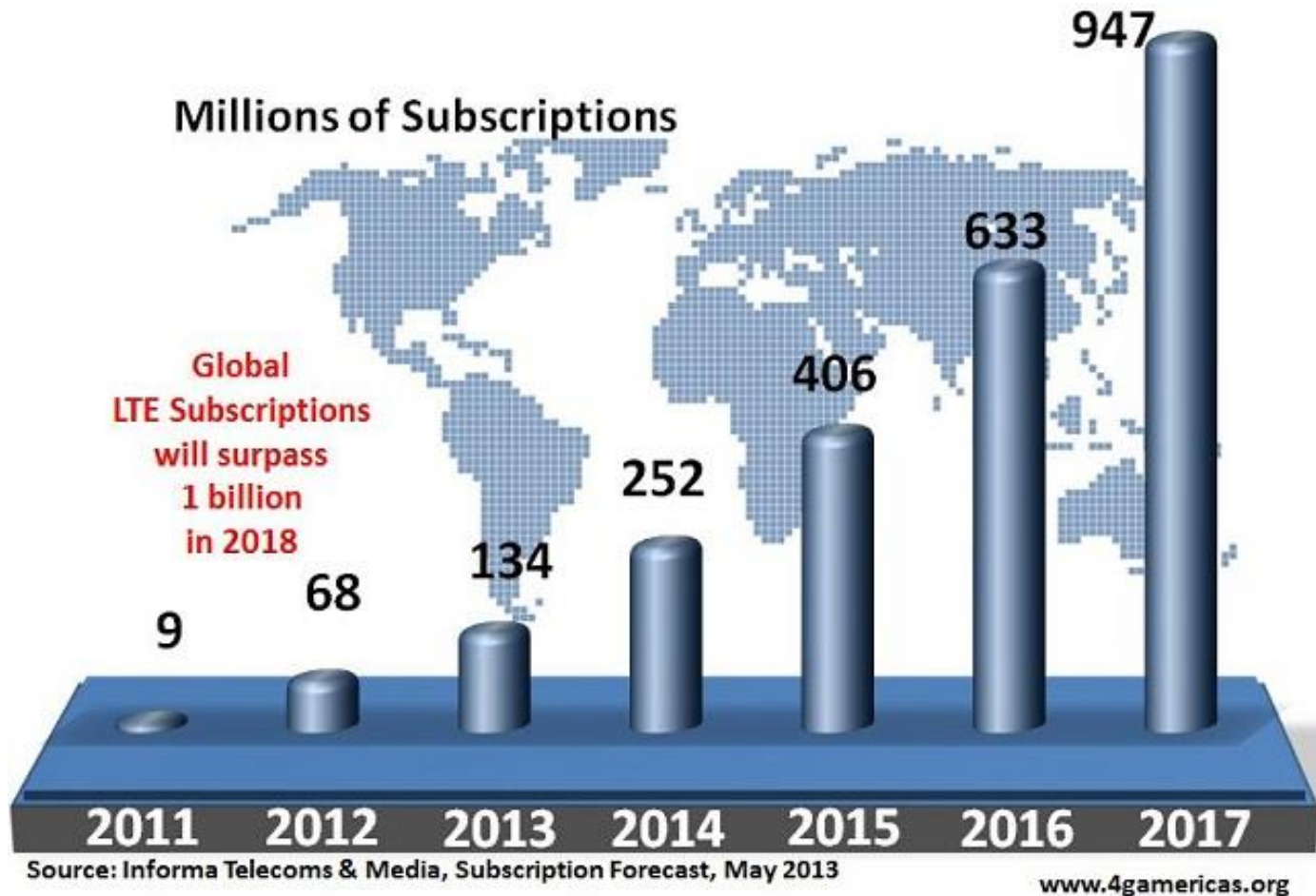# Internet-of-Things Applications Development for Private LTE Small-Cell Networks

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Project Overview and Description

- **LTE (Long Term Evolution) is future trend**
  - Initiated by 3GPP in 2004
  - Entered commercial markets in 2009

Millions of Subscriptions

Global LTE Subscriptions will surpass 1 billion in 2018

9   68   134   252   406   633   947

2011   2012   2013   2014   2015   2016   2017

Source: Informa Telecoms & Media, Subscription Forecast, May 2013

www.4gamericas.org

BUT

- **LTE is not extensively studied in private networks**
  - How network resources are utilized across different protocol layers for real users?
  - How can LTE be used in Internet-of-Things applications (smart factories and smart homes)?
  - Are inefficiencies in 3G networks still prevalent in LTE in private industrial applications?
- **LTE is not extensively studied in private networks**
  - ❖ This project → propose methodologies for interfacing, controlling and monitoring IoT devices in industrial settings over private LTE small-cell networks over 3.65 GHz frequency band.
  - ❖ → Characterize and optimize the performance of such industrial appliances over the private LTE network
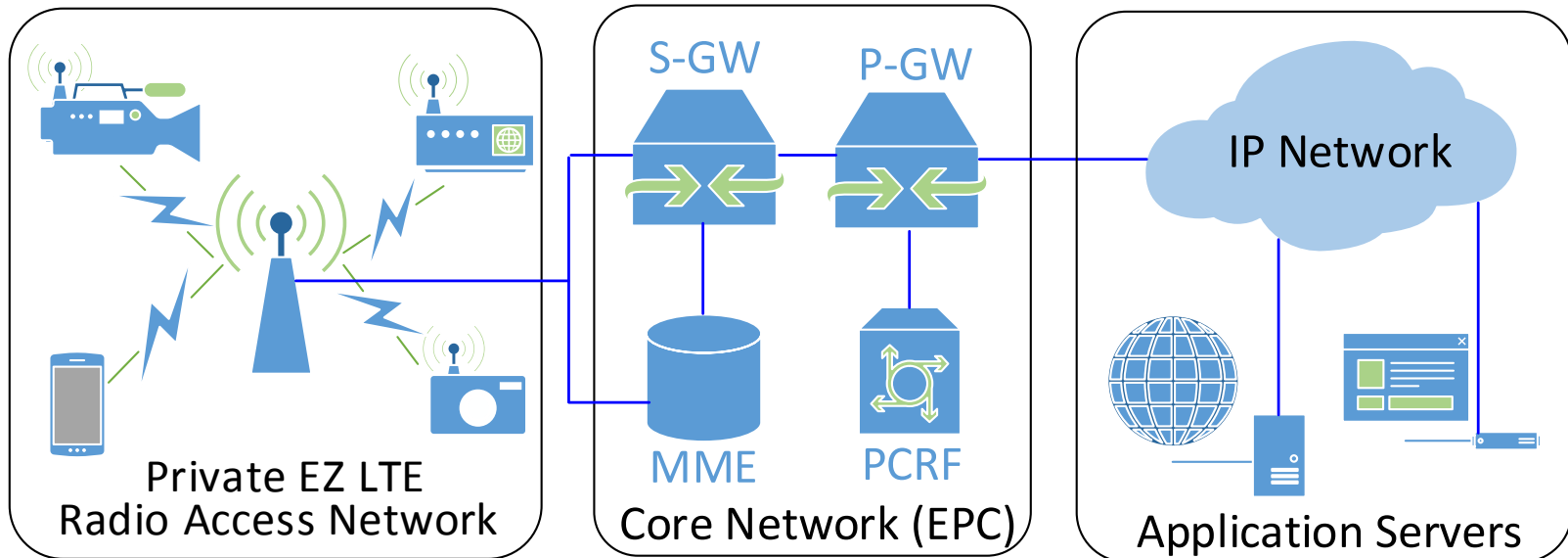
Approach

- **In this project, we focus on:**
  - Characterizing the usage of a private LTE network
  - Careful analysis of basic network characteristics (flow properties, network latency etc.)
  - Studying the preliminary results of an analysis of the suitability of private LTE networks for IoT

- **Novelty and benefits:**
  - Analysis of the suitability of LTE as the wireless technology to connect IoT gateways to the Internet
  - Validate the accuracy of bandwidth estimation algorithms using controlled experiments
  - Study on popular multimedia applications from the perspectives of network resource usage
  - Management of protocol and application design to more effectively take advantage of the available network resources

Project Tasks/ Deliverables

	Description	Date
1	Study of existing IoT tools and network utilization methodologies-algorithms.	12/2016
2	Define software architecture and hardware specifications for IoT applications.	4/2017
3	Development of the IoT framework over a private LTE network	8/2017
4	Finalize development, demo and report	8/2017

Executive Summary

Private EZ LTE Radio Access Network · Core Network (EPC) · Application Servers — S-GW, P-GW, MME, PCRF, IP Network

- **Provide network security** → various industrial appliances need to be interfaced directly to the LTE user equipment (UE) without intermediate agents.
- **Focus on the integration of LTE small-cell networks** → to industrial appliances (e.g. fluid control valves/actuators) with LTE UE over 3.65 GHz supporting standard industry interfaces.
- **Focus on enabling data management** → for connected objects and back-end infrastructure by developing and providing server side software and end point components under private LTE network.

REMAINING SLIDES For poster session ONLY (as many as you'd like)
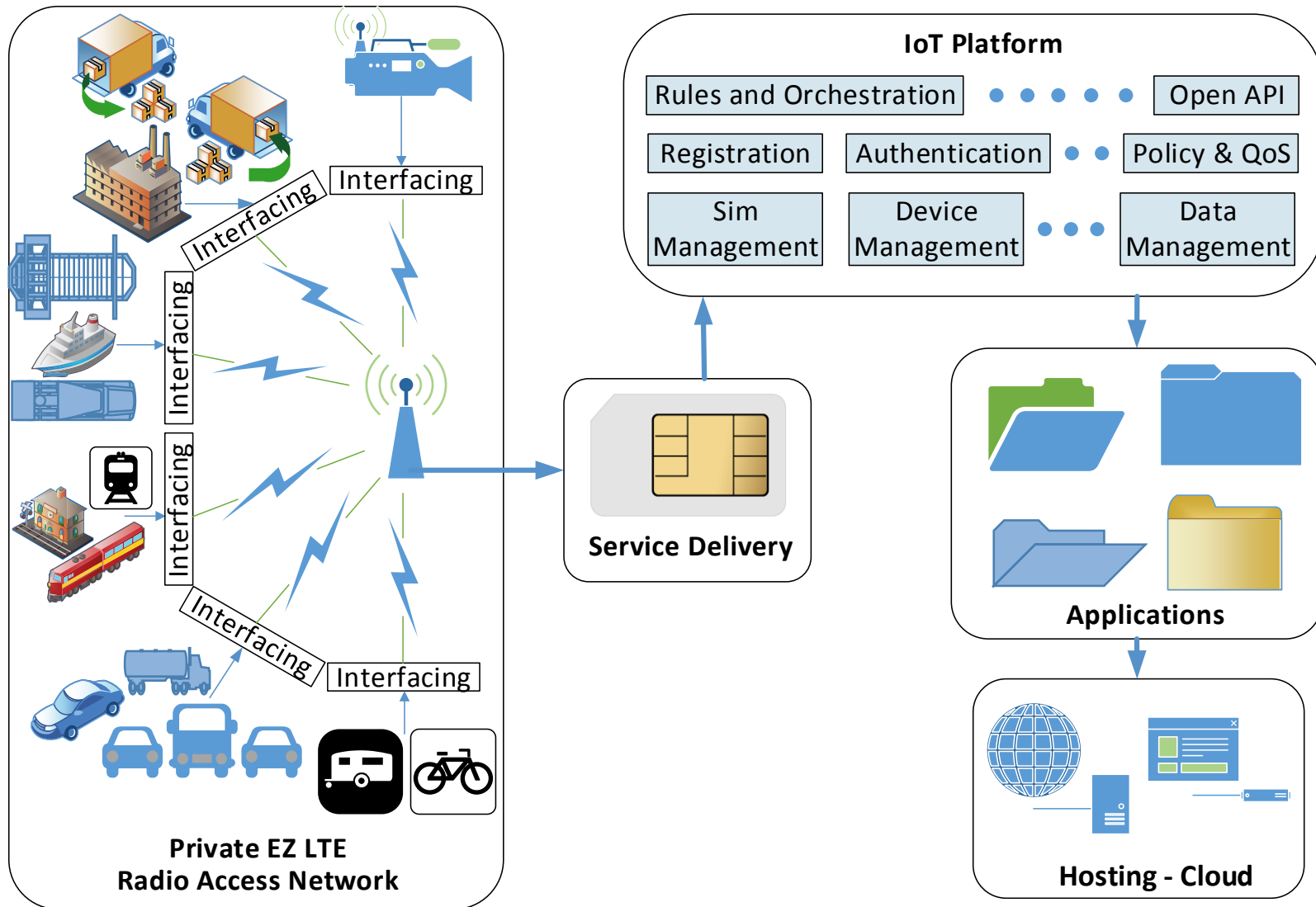
TECHNICAL DETAIL

Technical Details

- **Server → provides all the back-end functionality needed to operate large-scale and mission-critical IoT solutions**

- **Server handles:**
  - ❖ **all the communication across connected objects**
  - ❖ **including data consistency and security**
  - ❖ **device interoperability**
  - ❖ **failure-proof connectivity**

- **Server → offers well-established interfaces for integration with data management and analytics systems, as well as with any product-specific services.**

- **System architecture: IoT framework over private LTE networks**

Private EZ LTE Radio Access Network

Interfacing

Service Delivery

IoT Platform

Rules and Orchestration   • • • • •   Open API

Registration   Authentication   • •   Policy & QoS

Sim Management   Device Management   • •   Data Management

Applications

Hosting - Cloud

Device drivers

- **Essential part in IoT employment is the development of device drivers**
  - Replace unsafe Wifi with secure LTE

- **Set up cross-device interoperability**

- **Perform remote device provisioning and configuration**

- **Distribute over-the-air firmware updates**