather that pre-empting them.

The telecom viewpoint : opening up a third, new service domain

- **interpersonal**  **users ↔ users**
- **broadcast/retrieval**  **users ↔ stored information**
- **networked devices** **(users ↔) devices ↔ devices**





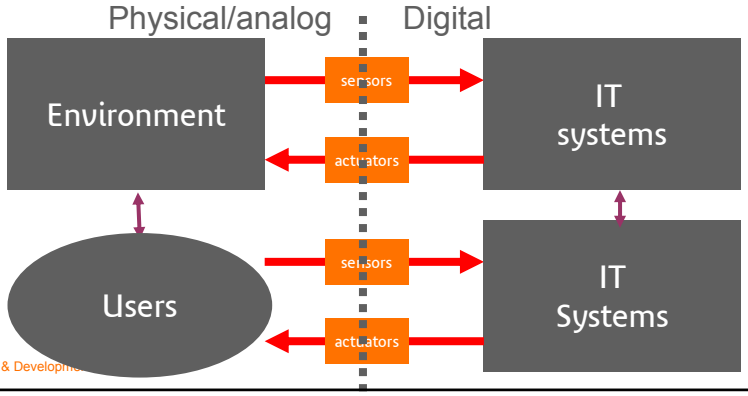
The smart *connected* device viewpoint

- **Smart devices are *not* smart because endowed with agent-like capabilities (autonomousness, proactivity…)**
- **They are smart because they are *connected* !**
- **All devices that are so far, neither communication nor information appliances can get connected**
  - Being connected = being "recognized" by another device
    - An entirely passive device can get recognized by various sensors :
      - *Optical, pressure, etc.*
- **Opening up a new, third domain of telecommunications :**

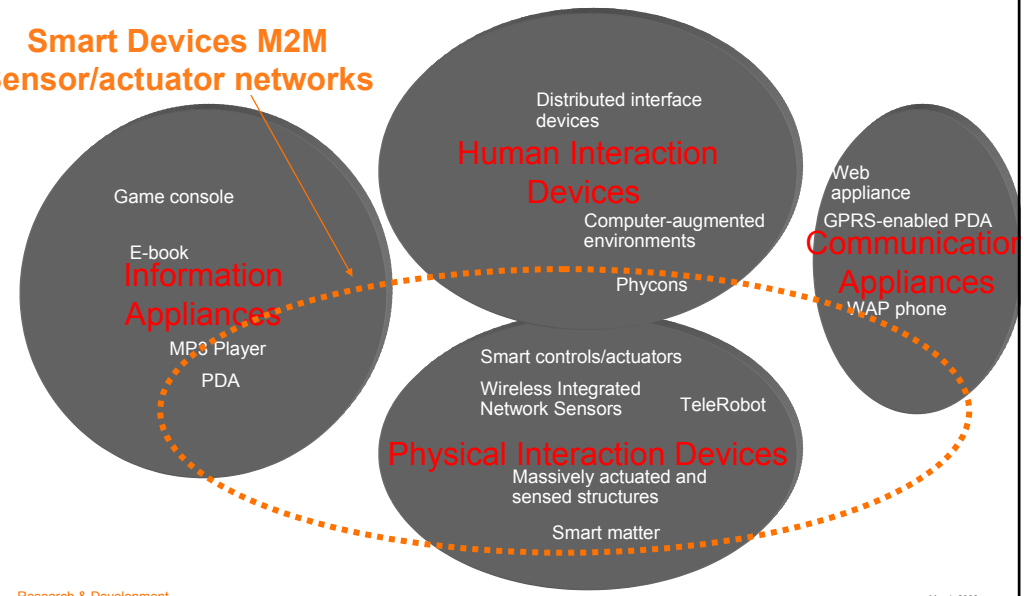
  "The future is not going to be people talking to people; it's not going to be people accessing information. It's going to be about using machines to talk to other machines on behalf of people. That's where the growth is going to be". (Paul Saffo)

The *physical interaction* dimension

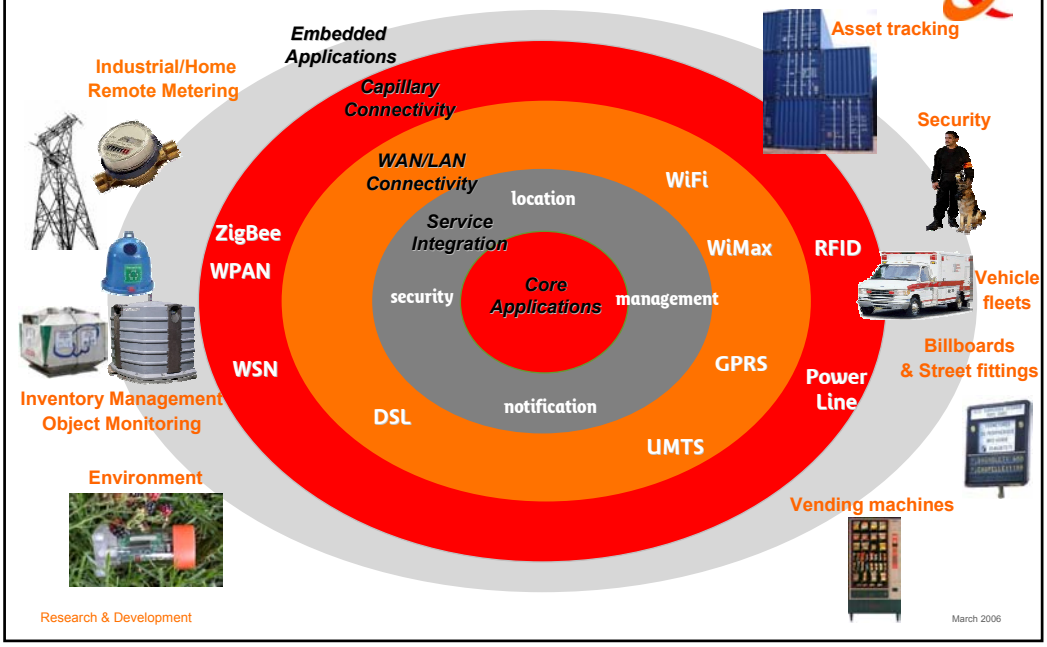
- **Smart devices are smart because they are *physically interacting* devices**
  - Bits and atoms…
- **Widening the interface bandwidth to the physical world**
  - Networked sensors & actuators
  - Enlarged & enriched human interaction, grounded and embodied in the physical environement



Smart Devices M2M Sensor/actuator networks

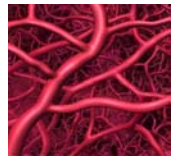


M2M applications



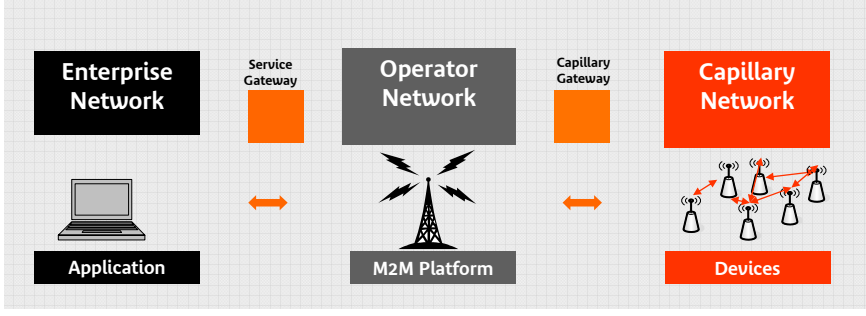
Principles of capillary networks

➔ **Capillaries** are the smallest of a body's blood vessels, measuring 5-10 μm. They connect arteries and veins, and most closely interact with tissues [...] Molecules such as oxygen, water and lipids can pass through them by diffusion and enter the tissues *(Wikipedia)*



➔ **"Cappilary networks" extend the reach of networks and services towards :**

- all devices equipped with sensors/actuators
- the physical environment in general



Elements of a capillary network

Integration software

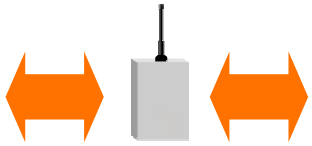
Middleware → integration with business application

Capillary Gateways

Interface for communication with tags and network management

LAN Connectivity

Routers, relays



Infrastructure of capillary network

Tags

Sensors

Actuators

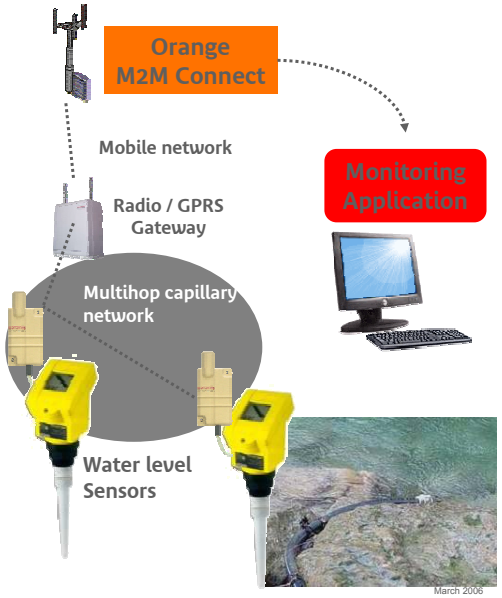
Environnement Sensing

Identification of objects

Device Control

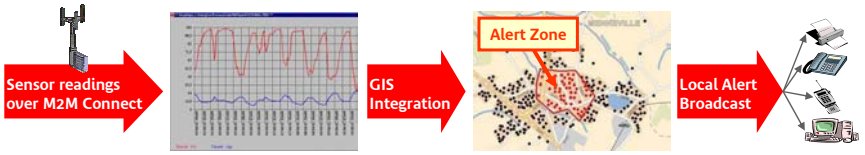
Example application : flood alert system (1/2)

- Monitor the level of a river and detect alert conditions
  - Transmit sensor readings via wireless capillary network
  - Forward measurements towards GPRS concentrator
- Consolidate and exploit measurements in a river supervision application

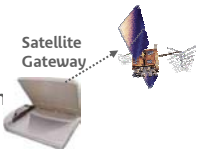


Flood alert system (2/2)

- Standard France Telecom M2M Service offering
- Integration of measurements in hydrographic software + Geographical Information System
- Multi-network broadcast of alert for local population



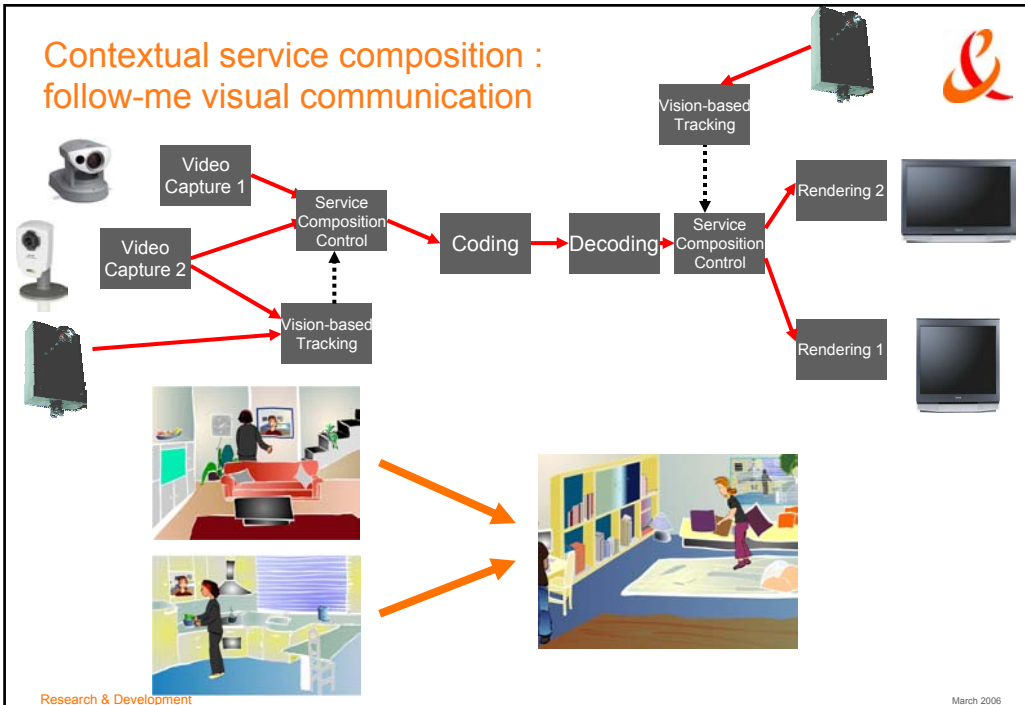
Use of a satellite gateway will extend the reach of this system



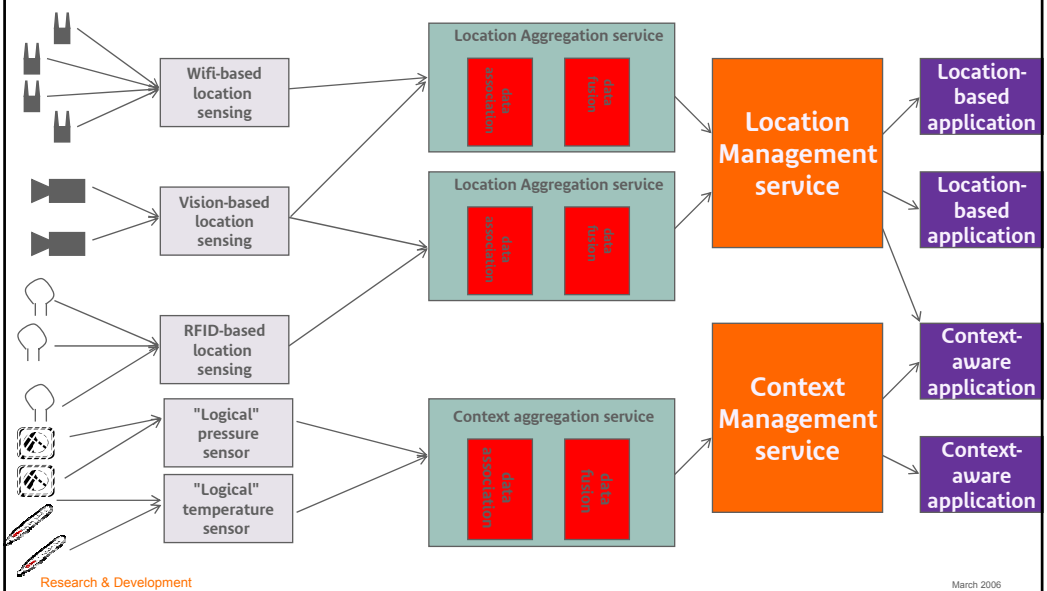
Smart Networked devices : from protocols to SOAs

- **Devices are seen exclusively through a "service" view, and managed as such by a service infrastructure**
  - Services abstract away …
    - Heterogeneous device platforms
    - Low-level network protocols
    - Different programmatic interfaces
  - A device may export several atomic or composite services
- **User-level services may be composited dynamically**
  - from several device-based AND purely software-based services
  - by taking into account
    - Explicit user control input
    - Implicit input : contextual information

Contextual service composition : follow-me visual communication



Context aggregation & management for smart spaces & ambient communication

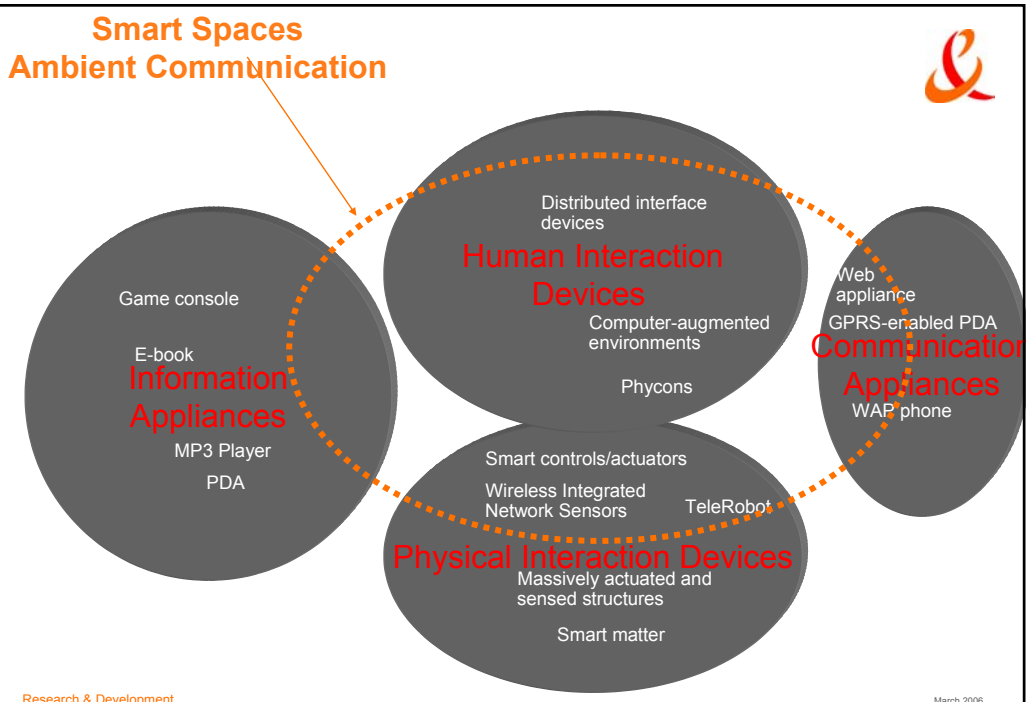


Research perspective : towards semantic modeling of device-based services :

- **SOAs provide a *syntactic* description of services, with two possible approaches :**
  - Syntax is encapsulated in method calls and method parameters (à la Jini)
  - A minimal common denominator set of programmatic interface, with compatibility pushed in the description of associated data (à la Web Services)
- **Interoperability does still require that client services "know" the features offered by service providers beforehand, either through a programmatic (IDL-based) or declarative (XML-based) interface**
  - "Closed-world" approach : all services and service features are known in advance and could (in theory) be standardized
- **Semantic modeling should make it possible for service requestors to "understand" what service providers have to offer**
  - "Open-world" approach : new, unknown or modified devices/services may appear at any time

Integrating physical context with semantic service descriptions

- **Physical context as a *common denominator* of device-based services**
  - Device-based services share at least ONE thing : being immersed in the physical environement
    - *Physical* context is what they have in common
  - General models and rules are easier to derive for physical context than for device-dependent service features
  - Services may be queried from contextual (extrinsic) features, as well as from intrinsic features
    - which display in this apartment has a resolution higher than XGA?
    - where is the nearest camera that can be used to identify such device?



From smart devices to smart spaces

➔ **Devices do still exist and communicate**
- **more** between one another
- **more** with the physical environnement (sensors & actuators)
- **less** with users!

➔ **Devices disappear from the user's *conscious* attention**
- User's time and attention is the only remaining bottleneck
- Devices must spare this ressource, first and foremost

➔ **Towards implicit interaction, using *context* information obtained from :**
- other devices
- the environment
- *not* the user

Towards an ambient communication space

- **The whole environment of the user becomes a unified interface**
- **Communication "terminals" are no longer :**
  - The exclusive focus of the user's attention
  - The exclusive support for a particular service
- **Interactive space integrates all communicating devices :**
  - Input human interface devices (microphones, cameras, tangibles, etc.)
  - Sensors in various physical modalities
  - Output human interface devices (displays, speakers, etc.)
  - Actuators in various physical modalities
- **Physical *context* data used as input to enable *implicit* interaction**
  - Context acquired through distributed sensors
  - Hierarchy of distributed fusion/aggregation/management systems
  - Sensor networking and sensor data management similar to M2M

Ambient communication : unobtrusive, unremarkable, subordinate to other activities

- **Beyond synchronous communication as implicit default**
  - Remote communication no longer has priority over local activities and face to face communication
- **Ambient communication**
  - Covers a continuous spectrum between :
    - non-communication and full communication
    - push and pull communication
    - synchronous and asynchronous communication
  - Adapts to user activities and routines
    - Thread(s) of communication may be interlaced with other activities
    - using implicit context-adaptive interaction when possible and relevant
  - Overcomes the saturation of the users' attention time and foreground cognitive bandwidth
    - avoiding unnecessary interaction with devices
    - making these devices *practically* invisible to users.

Conclusions and perspective : towards integrated device infrastructures for M2M services and ambient communication

- **Similar evolutions are required for both domains**
- **Dynamic configuration and composition of device-based services**
  - SOA paradigm takes upper hand
  - beyond syntactic interoperability, towards semantic interoperability
- **Complementarity of contextual data and explicit control input**
  - Context management becomes a basic infrastructure service
  - Service composition may be based on context