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Smart Nutrition Monitoring System Using Heterogeneous Internet of Things Platform

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Nutrition-based Health Issues

OBESITY AND OVERWEIGHT INCREASING WORLDWIDE

37

Percentage of the world's adult population that is overweight or obese

0

Number of countries succeeding in decreasing obesity in last 33 years

14

Percentage of overweight or obese children and adolescents worldwide

62

Percentage of the world's obese living in developing countries

3.4 million

DEATHS CAUSED by overweight AND OBESITY



Obesity and overweight INCREASED 27.5% IN ADULTS 47.1% IN CHILDREN SINCE 1980

Middle Eastern countries experiencing some of the largest increases in obesity globally: SAUDI ARABIA, BAHRAIN, EGYPT, KUWAIT, AND PALESTINE



THE US ACCOUNTS FOR 13% OF THE NUMBER OF OBESE PEOPLE GLOBALLY BUT JUST 5% OF THE WORLD'S POPULATION

OBESITY AND OVERWEIGHT CONTRIBUTE TO:



• CARDIOVASCULAR DISEASE



• DIABETES



• CANCER



• JOINT PAIN

- Overweight and obesity in Adults
 - US: 70%
 - \$200B
 - Australia: 63%
 - \$14B
 - Fiji: 51%

Outline

- Introduction and Background
- Internet of Things
- Smart Nutrition Monitoring System
- Adaption of Fog Computing
- System Realization and Prototype
- Conclusions and Future Works

Nutrition Monitoring System

- Manual methods
 - 24 hour recalls
 - Food frequency questionnaires
 - Smartphones
- Issues
 - Participants burden
 - Imprecise
 - Low completion rate (~15%)

The screenshot shows a web-based Food Frequency Questionnaire (FFQ) interface. At the top, there is a navigation bar with 'Home', 'About', 'Research', 'News', 'Media', 'Who', and 'Contact'. Below the navigation bar, the title 'Food Frequency Questionnaire (FFQ)' is displayed, followed by instructions: 'Please click on each of the items listed below and then answer each question. To read the instructions again, click [here](#) (opens in a new window)'. The questionnaire is organized into sections: 'Cereal', 'Bread and Savoury Biscuits', 'Potatoes, Rice and Pasta', 'Meat and Fish', 'Dairy Products', 'Fats and Spreads', 'Sweets and Snacks', 'Soups, Sauces', 'Drinks', 'Fruit', 'Vegetables', and 'Dietary Habits'. The 'Potatoes, Rice and Pasta' section is currently active, showing a list of food items with corresponding portion sizes and frequency options. A visual aid for 'Pizza, Calzone' is shown, with three images of different portion sizes (Small, Medium, Large) and a prompt to 'Choose your usual portion size for this food group'. The interface includes 'Save & Exit' and 'Submit FFQ' buttons at the bottom right.



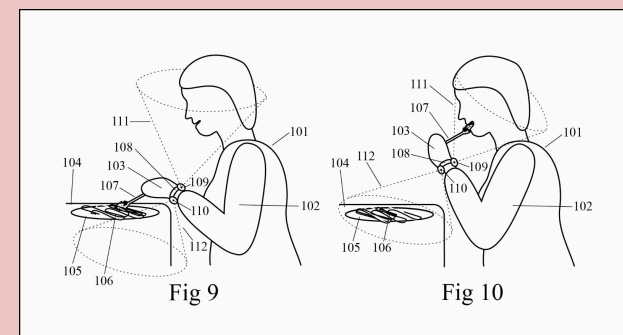
Nutrition Monitoring System

- Automatic methods
 - Sensor-based
 - **Environment sensors**
 - Removing the participant burden
- Issues
 - Imprecise (lack of food detection)
 - Not practical for free-living style
 - Privacy

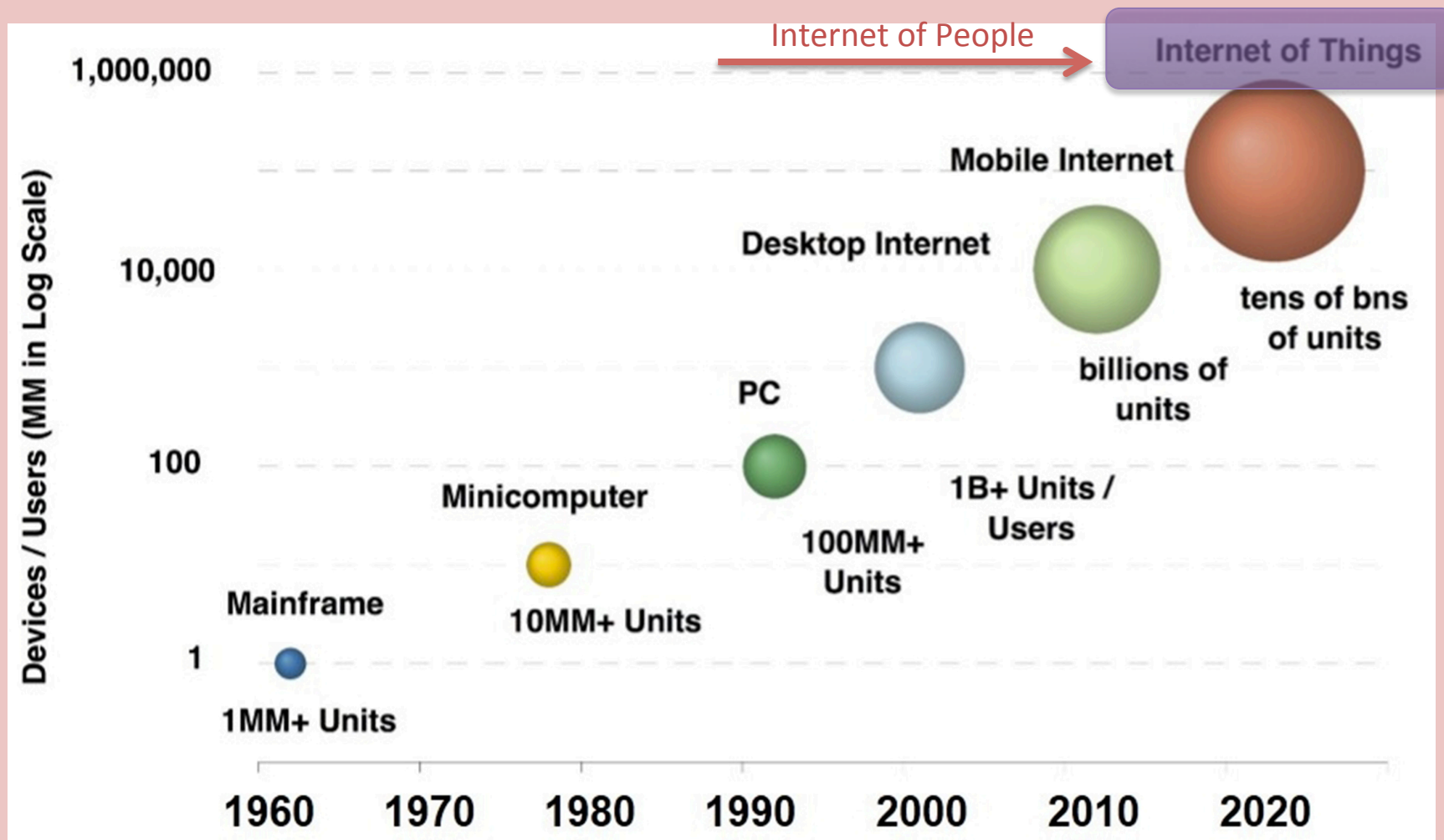


Nutrition Monitoring System

- Automatic methods
 - Sensor-based
 - **Wearable sensors**
 - Real time food intake monitoring
- Issues
 - Average accuracy of 90%
 - Only tested in lab environments
 - Single dimension



More Connected Devices on the Planet Today Than People



Internet of Things Applications



**Smart
Grid**



**Safety
Security**



**Connected
Home**



**Building
Automation**



**Lighting
Control**



**Smart
Devices**



**Health
Fitness**

Smart Nutrition Monitoring System

- Non-invasive
 - Minimizing the amount of direct input and actions from users
- High data accuracy and reliability
 - Heterogeneous IoT sensors
- Scalability
 - Cloud and Fog Computing



FOG-Engine: Decentralized Hierarchical Big Data Processing on the Edge

CLOUD

Data Processing, Mining, Storage, and Visualization



Data Preprocessing & Analytic

WAN: low b/w (x10MB/s)

FOG

FOG-Engine

FOG

FOG-Engine

FOG-Engine: Data Analytic micro-Engine

Network Access

Raw data



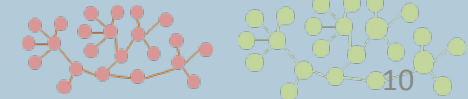
Network of Sensors and Actuators (Physical World)

LAN: very high b/w (x1GB/s)

MAN: high b/w (x100MB/s)

Network Access

Raw data

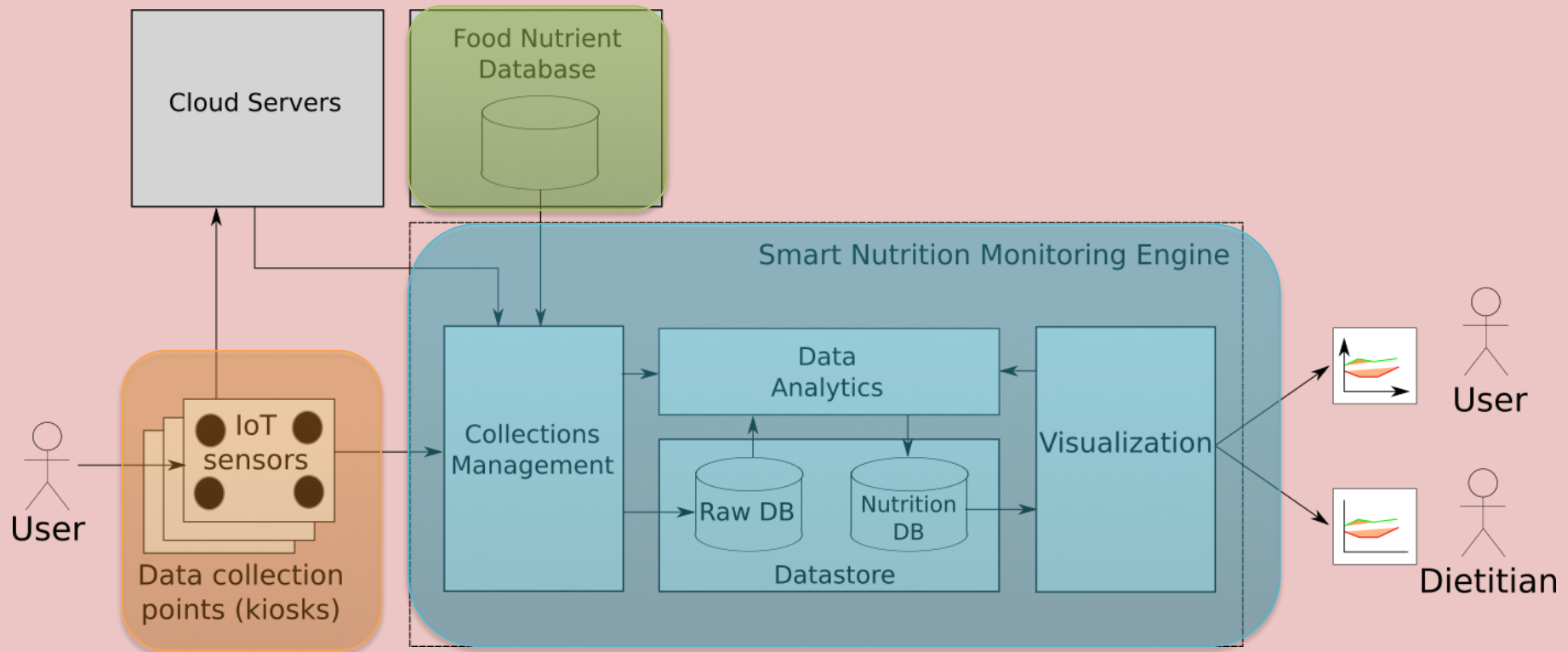


IoT's

Fog Computing

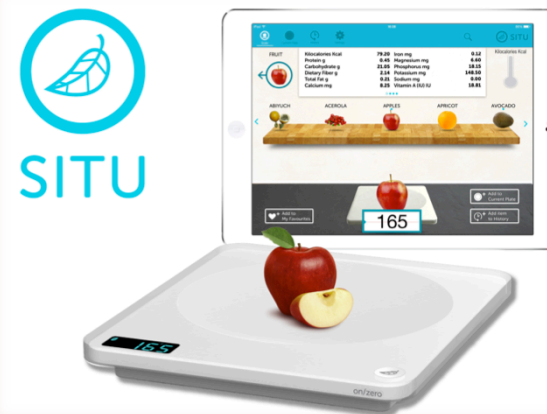
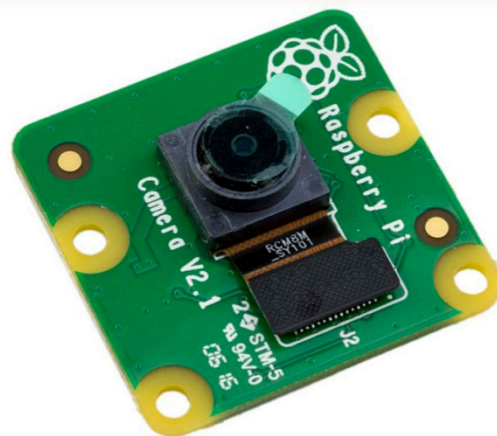
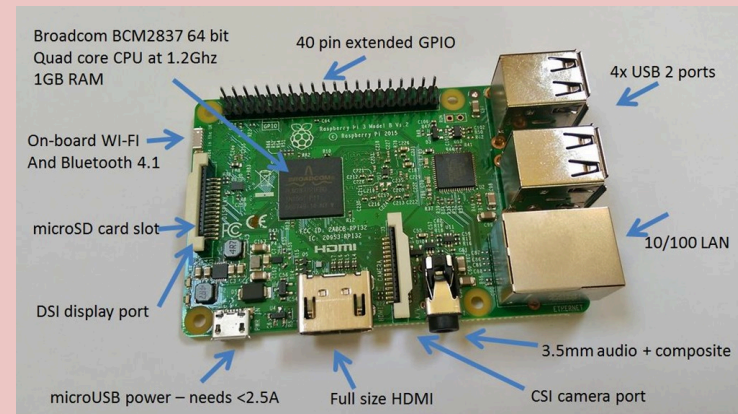
- **The Fog**
 - extends the cloud computing paradigm to the edge of the network,
 - enables a new breed of applications and services
 - an appropriate solution for the applications and services that fold under the umbrella of the IoTs.
- **Benefits**
 - low latency
 - location awareness
 - widespread geographical distribution
 - mobility support
 - the strong presence of streaming and real-time applications
 - heterogeneity

Architecture of Smart Nutrition Monitoring System



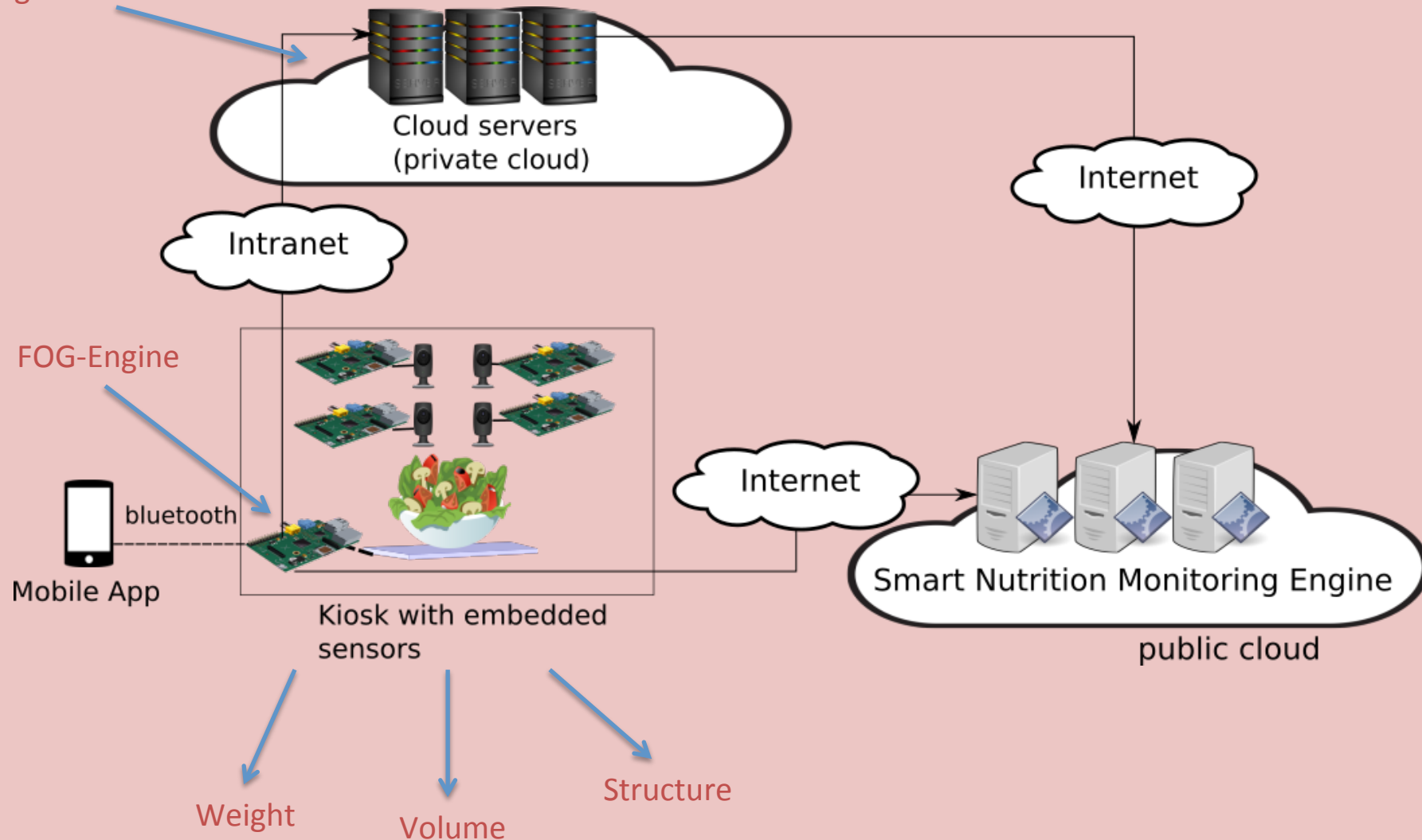
IoT Components

- Raspberry Pi 3.0 x 6
 - emteria OS
- 8MP Camera x 5
- Smart Scale x 1

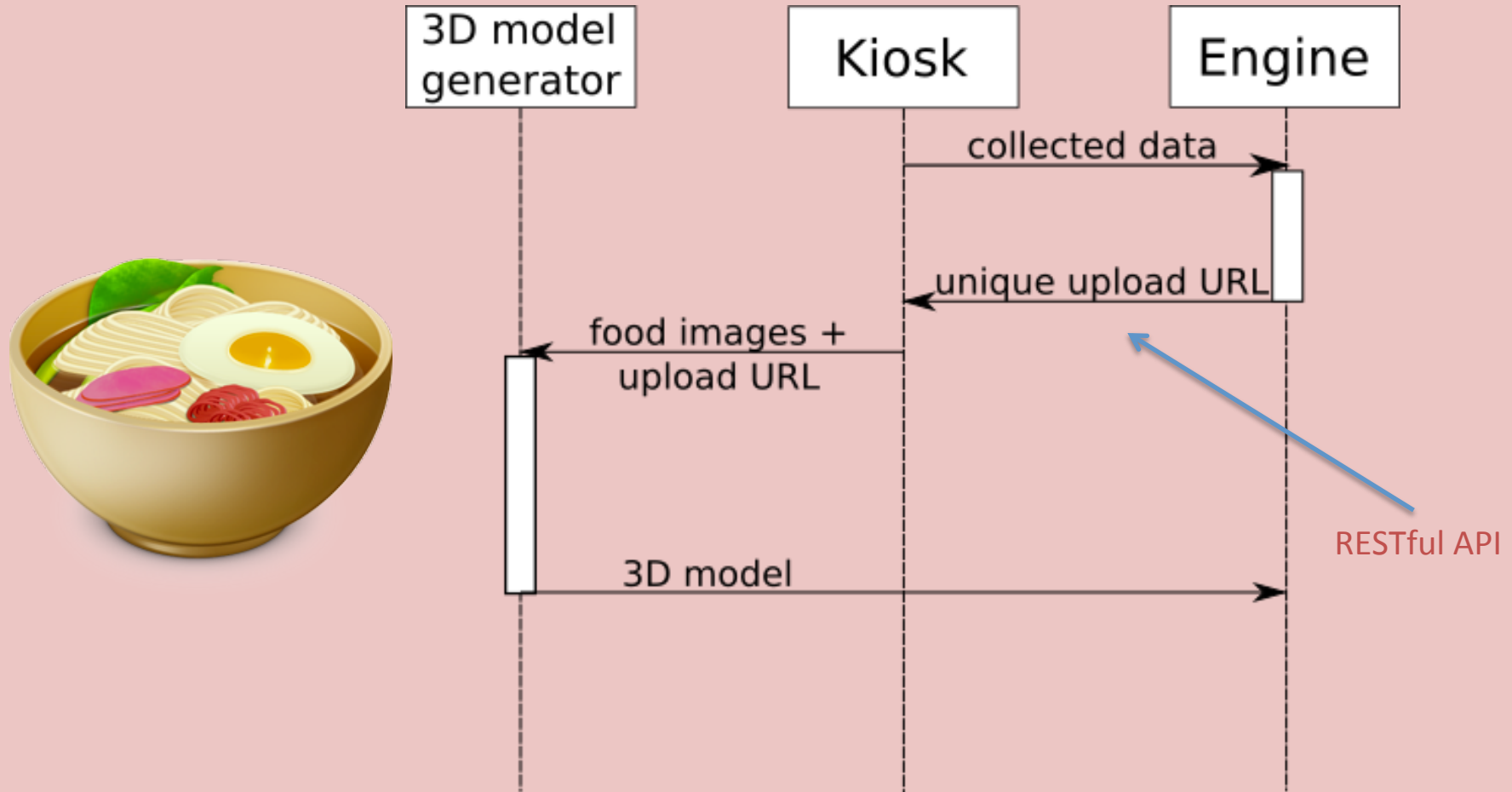


System Prototype

AgiSoft PhotoScan Pro



System Interactions



Conclusions and Future Works

- Smart nutrition monitoring system
 - Heterogeneous IoT sensors
 - Non-invasive
 - Utilizing Fog-engine
- Future works
 - Innovative Machine Learning for food detection and food classification
 - System validation and verification (by dietitian)



References

- Farhad Mehdipour, Bahman Javadi, Aniket Mahanti, "FOG-engine: Towards Big Data Analytics in the Fog", The 2nd IEEE International Conference on Big Data Intelligence and Computing (IEEE DataCom 2016), Auckland, New Zealand, August 2016.
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Thank You



General Architecture of FOG-Engine

