IoT-powered Smart Agents, Leading Post-App Age

Apr. 2016
# Cornerstones Technology

## Quick Overview

<table>
<thead>
<tr>
<th>Company</th>
<th>Solution/Services Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Smart Safety Agent Services (SW+NW+HW integrated solution)</td>
</tr>
<tr>
<td></td>
<td>Smart Evacuation &amp; Emergency Alarm System (Portable, Smart Safety &amp; Security)</td>
</tr>
<tr>
<td></td>
<td>LoRA Gateway (Low Power Wide Area Network) and its application services</td>
</tr>
<tr>
<td></td>
<td>As of ’16. March, +15 Korean and International business partners (B2B Partner Play)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Business Cases</th>
<th>Public Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KOICA CTS Program, Next-generational safety and security service development</td>
</tr>
<tr>
<td></td>
<td>Smart Community safety agent and its monitoring system (KORIL)</td>
</tr>
<tr>
<td></td>
<td>Smart safety and security system development on maritime affairs and ships (KIOST)</td>
</tr>
<tr>
<td></td>
<td>SEEAS system development for Korea Presidential Security Service</td>
</tr>
<tr>
<td></td>
<td>KRA next-generational environmental monitoring and safety response system</td>
</tr>
<tr>
<td></td>
<td>Seoul Metropolitan Government, Milyang, Incheon, etc</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lotte Department Store, Busan Centum City</td>
</tr>
<tr>
<td></td>
<td>SK Hynix, Cheongju Factory</td>
</tr>
<tr>
<td></td>
<td>DSME Okpo Ship-Manufacturing yard</td>
</tr>
<tr>
<td></td>
<td>Daelim Construction, new building construction site and managed services partnership</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Seoul Metro, Public LPWA and smart safety agent deployment</td>
</tr>
<tr>
<td></td>
<td>Busan Humetro, IoT-based smart safety and security system deployment</td>
</tr>
<tr>
<td></td>
<td>Santa-Maria Ferry and Passenger Terminal smart safety agent services</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Overseas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cast-info, Barcelona large-scale shopping mall smart agent services launching</td>
</tr>
<tr>
<td></td>
<td>Telkom Indones and Ichtus, smart safety and security agent services for BNPB, Jakarta, ...</td>
</tr>
</tbody>
</table>

| Patent | (`14. 8) Intelligent evacuation and its delivery |
|--------| (`14. 11) Smart agent for safety and its optimization algorithm |
|        | (`16. 3) Portable Smart Evacuation and Emergency Alarm (Co-patent with PSS Korea) |

| Award | Minister award at the National Safety & Security 2015 (MPSS) |
Content

1. Overview
2. Key Features
3. System Components
4. Case Studies
5. Global Business Outlook
Our Vision
Changing The Way We Protect Life

Cornerstones Technology is a fast growing IoT venture providing Smart Agent services powered by real-time optimization and artificial intelligence.

- Legally approved and certificated (KC)
- 2 patents registered, 1 patent submitted
- 2015 Winner of the national safety and security competition (awarded by the Minister of public safety and security)

- Field tests at large scale sites (Lotte, SK, DSME, etc.)
- Successful operation records at various industry fields

- Local partners in various countries: Indonesia, Spain, UAE, Israel, Singapore, Swiss, Canada, and U.S.
- Iconic Smart Agent Venture company selected by the Korean government
Overview: Definition

Smart Agent

Smart Agent delivers real-time safety and security intelligence powered by IT and OT convergence.
Overview: Uniqueness
Smart Agent Technology

Simple Configuration

- Convenient Installation & Configuration
- Integrated Sensors
- Lightweight and Easy to carry around
- Intuitive User Interface

Independent Network

- Low power, Long Range stable network
- Secure Network (Encoded LoRa & Secure WiFi)
- Active Frequency Modification

Power Sustainability

- Power can be sustained for 24 hours in case of facility black out
- Portable recharging and carrying case
- UPS & rechargeable batteries
Overview: Need for Change
Belated Notice and Unclear Guide

Belated Notice + Evacuation Guide

(Goyang) Complicated indoor structure, 6 victims are found in toilet of B1F, located opposite side of evacuation route

(EJB) Reported at 11min later after fire, Belated guide 17min after, resulted in 128 suffers

Unclear Guide causes bigger damage

(Gumi) 5 dead and 18 suffers by Foshan leakage because of belated evacuation

(Sangju) Hydrochloric acid leakage, Belated evacuation without clear guidance
Overview: Need for Change

Why Do We Need Clear & Concise Guide

Body changes in a panic situation

- People need SIMPLE guide under emergency

Seoul National University Hospital, Junsoo Kwon, 2012

Safety-staffs should also be protected

- Miracle of the Morgan-Stanley: 2,680 employees are evacuated safely from 22 stories of the WT tower at 911 incident
- Morgan-Stanley Heroes: Safety staffs were all dead in the tower

Morgan-Stanley, 2001
Overview: Need for Change

IoT Industry & Smart Agents

Fast growing IoT Industry

- It is expected for IoT industry to be bigger than 300B by 2020

Gartner, 2014

Smart Agents are leading Post-App age

- We will evolve to a post-app world with intelligent agents delivering dynamic and contextual actions and interfaces

Gartner, 2015.10
Overview: Before and After Smart Agent

Belated Notice and Response
(Static Passive Signage & Alarm)

- Manuals are always in booklet
- Dependent on playing mere sirens repeatedly
- Not reflecting the incident location and its types
- Exit signage is perceived only by low percentage of people
- Rescue activities go challenging without contextual awareness

Smart Agent
(Real-time Safety Intelligence Delivery)

- **Faster initial response** within golden time is most important to help more people evacuated safely

- **Safety intelligence should be delivered in a real-time manner** to protect people and safety staffs

- Innovation will be happened by well arranged smart agents to deliver real-time safety intelligence at all times

- Smart agents can be varied in different environments: indoors and outdoors
## Overview: Before and After

### Expected benefits, indoor and outdoor

### Indoor environment

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siren (Response rate 13%)</td>
<td>Audio agent (RR 78% ↑)</td>
</tr>
<tr>
<td>Passive static sign (Recognition rate 38%)</td>
<td>Dynamic LED sign (Up/Down/Right/Left)</td>
</tr>
<tr>
<td>Fixed flash lamp</td>
<td>Dynamic lighting arrows</td>
</tr>
<tr>
<td>Safety staff arrangement</td>
<td>Virtual staff at any time</td>
</tr>
<tr>
<td>Unified message</td>
<td>Location/Event-based</td>
</tr>
<tr>
<td>Sequential evacuation by human staff</td>
<td>Optimization algorithm-enabled evacuation</td>
</tr>
<tr>
<td>Only by regulated sensors</td>
<td>+ sensors-embedded agent</td>
</tr>
</tbody>
</table>

### Outdoor environment

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual delivery between center and field</td>
<td>Real-time delivery supported by process automation</td>
</tr>
<tr>
<td>Loudspeakers (manual)</td>
<td>+ Customized virtual staffs</td>
</tr>
<tr>
<td>General/unified guide</td>
<td>Location/Event-based</td>
</tr>
<tr>
<td>Wired electricity/Ethernet-based</td>
<td>Low Power Wide Area Wireless Sensors Network</td>
</tr>
<tr>
<td>City downtown focused</td>
<td>Community-wide for BOP</td>
</tr>
<tr>
<td>Formal/Ideal guide</td>
<td>Contextual guide</td>
</tr>
<tr>
<td>No black box loggings</td>
<td>Fast recovery and continuous improvement</td>
</tr>
</tbody>
</table>
Key Features of Smart Agent Technology

1. Smart Agent stations are embedded into Smart Spaces

2. Low Power Wide Area Network (LPWAN)

3. World Best Real-time Optimization Computing

4. Multi-dimensional geo-spatial Black-box Logging

5. Real-time Safety Intelligence Delivery
Key Features
Smart Agents into Smart Spaces

IoT enables to deliver real-time safety intelligence providing visual and voice evacuation guide based on

- Voice guidance is adaptive to events and real-time situations
- Preset guides for each emergency (e.g. fire, terror, contamination)
- Fully operational in the absence of wired power & network supply
- Situational analysis using ad-hoc networking

Prevent human errors from illusory memories
Embedded safety intelligence
Real-time situational awareness
Cornerstones Technology provides Long Range (LoRa)-based LPWAN gateway, using de-facto world standard, to enable smart agent services.

- 1km (indoor)/15km (outdoor) network coverage
- Ultra low power (Range@10mW)
- Symmetric two-way networking
- Connecting fixed + portable agent nodes
- Flexible frequency change
- Support maximum battery longevity
We proved real-time evacuation route optimization algorithm (Time Expanded Minimum-cost Maximum-flow Evacuation Algorithm) performing best in comparison with famous Edmonds-Karp Algorithm (Existed Algorithm) and world-best existed mathematical solver program such as ILOG CPLEX and Guroby software. (Tested at Seoul Gangnam CGV multiplex building, Node: 98, Arc: 252)

Performance comparison with commercial expensive mathematical solver/open source algorithm

Only Cornerstones Technology is appropriate real-time optimization for smart agent.

<table>
<thead>
<tr>
<th></th>
<th>Cornerstones Technology</th>
<th>ILOG CPLEX</th>
<th>Guroby</th>
<th>Existed Algorithm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computation speed</td>
<td>&lt; 1 Sec</td>
<td>6.65 Sec</td>
<td>9.11 Sec</td>
<td>&gt; 1.5 hour</td>
</tr>
<tr>
<td>Time to evacuate (optimization result)</td>
<td>193 Sec</td>
<td>193 Sec</td>
<td>193 Sec</td>
<td>193 Sec</td>
</tr>
<tr>
<td>Total time</td>
<td>194.5 Sec</td>
<td>213 Sec</td>
<td>220 Sec</td>
<td>16,393 Sec</td>
</tr>
</tbody>
</table>
Key Features

Multi-dimensional geo-spatial Logging

Smart agent system supports black box logging services by transforming spaces into smart spaces which can provide meaningful dataset for root causes analysis, fast recovery, and continuous improvement.

Multi-dimensional network model

- Design evacuation routes
- Create 3D optimal routes by connecting 2D paths
Key Features

IoT-enabled Next Gen. SOP

Smart agent enables to execute IoT-based next generational standard operating procedure by connecting things, people, process, and data.

Sensing

- Temperature
- Fire & explosion
- Toxic Gas
- PM2.5
- Water quality

Analyzing

- Event
- Site condition
- Risk
- Threshold
- Disaster
- Diffusion rate

Responding

- Optimal evacuation route delivery
- Space topology intelligence
- Congestion detection

Reporting

- Accidents diffusion
- People flow results
- Evacuation execution logs (detection rates, efficiency, etc.)
- Damage report
- Water supply report
- Improvement recommendations

- Evacuation Status (Routes, remaining people)
- On-site intelligence (Command, Field agent)

Evacuation

Rescue

Support Process

Data

- Numbers counting
- Locations
- Congestion
- Terrorism

- Incident
- Problem
- Device failure
- System failure
## System Components
### Smart Agent System

<table>
<thead>
<tr>
<th>Smart Agent Devices</th>
<th>LoRa Networking G/W</th>
<th>Smart Agent Platform (S/W + Server)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency event</td>
<td></td>
<td>① Send collected event data to LoRa G/W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>② Send event location data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>③ Calculate optimal evacuation routes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>④ Real-time update optimal routes considering real-time changes</td>
</tr>
<tr>
<td>Real-time delivery</td>
<td></td>
<td>⑤ Control stations to deliver appropriate safety activity messages</td>
</tr>
<tr>
<td></td>
<td></td>
<td>⑥ Send station operation activities via LoRa</td>
</tr>
<tr>
<td></td>
<td>N/W Switch</td>
<td>Smart Agent Platform Manager</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Monitoring•Alarming•In Action)</td>
</tr>
<tr>
<td></td>
<td>Manual inputs in the PoC phase at the real-time operational environment</td>
<td></td>
</tr>
</tbody>
</table>

*Figures and diagrams are not translated.*
System Components
SEEAS (Smart Emergency & Evacuation Alarm System)

By sensing environmental conditions such as fire (flame, smoke), power failure, dust density, temperature, and illumination, security officers on guard are notified at once.

The presidential security service can be ensured by detecting any threats and assessing risks in real time.

Deployment of Smart Agents

Real time threat detection and alarm

Alert to security on guard using mobile devices
System Components
SEEAS at a glance

Portable Service Server
- LoRa Gateway
- Wi-Fi A.P
- Service Server
- UPS
- Authorized Secure Wireless Access

Emergency Bell (for VIP)
- LoRa Gateway
- Wi-Fi AP
- Service Server (Laptop)
- Emergency UPS
- Normal AC Power line
- Movable Hard Case

LoRa Comm.

Sensing Station / Pole
- Station
  - Flame Sensor
  - Smoke Sensor
  - Temperature Sensor
  - Light Sensor
  - Micro-particle Sensor
  - LED Lighting
  - Loud Speaker
  - Rechargeable Battery
- Extending Portable Pole
- Wi-Fi Repeater

Station Monitoring Info
- Event Alert (Sound/Vibration/Test)
- Emergency Bell Signal (Sound/Vibration/Test)
- Sensor Signal
- Station Monitoring Info
- Station Layout/Registration
- Server Authentication
- Android App.

Station Charging Case
- Portable Station Charging Case
  - 10 Stations Carrier
  - Charging Cradle
  - AC Power Line
  - Charging Status LED
  - Movable Hard Case

Mobile App
- Mobile App For Security Agents
- Station Monitoring Info
- Sensor Signal
- Server Authentication
- Android App.
3 System Components
Multi-Sensor Integrated Station

- Temperature and smoke sensors
- Wireless transmission of sensing data
- Support various local radio frequency
- Rechargeable battery pack
- White LED emergency lighting
- Voice alarm with embedded speaker
- Configuration via LoRa gateway

Illustrative Image of Sensing Station & Block Diagram

- Power Module
  - IN: AC100~240V
  - OUT: DC 8V
  - Battery: DC 4.8V

- Sensor Module
  - Temp.: TC1047
  - Smoke: GSAT11

- Control Module
  - STM32L100RB MCU
  - ARM 32-bit Cortex™-M3
  - 128 Kbytes of Flash memory

- RF Module
  - Frequency Setting
  - SX127x LoRa Chip Set

- Emergency Lighting
  - White LED

- Audio Speaker
  - Max 5W
# System Components

**Installation**

- Installation method can be decided depending on existing exit signage location, width and height of aisles
- It's recommended for PoC project to attach smart agent stations with double-sided scotch tapes

<table>
<thead>
<tr>
<th>Method</th>
<th>Type-A</th>
<th>Type-B</th>
<th>Type-C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image</td>
<td><img src="image1" alt="Type-A Image" /></td>
<td><img src="image2" alt="Type-B Image" /></td>
<td><img src="image3" alt="Type-C Image" /></td>
</tr>
</tbody>
</table>
| Pros and Cons | - Floor-mounted  
- It’s limited to sense temperature and toxic gases  
- It may use additional speakers | - Portable by using flexible poles  
- Poles can be fixed to the floor  
- Easy to move or relocate stations  
- General installation | - Wall-mounted  
- Walls or doors near to exit gates  
- Recommended to consider massive moving lines  
- It requires additional installation cost to connect with power lines |
System Components
LoRa Gateway

- Supporting LPWAN connectivity for stations and emergency call buttons
- Receiving environmental conditions data from stations
- Enabling to request and receive data based on predefined polling intervals
- Sending station communication failures and sensor error data to portable server
- Sending operational configuration data from portable server to station
- Updating device patch and sound data of stations

LoRa Networking GW and its Block Diagram
System Components
Video and Audio Interface Modules

Safety intelligence delivery modules (SIDMs) are external devices that enable to interface with digital information displays and loudspeakers.

**OOH (Out of home) Displays**
- Large LED screens
- Digital Signage
- Bus stop display
- ATM
- Digital Advertisement boards
- Public display
- etc.

**Indoor Displays**
- Information KIOSKS
- ATMs
- Indoor digital signage
- Elevator display
- Public space Televisions
- Digital Menu boards
- Indoor LED
- Media walls
- Etc.

**Legacy connections**
- (Bypass/Source Change)

**LPWAN**
- (LoRA)

**LoRa GW**

**SIDM**

**Smart Agent Server**

**AS-IS**
- Existing Media Player
- Display Cable

**TO-BE**
- SIDM
- (Bypass / Dynamic Source change)
- Display Cable
- Display
- Audio Play
3 System Components

Service Platform: Monitoring Applications

- Location-based stations and LoRa G/W monitoring
- Real-time views on environmental conditions
- Status monitoring (Floors/Trains/Ships etc.)
- Alert/Manage sensors and alarming pop-up
- Visualize sensor level values

- Mobile-app for installing and operating stations
- Register and manage status of each devices
- Monitor location-based event and collect data
- Alert/Manage sensors/batteries (pop-up alarming)
- Visualize sensor level values

Integrated Monitoring Software
(CST-SAP-V1.0)

Mobile Applications for Installation and Monitoring
System Components
Smart Agent System

Smart Agent will show core features using its integrated platform at the real environment including temperature, toxic gases, and event data at various selected locations where smart agent stations are installed.

Inside of BNPB Building

Integrated Multi-sensor Station

LoRa Communication (917MHz)

Bridge Communication

Integrated Monitoring Software (CST-SAP-V1.0)

Command & Control Server

Ethernet (TCP/IP)

Operation Server

Monitoring PC

Mobile applications for field managers

LoRa Module

Stations

LoRa Gateway_Sender (CST-N001)

LoRa Gateway_Receiver (CST-N001)

Integrated Monitoring Software (CST-SAP-V1.0)

Ethernet (TCP/IP )

Network Gateway

LoRa Comm. Distance < 300m

LPWA Communication (Sensor data -> LoRa transfer)
4

Case Studies

Leading innovations across industry

**Large scale buildings/facilities**
- High-rise buildings
- Shopping malls
- Metro stations
- Transportation terminals & airport/port
- Smart Facility Management integrated with existing systems

**Factory/Industrial Plants**
- Large industrial factory and plants
- Construction sites
- Real-time monitoring of environmental conditions through portable smart agents
- Preventive actions and immediate response to alerts

**Smart City/Urban Infra**
- Smart city environmental monitoring stations on top of independent LPWA network
- Smart services infrastructure using portable and fixed smart agent stations
- Tentative sensors network for downtown environmental monitoring for constructions, etc.

**Physical Security**
- Presidential Security Services
- Private VIP security
- Personal Security Detail (PSD) solutions
- Environmental monitoring market will be 2.2B USD by 2019
Case Studies
Private – Shopping mall

- Lotte Department Store at Busan Centum City
- Smart Agent-based safety and security services designed

**Needs**
- Real-time response to safety alerts
- Regular evacuation simulation training using Smart Agent

**Values**
- The most safe shopping center in the world
- Changing the way to secure people safety
Private – Multiplex Cinema Network

Case Studies

• The largest cinema network in Korea
• Smart safety agents enabled real-time evacuation
• Pilot project at Seoul Gangnam multiplex building

Needs

Faster evacuation within golden-time
Protect customers and employees based on next-generational standard safety operating procedures

Values

Customer safety is always on top priority
Enhancing premium brand image for leading new digital culture
Case Studies
Private – Shipyards

- Real-time fire and gas detection through ship manufacturing processes
- On-site smart safety agent system deployments at multiple shipyards
- LoRa-enabled environmental condition monitoring

Needs

Wireless communication has not been well operated. LoRa-based LPWAN is working well for both shipyards and ships.

Values

Greater economic values
- Post-disaster Cost (70M USD average) is 100X larger than Smart Agent Investment (700K USD average)
Private – Manufacturing Factory

Case Studies

• Large-scale semi-conductor manufacturing factory
• Pilot smart agent system deployments at two selected factories located in Ichon and Chongju
• Real-time environmental monitoring and faster disaster response to protect and evacuate employees effectively

Needs
Active management system for prevent and immediate respond to harmful events
To meet higher level of international standards and industrial leading brand image

Values
Greater loyalty and higher pride of the employees
Economic values by preventing any human accidents
Case Studies
Private – High-end Buildings

- Value propositions for master / property developers
- Greater brand image for new buildings and facilities

Needs
- Smarter safety and people protection system
- Unique value creation for tenants

Values
- Increasing asset value
- Attracting Anchor-tenants
Public – Metro Cars and Stations

Case Studies

- Metropolitan subways environmental condition monitoring
- Smart evacuation from metro
- LoRa-based real-time monitoring and faster disaster response to any dangerous events

Needs

Smart Agent-enabled optimized emergent passenger evacuation
Remote real-time monitoring of various hazardous environmental conditions across tunnels and stations

Values

Protecting people and metro safety managers from dangerous events and emergent recovery activities
Cornerstones Tech built a planned roadmap to be a global company making fast evolution from On-Premise Development onto Safety-as-a-Service model based on multi-national partnership.

Phase I : On-Premise Dev. & Maintenance

Phase II : Life Protection-as-a-Service

Phase III : Safety-as-a-Service Globalization

On-Premise Development & Maintenance based on collaborations with channel partners

Solution sales and lease program operation for existing facilities and new building constructions

Global operation partnered with strategic partners
Cornerstones Technology is growing with B2B partners focusing partner enablement for fulfilling demands of end clients.

- Sales & Contracting
- (Installation)
- (O&M Support)

---

- Smart Agent (HW/SW)
- Technical Support
- Training
Cornerstones Technology is targeting to build global partnerships at multiple countries, starting from Barcelona Spain, founding Cornerstones Tech Global in 2015 and Cornerstones Tech USA in 2016.
The expected market size and profitability of Smart Agent is estimated as follows:
Thank You.

Safety Innovation is essential to link hope of the present with dream of the future.