InLife IoT Platform:
next generation
of smart learning

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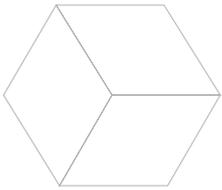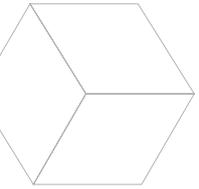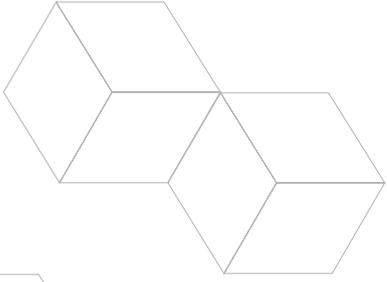Bruno Marcon, Thales Research & Technology, France

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02 november 2018

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Preface

Serious Games are digital applications designed for **education** and **fun learning**. The market for educational games has been rapidly growing over the last decade, enabling advertisement interventions and brand awareness, along with helping learners to bridge theory with practice. Serious games have huge potential in various domains including education, corporate, healthcare and advertising, as they sponsor motivation through gameplay. Serious games are currently used for training, marketing, sales, product development, emergency services, recruitment, and competence building.

Serious Games find application in disparate industry sectors such as aerospace & defense, automotive, corporate, education, energy, government, healthcare, education, retail, media & entertainment, simulation, research, tourism, agriculture and others. Such verticals are expected to record high growth rate by 2023 and the education and training sector accounts for the major share of the market.

In most emerging educational and game-based learning environment, interaction with the physical space is very limited or absent. **InLife proposes an innovative smart educational framework** which enables end-users' engagement with purpose, problem-solving and social skill training, while simultaneously providing educators and tutors with real time analytics and evaluation tools.

InLife extends the real-life into games and vice-versa by the use of gamification combined with IoT Platform, thus creating the framework to develop engaging educational environment.
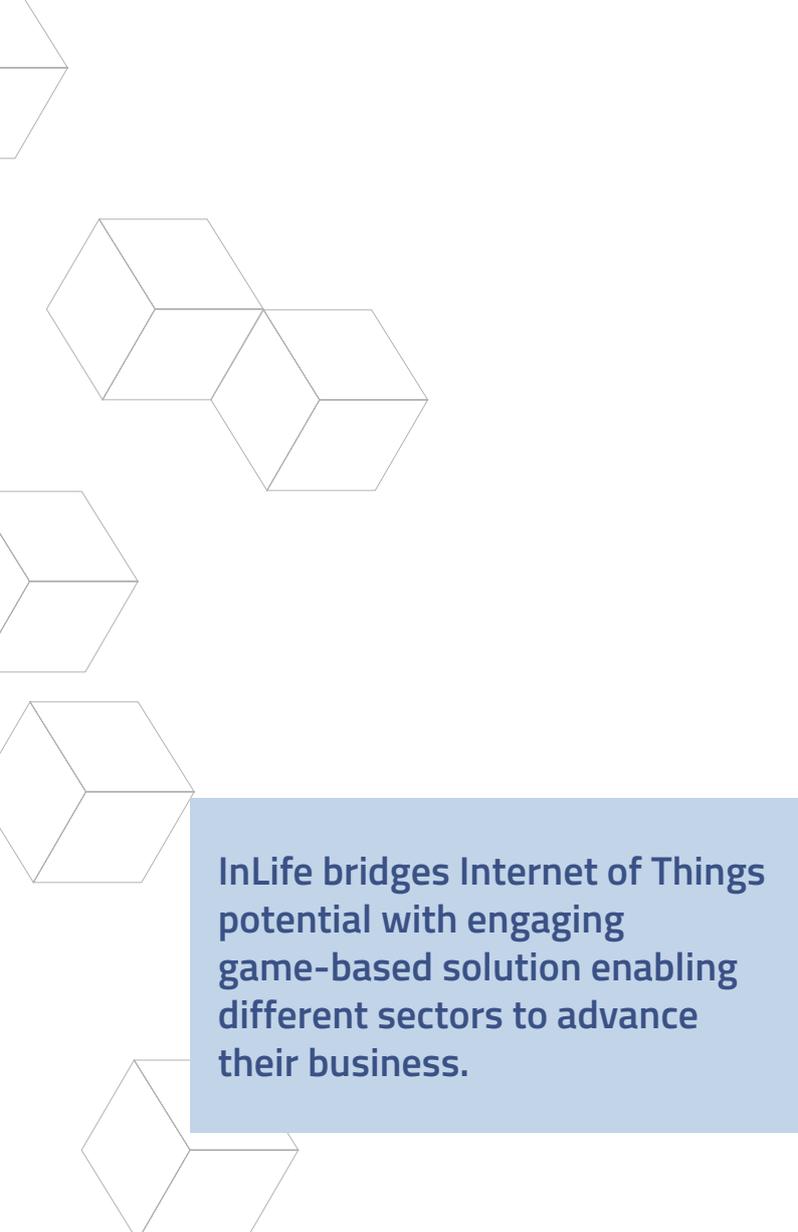
1. The impact of iot and game-based learning

InLife addresses the growing market of games-based learning enhanced by IoT, giving primary focus to the areas of education to sustainability and social inclusion. The industry of game-based application is in a period of transformation due to new and innovative learning products. According to a recent study in 2018 (Metaari Research), the total size in terms of value for the serious games market is expected to worth almost $17 billion by 2023, growing at an estimated Compound Annual Growth Rate (CAGR) of 37,1% between 2018 and 2023. The education and corporate segments account for the major share of the market and are also expected to grow at the highest CAGR between 2018 and 2023.

InLife bridges Internet of Things potential with engaging game-based solution enabling different sectors to advance their business.

- **Serious game companies:** InLife enables third-party serious game companies, as well as independent developers and creators, to implement their own applications using the InLife framework, making use of its unique combinations of Gamification and IoT features.
- **IoT vendors and solution providers:** InLife opens up new market opportunities for IoT solution providers, allowing them to boost their sales and revenues by providing IoT infrastructure for the deployment of serious games in various premises.
- **Education, training and social inclusion organizations:** InLife contributes into the uptake of serious games and gamified applications as learning and motivational tools in education institutes, training centres and social inclusion related organizations.
- **Public authorities, various corporations:** InLife supports public authorities to promote the active social engagement in smart city and enables corporations to actively engage employees in their goals and improve performances (either educational, environmental, social, business or other).

2. The InLife framework

The InLife Platform links players' performances to real-life behaviours, detectable through an IoT network.

InLife Platform advances a robust, integrated and flexible game development framework providing the necessary ICT tools and IoT services for building reality-based serious games solutions. InLife implements an event-driven environment, where digital game worlds are tightly bound to real-life actions and conditions.

Three main layers and a configurable free SDK compose the InLife framework.

Figure 1:
InLife Platform framework

inLife platform

FREE SDK

IoT Adaptation Layer

Game Engine

Analytics
INCENTIVES + STATISTIC SERVER

EDUCATIONAL GAMIFIED FRAMEWORK

Educators   Developers   Companies
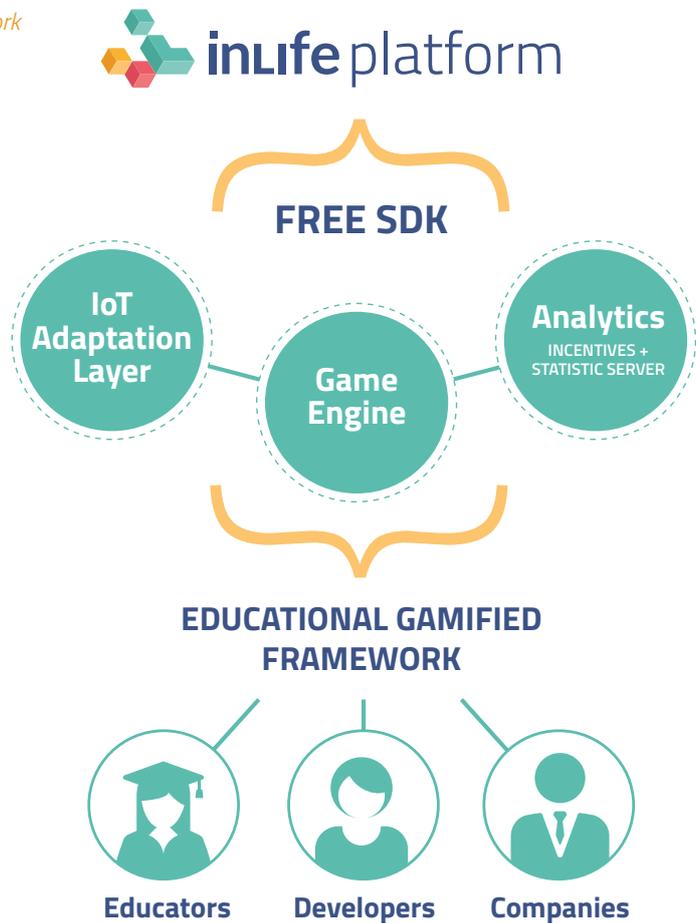
IoT Adaptation Layer:

Data aggregation in InLife is built on top of an open and flexible IoT Platform, which facilitates registration, communication, data flow and smart device management providing the core IoT infrastructure and services. The IoT platform implements both vertical and horizontal functions to support Gamification Layer applications. The essence of InLife's IoT platform is to enable the secure connection of a multitude of heterogeneous sensing and actuating devices, having different constraints and capabilities.

Game Configuration Engine:

Gamification Layer is responsible to monitor and control Game-based applications evolution and players' progress timeline integrating in a smooth and interoperable way the developed ICT-enabled automation and modelling components and services of the InLife open framework. The Game Learning Analytics Model (LAM) is an integral part of InLife pilot games, it assures the effectiveness of the game's learning goals and it is responsible for the alignment of collected data.

Analytics Layer:

Evaluating the learning effectiveness is crucial. Serious Game Analytics integrates a number of artificial intelligence mechanisms and powerful analytics tools to understand in-game player behaviour and better measure overall Serious Game business success. The main goal is to provide advanced game analytics, while assuring functional consistency, data transparency and hiding any heterogeneity issue. The framework is able to seamlessly define and integrate sophisticated behavioural models for (group of) trainees.

IoT cloud server
Resource manager
ActionEvents lifecycle manager
IoT Database

Sensor environment
IoT gateway SoC (RPI)
IoT gateway Android app
IoT gateway (3rd party API)

Game Configuration Engine
Definition of actionEvents
IoT configuration

3. The Architecture

A **flexible and modular architecture** of the IoT platform speed up the integration of IoT and game components. The high-level architecture of the InLife IoT adaptation layer (also called InLife IoT component) and its interaction to the Game Configuration Engine is shown in the figure below:

Figure 2:
Game Configuration Engine

IoT cloud server

| Game configuration Engine | lot access API | Resource manager | ActionEvents lifecycle manager | IoT database |

- **IoT missions**
  - Definition of actionEvents — Educator, Game Developer
  - IoT Configuration — Game Developer

- IoT database
  - Lists of sensing devices
  - Activated actionEvents
  - Collected measurements

IoT Platform

com. SDK

IoT gateway

WiFi | WiFi

| SoC (RPI) — RF com. | Android app — BLEI | (3rd party API) — nternet |

Internal components of the IoT cloud server (i.e. resource manager, actionEvents lifecycle manager and IoT database) have been developed in Java (Spring framework, Apache Tomcat 8.5.11). The source code for these components is proprietary.

The software scripts executed in GWs to transfer data from sensing devices to the IoT cloud server (i.e. client applications) are provided as executables to any interested third party. To extent the list of supported/connected sensing devices, partners can develop and install in GWs the corresponding client applications.

In the next table, the technology is summarized that has been used to implement the InLife IoT adaptation layer

Module	Technology	
IoT Platform	Kaa Platform v. 0.10.0 and DeviceHive v. 3.4.5	
GCE- IoT component communication	RESTful API	
Software framework for backend services and data mgmt.	Apache Tomcat 8.5.11 Java Spring Framework	
Data/Measurements storage	MySQL 5.7.22	
Distributed Messaging System	ZeroMQ	
Gateways (demonstrated in InLife pilots). This is extendable	3 Types of GW are demonstrated in the project: • Raspberry PI3 Model B (C++ and python libraries) • Android tablet application (implemented in Java for > Android 6.0) • Desktop application using open API of smartplugs (implemented in Java)	
Communication protocols	Ethernet protocol (between IoT Platform and GWs). This communication is secured by using a MD5-based cryptographic schema. SPI/I2C (between GWs and pluggable devices), HTTPS (between GWs and smart devices), Bluetooth 4.0 (between GWs and beacons) Proprietary RF protocol (between GWs and wireless devices)	
Connected Devices (demonstrated in InLife pilots). This is extendable given that the appropriate client applications are onboarded in the GWs.	Arduino	Arduino Uno
	RFID	Libelium – RFID 13.56 MHz / NFC Module
	Smart plug	BOSS – 220 SmartPlug
	Beacon	kontakt.io – Beacon Pro
	Temperature sensor	PrivateEyePi – Wireless
	Motion sensor	PrivateEyePi – Wireless
	Magnetic switch & water level sensors	PrivateEyePi – Wireless
	Light sensor	BH1750FVI – SPI

3.1 Incentive server and analytics

A more advanced Analytics and Statistics integration in an IoT platform allows an intelligent rewards management.

The Incentive Server is the module responsible of rewards computation. It analyses Player's behaviors, actions and results in the game and use Artificial Intelligence and some learning to suggest the best reward that should motivate a player to accomplish an action. The Incentive Server uses the following standards:

Table 6: InLife Incentive server standards

Module	Technology
Incentive Server	Java 1.8
Service communication	RESTful API
Software framework for backend services and data mgmt.	Glassfish Grizzly HTTP Server
Data storage	PostgreSQL 9.5
Communication protocols	HTTP

**Compatibility with:
Kaa IoT Platform
DeviceHive IoT Platform
Unity**

3.2 Technology compatibility

A flexible architecture is our priority to provide IoT developers and game developers an easy-to handle environment in which use their own favorite programming language. They could use popular Open Source IoT Platform as Kaa and DeviceHive and integrate a wide rage of sensors and IoT devices in a solid gamified system.

The InLife IoT adaptation layer is compatibility with the following open source IoT Platforms:
**Kaa IoT Platform https://www.kaaproject.org
DeviceHive IoT Platform https://devicehive.com**

The IoT adaptation layer provides the basic features for the integration of third-party systems. This solution is targeted to a broad community of developers, data processing providers, telecommunications companies, and industries with expertise in IoT. InLife IoT Platform is also supported by research units; becoming a partner allows you to participate in the growing gamification market.

The InLife SDK is compatible with Unity3D a cross-Platform leading game engine.
Compatible with Unity

4. Security

The IoT adaptation layer leverages on security features of Kaa and DeviceHive IoT Platforms to protect communication between the cloud services, gateways and the sensing devices. Both these IoT Platforms provide role-based authentication and access for endpoints (Kaa uses a hybrid encryption system based on RSA-2048 bit keys and AES-256 bit keys, while DeviceHive uses JSON Web Tokens) and TLS connectivity for communication between devices and interfaces of applications. In InLife Platform, messaging between the IoT adaptation layer and the Game Configuration Engine (GCE) is protected by using a MD5-based cryptographic schema that verifies data integrity.

5. The implementation model

Sensor   **IoT Server**   **Game Server**   **Game**
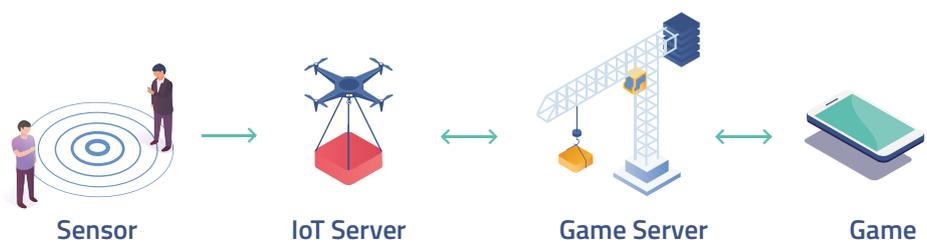
For more resources, please visit the inlifeplatform.eu

How to integrate IoT missions:

1. Place and assemble gateways and sensing devices on your site.
2. Install the appropriate images on gateways.
3. Develop server and client applications (running in GWs) for each additional GW and linked sensing devices.
4. Define actionEvents and IoT missions upon the integrated devices through the Game Configuration Engine.

6. InLife Platform features summary

InLife Platform Services	• Free InLife SDK Platform (compatible with Unity 3D) • IoT Server • Incentive Server • Game configuration engine • Statistics server
Deployment	Cloud, Saas, Web, Mobile - Android, Mobile - iOS
IoT and connectivity	Wireless sensors, Smart meters and smart plug, Zigbee, Arduino. Compatible with Kaa IoT Platform and DeviceHive IoT Platform.
Gamification Features	• ActionEvents creation • Game environment design • IoT adaptation • Badges management • Learning Goals Setting • Multilanguage support • Performance metrics • Activity analytics and statistics • Rewards management • Incentive Server • Social network APIs integration

**InLife SDK
Download for Free**

7. Additional support

- Installation support and maintenance of the IoT adaptation layer which have been integrated in the GWs.
- Software development, installation and maintenance to support additional GWs and sensing devices.
- Game Customization: support for the definition, configuration and onboarding of additional IoT missions.
- Additional modules: extraction of reports about past data/measurements recorded by the integrated sensing devices.

Consulting and Integration

SYNELIXIS

five flames mobile

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THALES

Looking for flexible, open and advanced gamification Platform for your IoT business?

Learn more about InLife Platform
► www.inlifeplatform.eu