CHARIOT – 3rd Workshop

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IoT Data Security and Privacy Solutions – Challenges and Opportunities for Airports

The CHARIOT Integrated Solution

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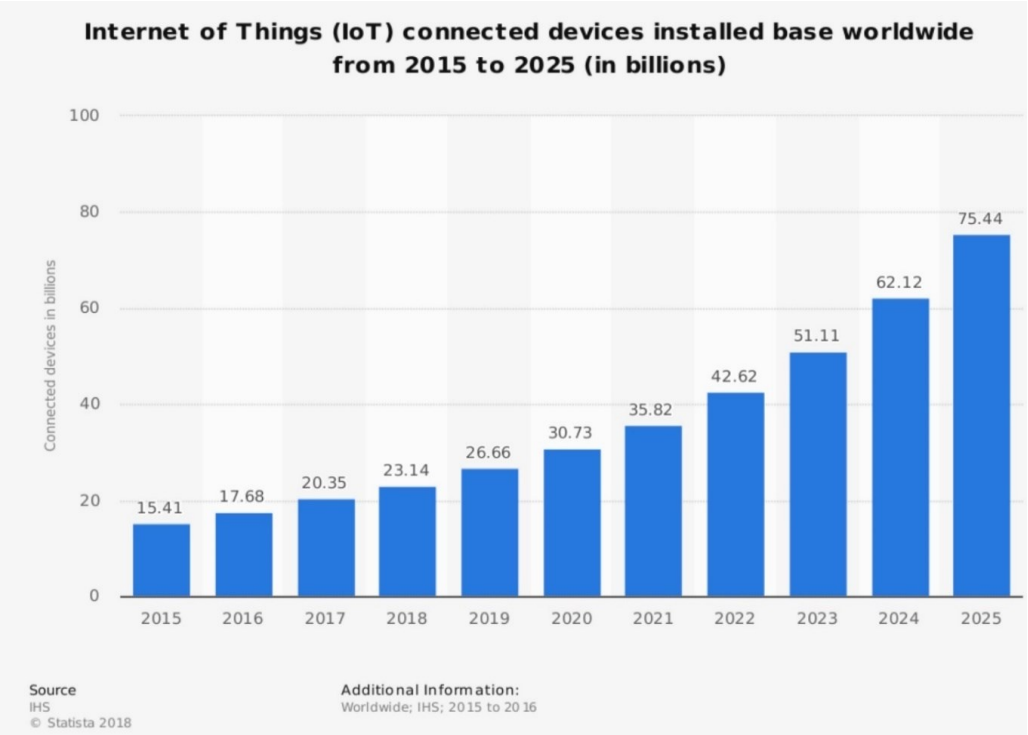
CHARIOT – Industrial IoT Status

- By 2025 it is anticipated that there will be 75 Billion IoT-connected devices Worldwide
- Spending on IoT devices and services reached $2 trillion in 2017, with China, North America, and Western Europe accounting for 67% of all devices (Gartner Inc)
- Growth in connected devices is anticipated accelerate due to a rise in adoption of cross-industry devices (LED lighting, HVAC systems, physical security systems and lots more)
- In recognition of this, Secure IoT is now becoming a more important focus of attention



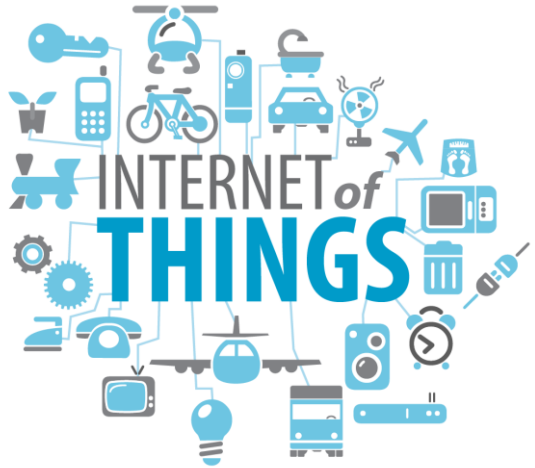
CHARIOT – Industrial IoT Challenges

- Internet of Things (IoT) security breaches have been dominating headlines recently
- 96% of security professionals expect an increase in IoT breaches this year
- Recently, ISP Dyn came under attack – cyber-criminals commandeered a large number of internet-connected devices (mostly DVRs and cameras) to serve as their helpers
- Requests for government regulation of the IoT, asserting that IoT manufacturers and customers are not paying attention to the security of IoT devices (Bruce Schneier, Cybersecurity expert)
- COVID-19 has increased security issues as even more IoT devices (incl. personal equipment) are being used for remote work often from non-secure networks – we are lacking trust!

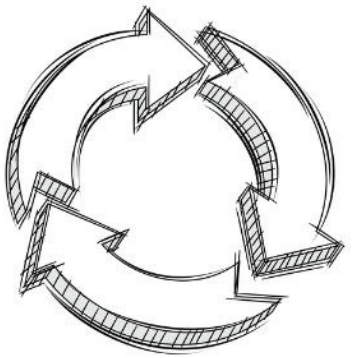
The CHARIOT project

Cognitive Heterogeneous Architecture for Industrial IoT "CHARIOT"

Topic:	IoT-03-2017 - R&I on IoT integration and platforms
Type of Action:	Research and Innovation (RIA)
Funding:	4,928,562.50 €
Duration:	36 months
Start Date:	1/1/2018



CHARIOT Technical Outcomes 1/4



IoT Devices' Lifecycle management

- Blockchain-based PKI for sensor and gateway authentication
  - Embedded keys in sensors and gateway (sensor controller)
  - Blockchain enabled gateway and server
  - CHARIOT sensors' prototype developments (Wifi and BLE)
- Blockchain-aided encryption between all IoT network endpoints (sensor/gateway/FOG)
- Mobile application for sensor provisioning in the IoT network utilizing the four-eye principle
- Blockchain-based state management for sensors (decommissioned, faulty, compromised etc.)

CHARIOT Technical Outcomes 2/4

IoT Firmware Development and Deployment

- **Securing firmware through rule-based code analysis and injection of analysis results & the source code hash within the binary code**
- **Security Engine: filter firmware based on rules applied on the injected analysis results**
- **Security Engine: processes firmware binaries and identifies security vulnerabilities (e.g. code injection) by cross-referencing historical software updates and vulnerability databases**
- **Extraction of the injected firmware hash and version and validation with the blockchain at the gateway level.**

CHARIOT Technical Outcomes 3/4

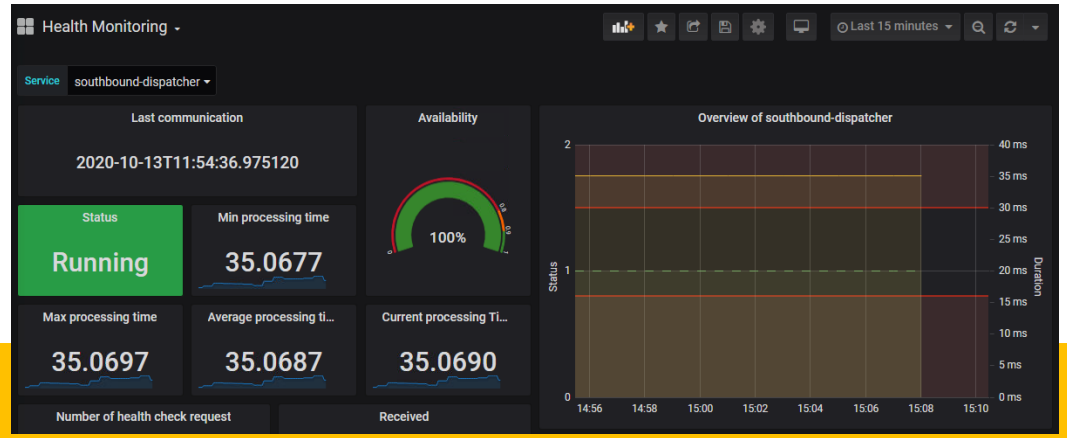
Intelligent IoT Data Analytics and IPSE

- **Privacy Engine:**
  - ensures privacy by design by handling the data encryption policies based on blockchain
  - detects sensitive data streams through analysis of the sensor data
- **Safety Supervision Engine:**
  - Machine learning anomaly detection based on user-defined models and neural networks
  - IoTL to manage the dynamic network configuration, describe access control rules and define the network topology
- **Predictive Analytics:**
  - Use predictive analytics algorithms and analytics processing tools to highlight out-of-bounds behaviours and assess combined interdependent risks

CHARIOT Technical Outcomes 4/4

Platform and User Interfaces

- **CHARIOT Platform core:**
  - orchestrating mechanism for sensor data ingestion, management, storage, normalization and external connectivity API
  - managing machine learning models training on the cloud and fog utilization
- **Device Management Dashboard:**
  - handling blockchain devices registration, firmware updates and engine management as well as a user interface for the IoTL
- **Operational Dashboard:**
  - providing Engines' health and performance monitoring as well as alerts' and sensor data visualization
- **Agent-based simulator:**
  - to support IoT applications modelling and Privacy, Security, Safety Threat Vulnerability Analysis using multiple methods of assessment such as agent and network-based methods



CHARIOT Deployment and Piloting Activities

SMART BUILDINGS (IBM campus)

Monitoring IoT devices and communication in a building (& rooms) environment, Enable IoT evolution to a cognitive IoT environment and Provide a safer & efficiently managed working environment.

- Utilization of sensor data during a fire hazard event
- Checks for security problems in the binary firmware updates on the CHARIOT fog server
- Uses Blockchain to encrypt the readings of presence sensors.
- Sensitive data privacy

RAIL (Trenitalia/FST)

Monitoring the data traffic between the on-board IoT sensors (installed in the mechanic and electronic equipment of the train) and the Dynamic Maintenance Management System (DMMS).

- Early detection of anomalous data communication (distorted data)
- Early detection of unauthorized IoT devices (Gateway blockchain and SE checks on sensors' firmware)
- Early alerting for potential security violation (notify the security manager)

Airport (Athens International Airport)

Monitoring IoT devices and communication in an airport environment, fire alarm situations and intermediate security & safety layer, detect unusual patterns of signals from IoT devices.

- Enhance facilities protection on physical & cyber threats
- Early detection & prediction of hazardous situations
- Reducing the false positive alarms
- Warrantee the comfort and safety of the people located to the airport (travellers and employees).

Cybersecurity Challenges – Alignment 1/4

- Eavesdropping/Interception/ Hijacking
- Man-in-the-middle attack
- IoT protocol high jacking
- Network reconnaissance
- Ruggedized communication protocol and encrypted communications between devices and controllers/gateways supported by blockchain
- Provisioning of all sensors in an IoT network through blockchain registration/affirmation
- Blockchain-based PKI for sensor and gateway authentication
- Four-eye-principle based sensor provisioning in the IoT network
- Dashboard-based solutions for sensor configuration, management and alerting

Cybersecurity Challenges – Alignment 2/4

- Nefarious activities and Abuse
  - Malware
  - Denial of service
  - Software/hardware/
  - info manipulation
  - Targeted attacks
  - Abuse of personal data
  - Brute force

- Firmware static analysis avoiding software vulnerabilities (etc.) at source code and existence of backdoors, software scope alteration etc.
- Firmware binary checking against injected code at execution level avoiding Ransomware, viruses, Trojan horses and spyware
- Firmware hashing and meta data storage inside the binary (and blockchain) for increased software update assertion
- Orchestrating mechanism for sensor data ingestion, management, storage, normalization and external connectivity API
- Registration of sensor status and alerts in blockchain affirming transactions and events
- Private data automated flagging and reporting
- Safety engine managing topology, sensors deployment, commissioning and provisioning
- Data encryption policies based on blockchain technologies to avoid privacy breaches in the IoT network
- Dashboard-based solutions for sensor configuration, management and alerting

Cybersecurity Challenges – Alignment 3/4

- Unintentional (accidental) Damages
- Unintentional configuration changes
- Damages by third parties
- Erroneous usage by administration
- Orchestrating mechanism for sensor data ingestion, management, storage, normalization and external connectivity API
- Machine learning anomaly detection based on user-defined models and neural networks
- IoTL (language) for dynamic network configuration, access control rules and network topology definition
- Dashboard-based solutions for sensor configuration, management and alerting

Cybersecurity Challenges – Alignment 4/4

▪ Failures and Malfunctions	▪ Failure of sensor or device ▪ Software vulnerabilities exploitation ▪ Failure/malfunction of control system	▪ Machine learning anomaly detection based on user-defined models and neural networks ▪ Predictive analytics to highlight out-of-bounds behaviors and assess combined interdependent risks
▪ Legal	▪ Contractual requirements ▪ Violation of rules	▪ Machine learning anomaly detection based on user-defined models and neural networks ▪ Predictive analytics to highlight out-of-bounds behaviors and assess combined interdependent risks
▪ Physical Attacks	▪ Sabotage / Vandalism	▪ Out of CHARIOT scope for CHARIOT however support for malfunctioning devices is provided

Status and Upcoming Steps

- **Technical Developments** ✓
- **Technical Integration, Testing and Deployment** ✓
- **Validation at Industrial Sites**
  - Interfaces and local connectivity ✓
  - Functional and Operational performance ⏳
  - Dashboard and UI **validation and feedback**

Contact Details

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