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Supporting Multiple Smart-City Applications based on MUSANet, a Common IoMT Middleware



Outline

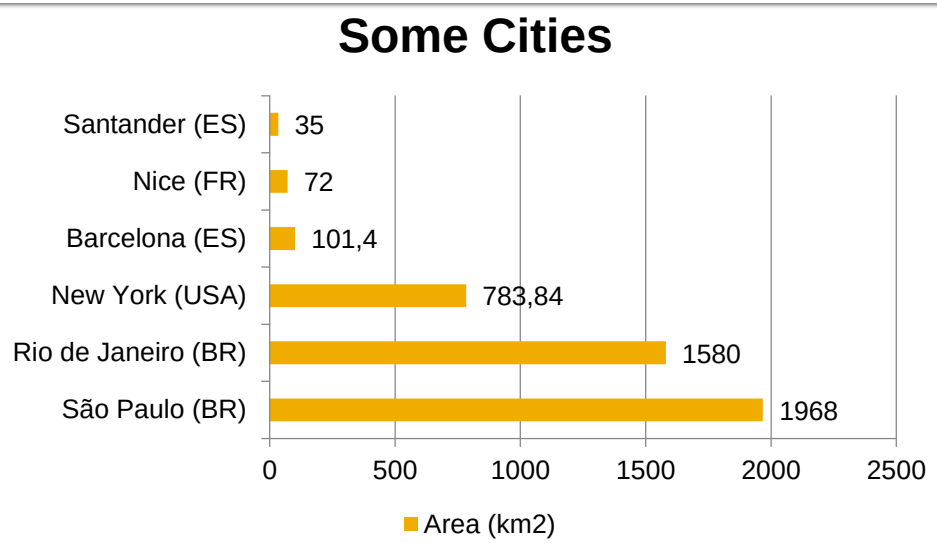
- Motivation
- MUSANet architecture
- Some applications
- New application deployment
- Next steps

What's the size of the problem?

Nice - France

Barcelona - Spain

Santander - Spain



Sources:
- Google Maps
- Wikipedia

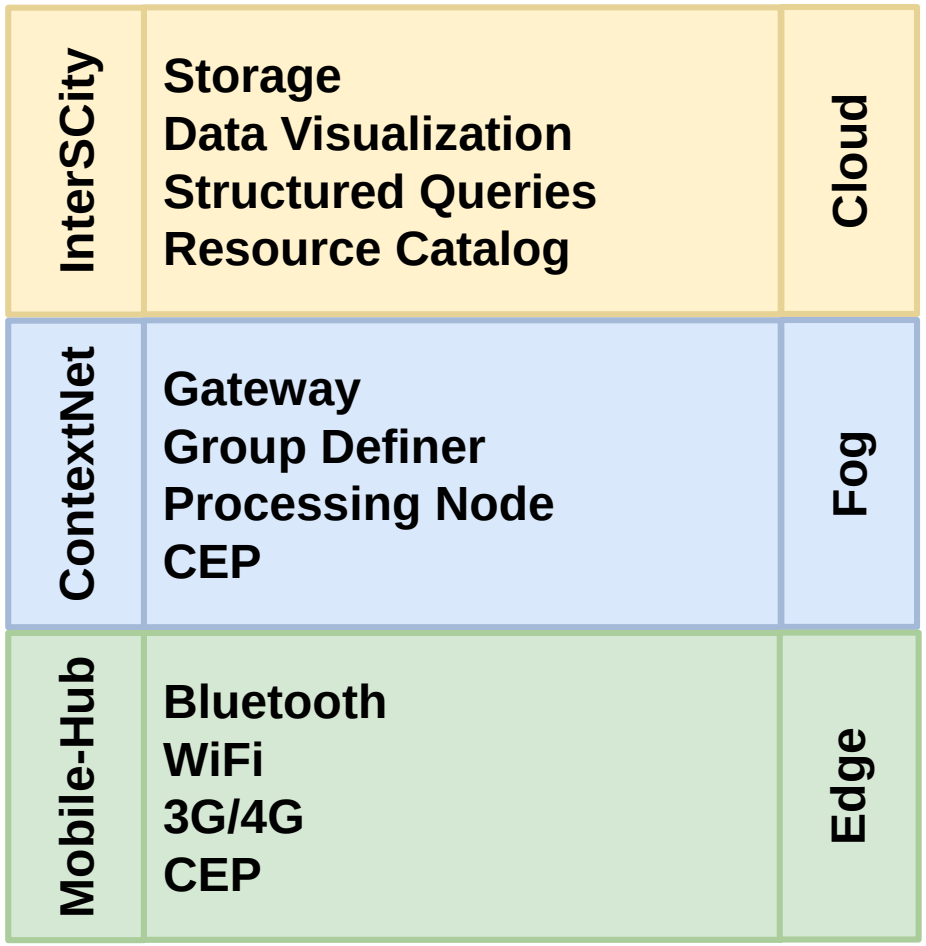
MUSANet Architecture

MUSANet

- Mobile Urban Sensor and Actuator Network

Three-tier architecture

- Cloud
- Fog
- Edge



Lower Layer: Mobile Hub

Sensor gateway	• Bluetooth / BLE • Smartphone sensors • Sensor discovery and data collection
CEP	• Complex Event Processing • Data stream
Context-aware	• Location • Timestamp

B. Gomes et al, “A Middleware with Comprehensive Quality of Context Support for the Internet of Things Applications,” Sensors, vol. 17, no. 12, p. 2853, 2017.

Middle Layer: ContextNet

Goals:

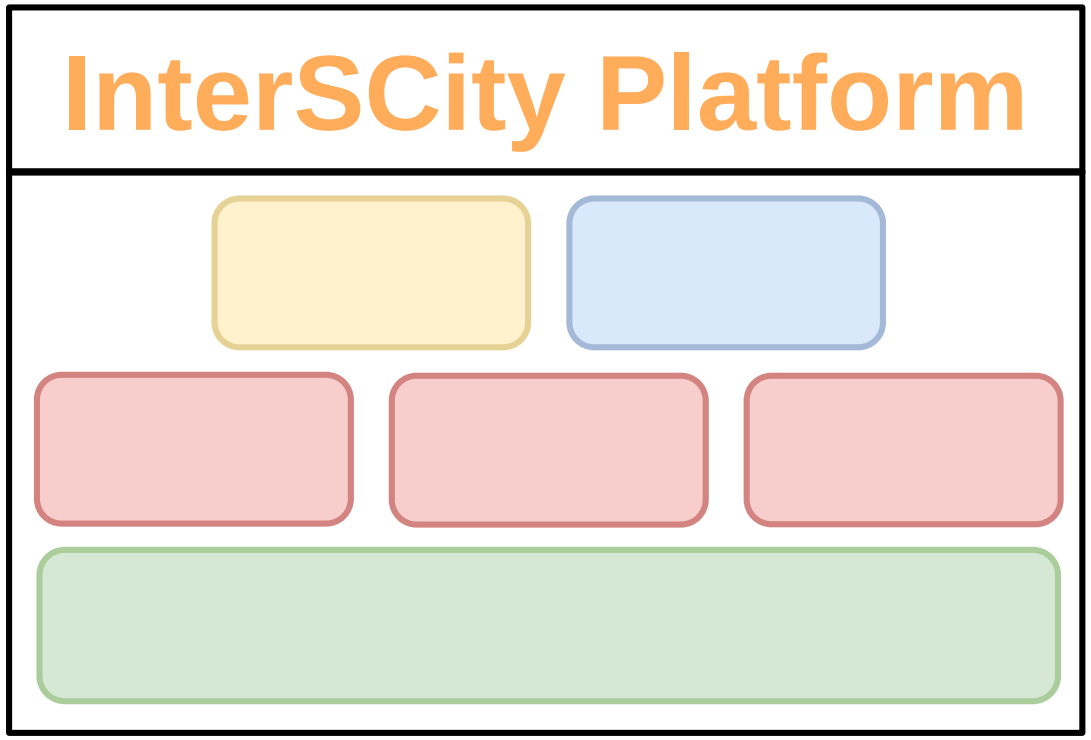
- Scalable software architecture for mobile communication and low latency processing.
- Processing of mobile data streams.
- Complex Event Processing (CEP) distributed.
- Context-awareness and adaptation.
- Support for mobile-mobile collaboration and coordination.

M. Endler et al, “ContextNet: context reasoning and sharing middleware for large-scale pervasive collaboration and social networking,” in Proceedings of the Workshop on Posters and Demos Track. ACM, 2011, p. 2.

Upper Layer: InterSCity

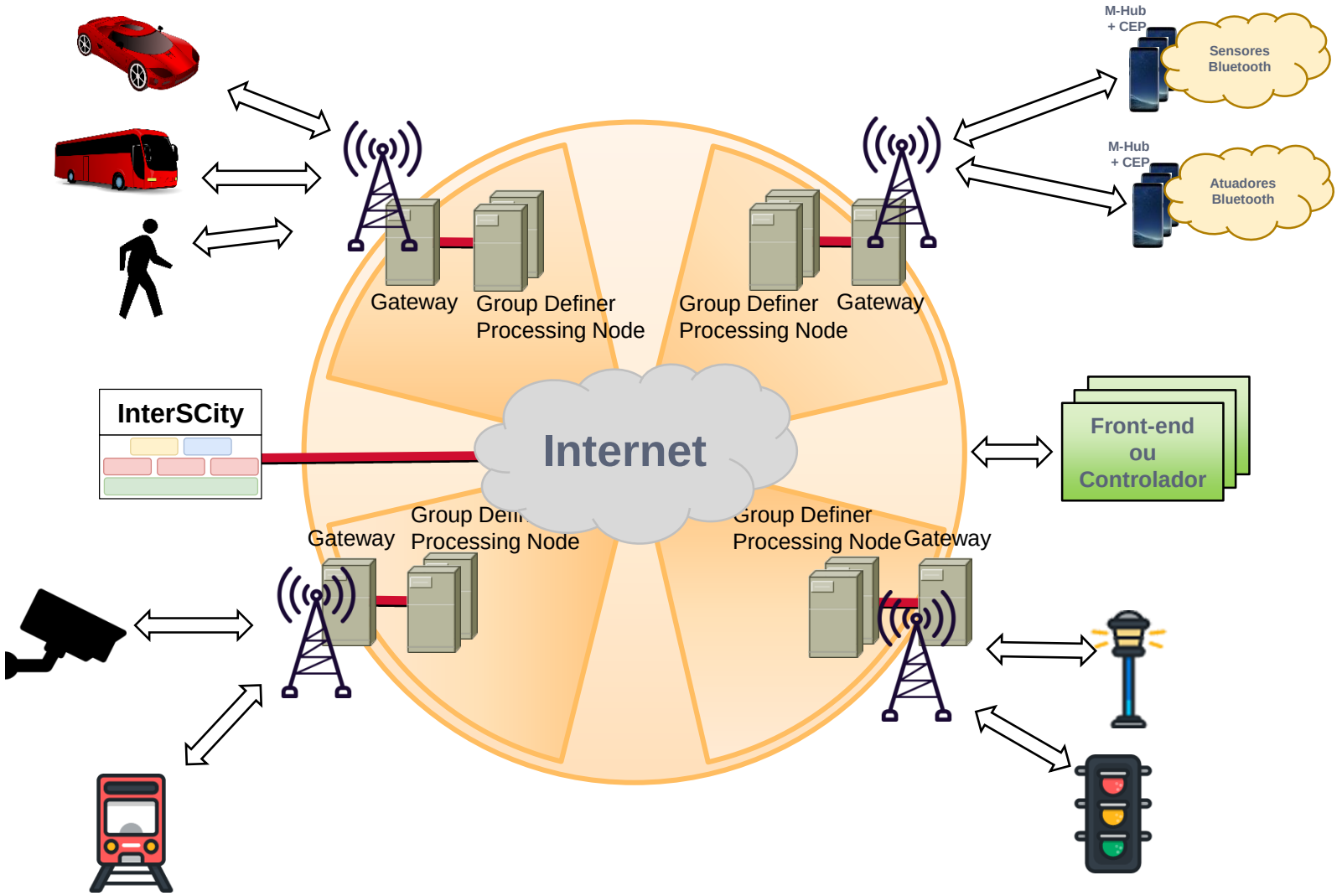
Model based storage and retrieval of sensor data

- Microservices
- Access over HTTP
- Structured queries
- Publisher/Subscriber broker
- Smart City resource models

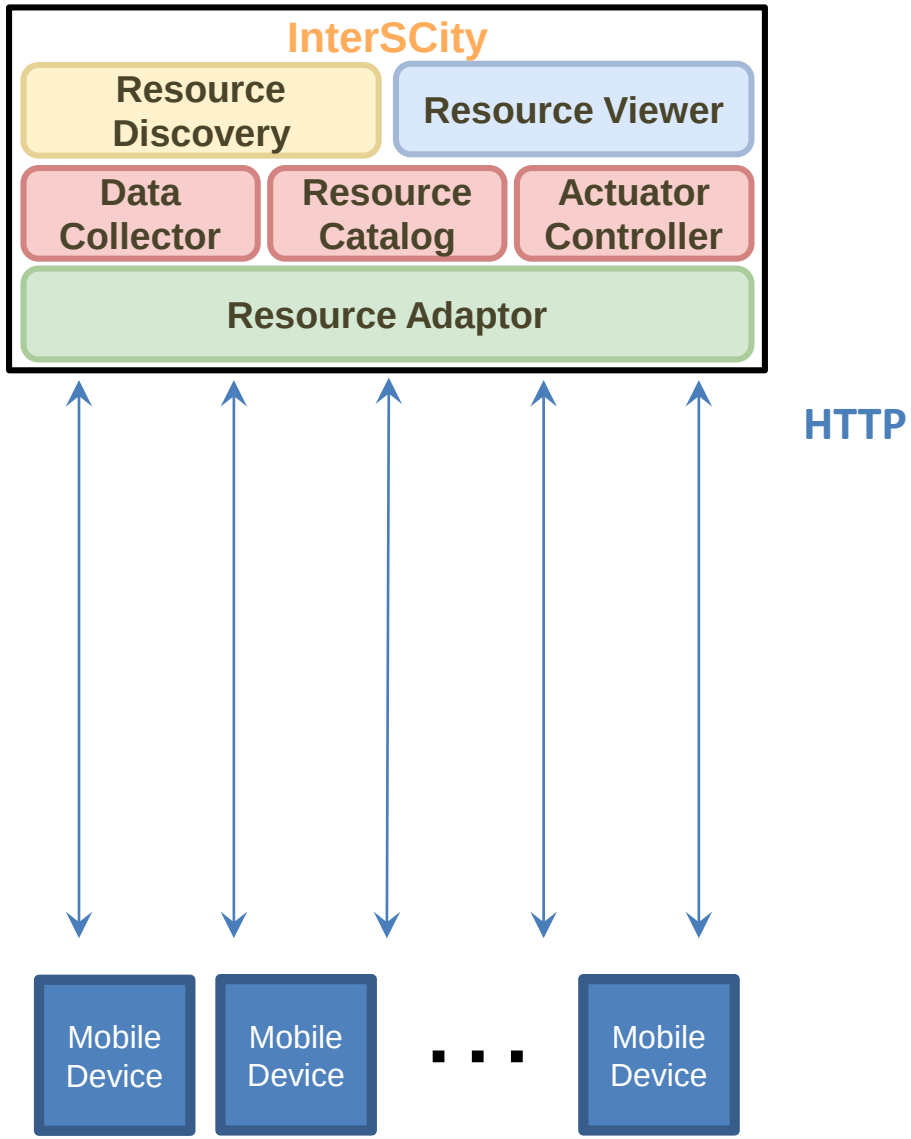


D. M. Batista et al., “InterSCity: Addressing Future Internet Research Challenges for Smart Cities,” in Network of the Future (NOF), 2016 7th International Conference on the. IEEE, 2016, pp. 1–6.

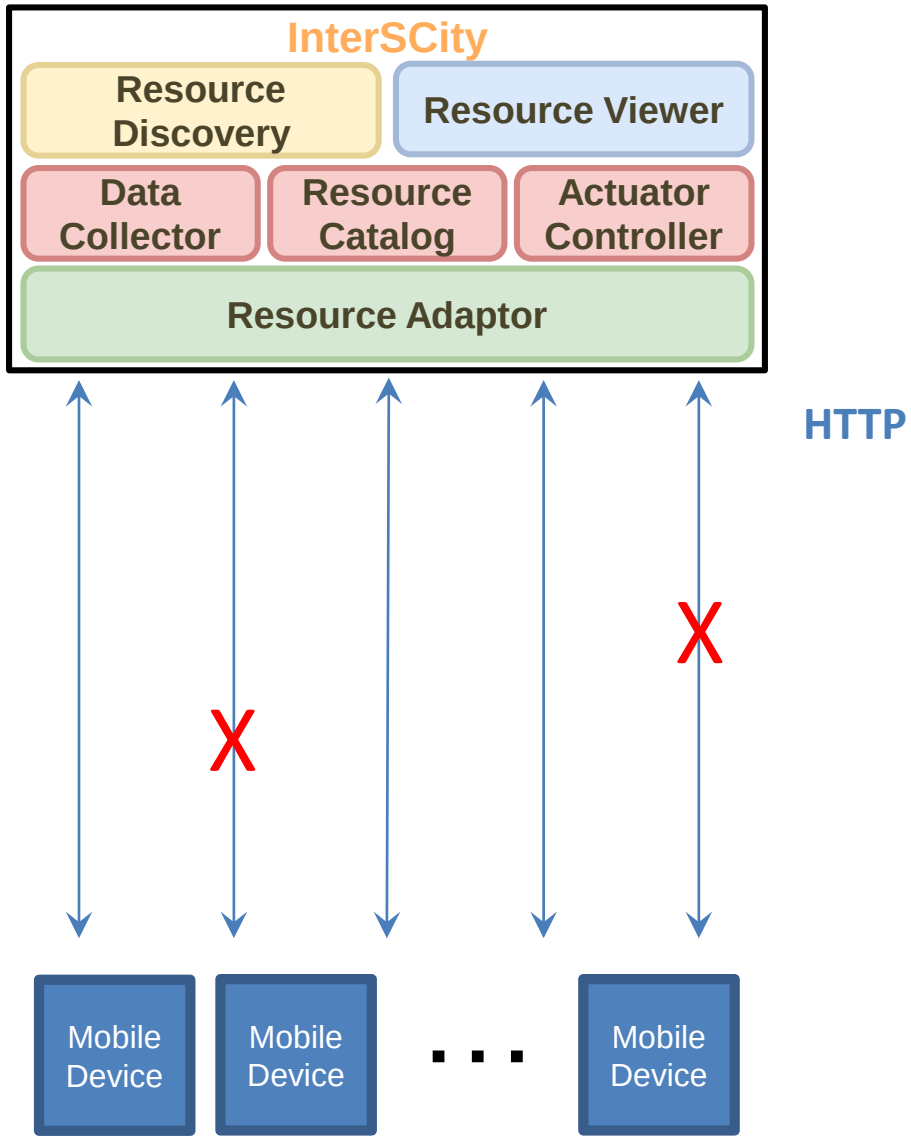
MUSANet


M-Hub
+ CEP
Sensores
Bluetooth
M-Hub
+ CEP
Atuadores
Bluetooth
Gateway
Group Definer
Processing Node
Group Definer
Processing Node
Gateway
InterSCity
Internet
Front-end
ou
Controlador
Gateway
Group Definer
Processing Node
Group Definer
Processing Node
Gateway

MUSANet


InterSCity
Resource Discovery
Resource Viewer
Data Collector
Resource Catalog
Actuator Controller
Resource Adaptor
HTTP
Mobile Device
Mobile Device
Mobile Device

MUSANet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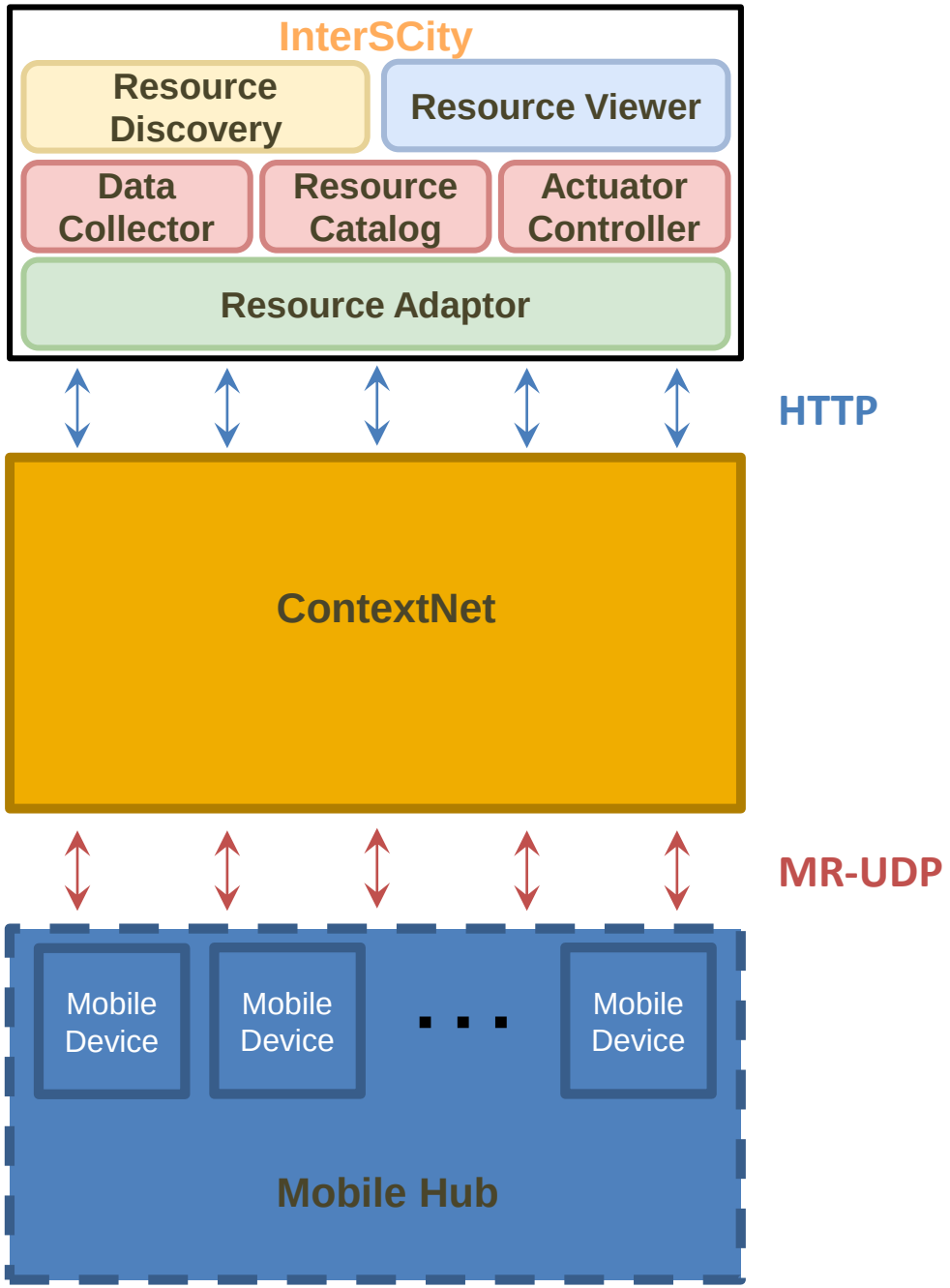
MUSANet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MR-UDP
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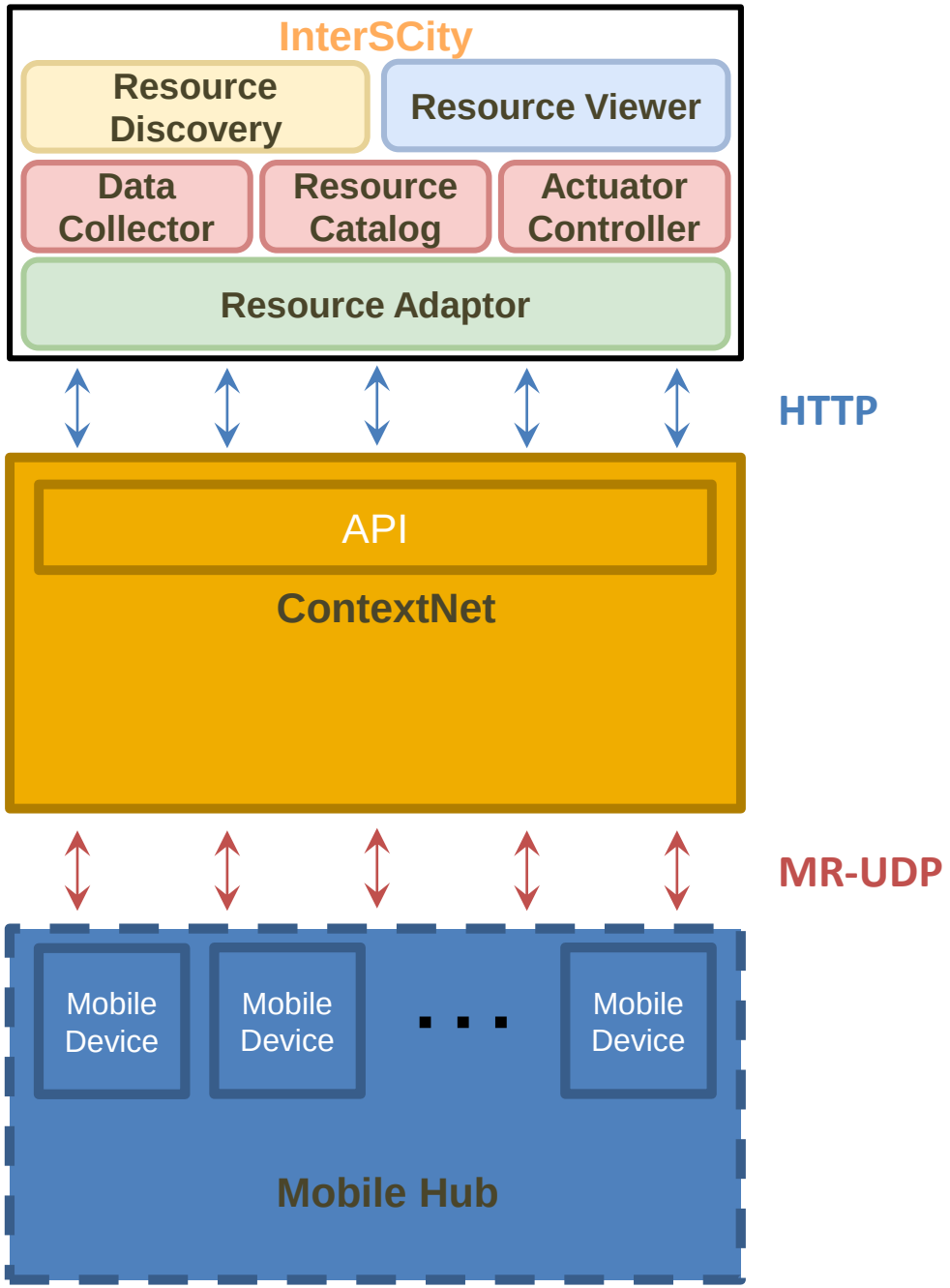
Mobile Device
Mobile Hub

MUSANet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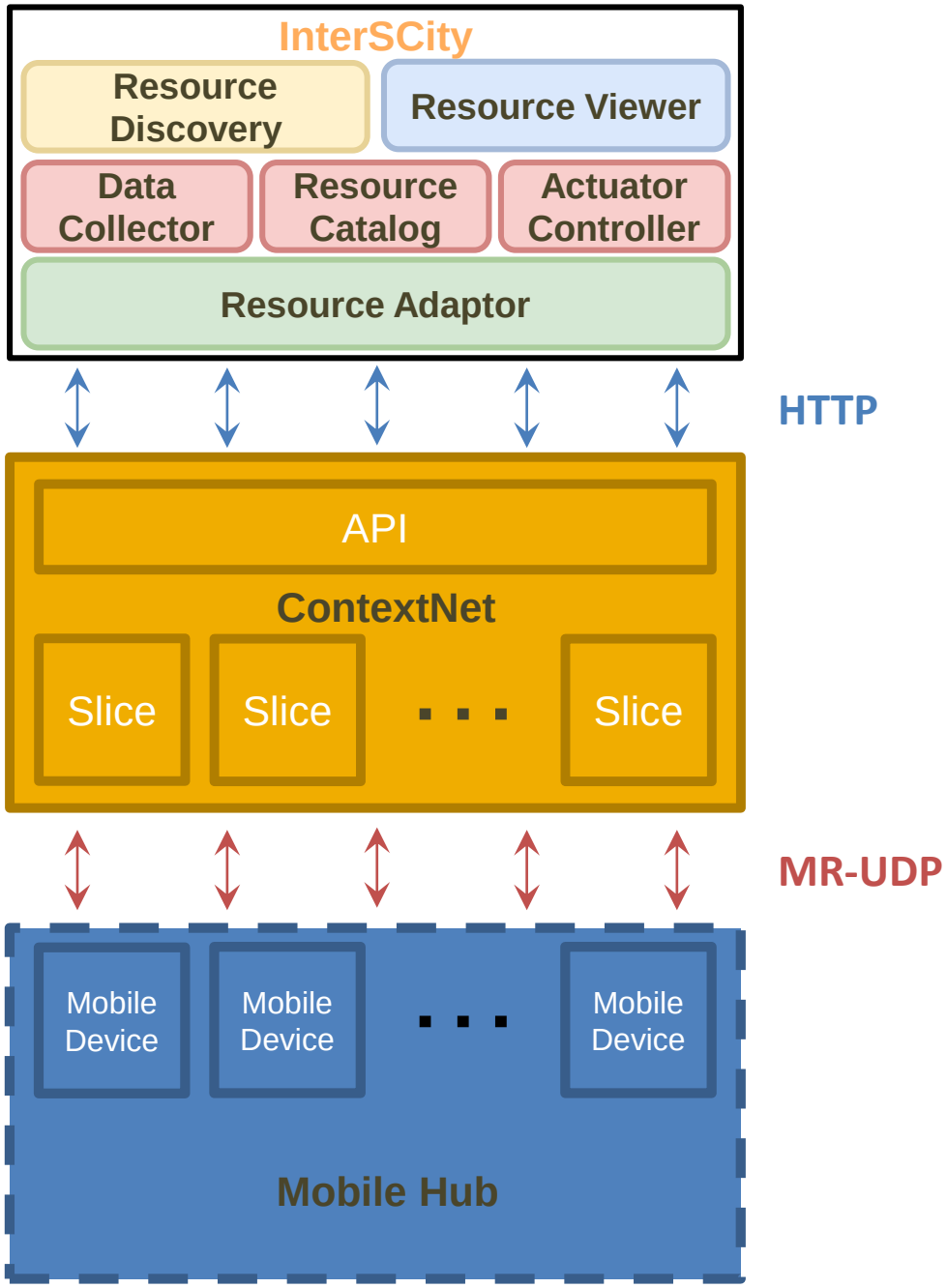
MUSANet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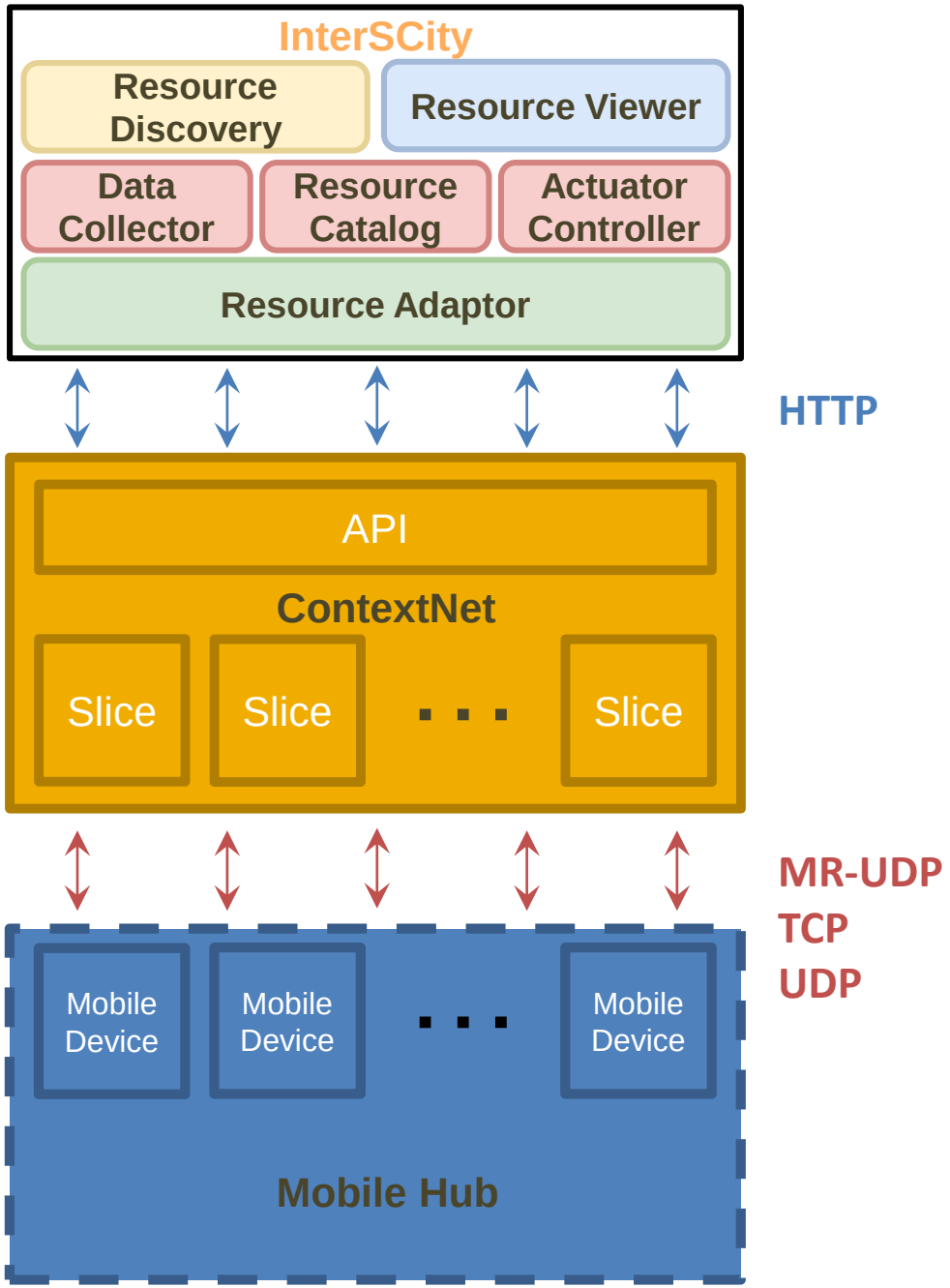
Mobile Hub

MUSANet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HTTP
API
ContextNet
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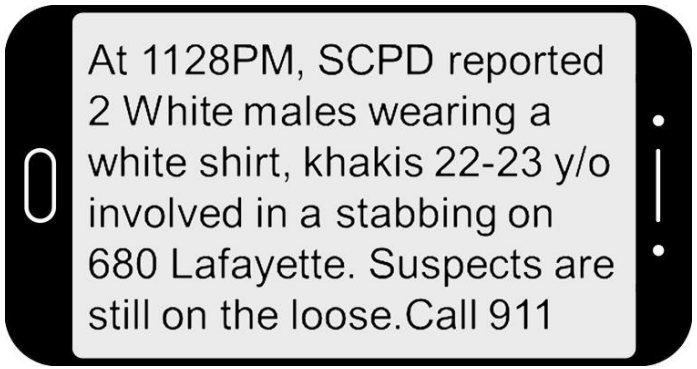
Slice
MR-UDP
TCP
UDP
Mobile Device
Mobile Device
. . .
Mobile Device
Mobile Hub

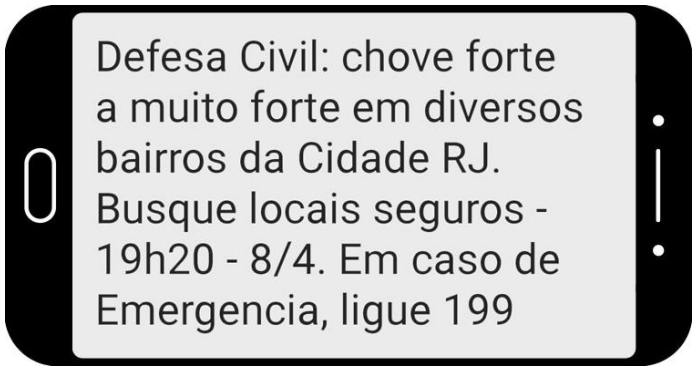
Case Studies

- Applications
  - Bus tracking
  - Where is my bus?
  - REGIONALert
  - Heat Island
  - Face Detection
  - ALPR
  - Face Recognition

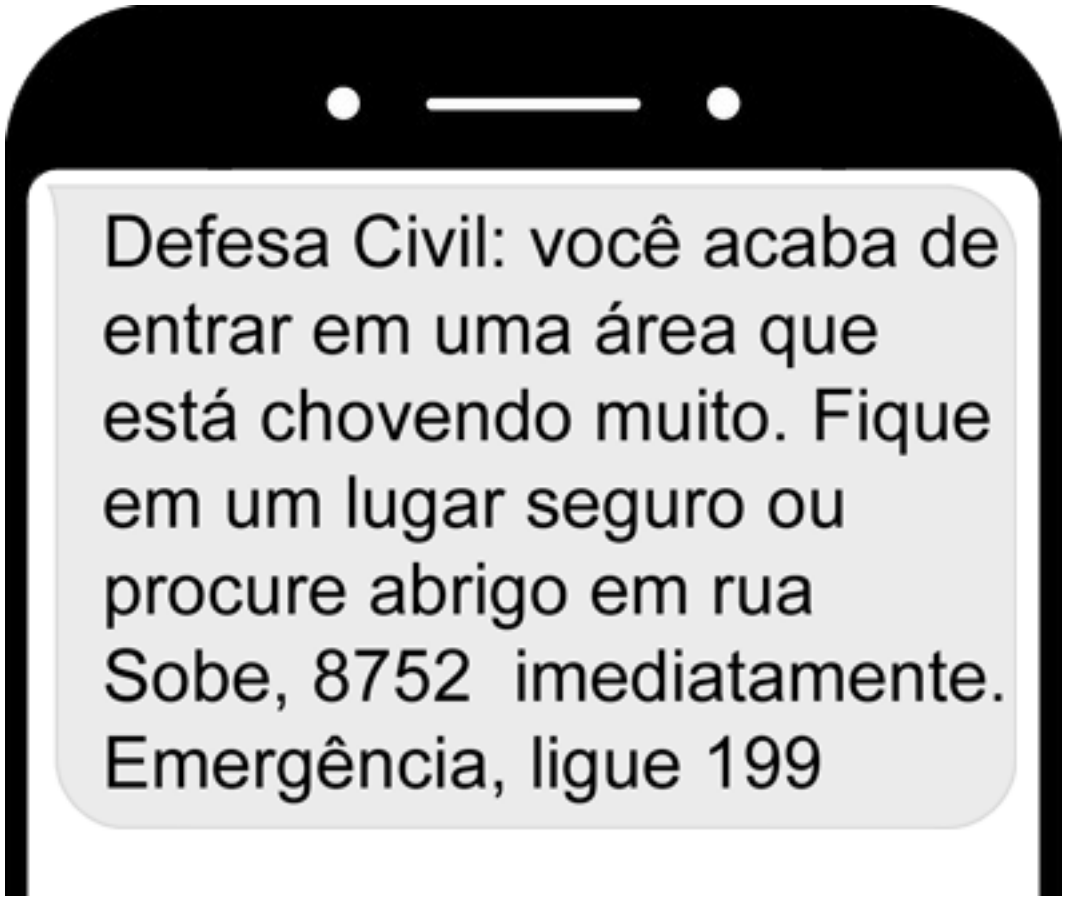
Motivation

Existing systems

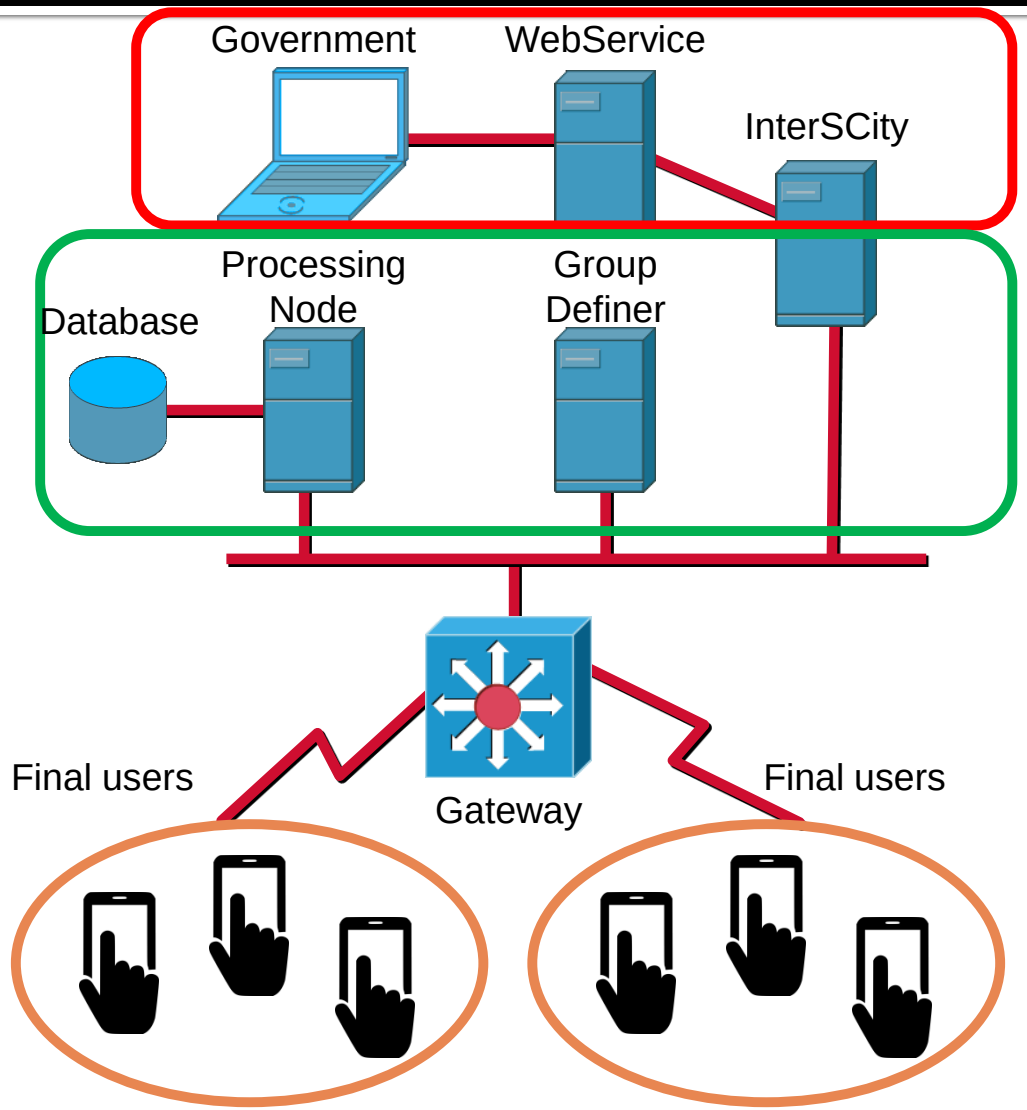




Proposed system

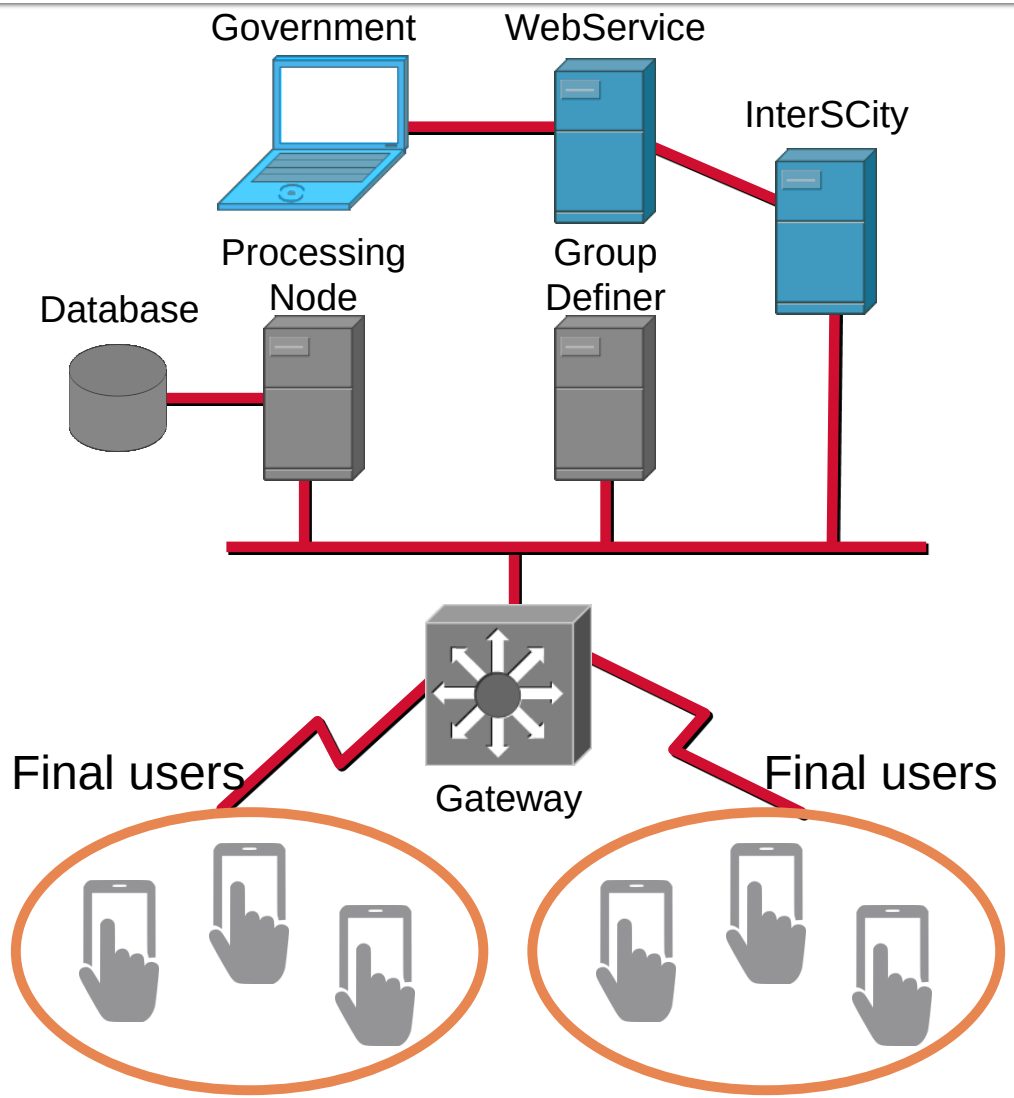


Case study: RegionAlert



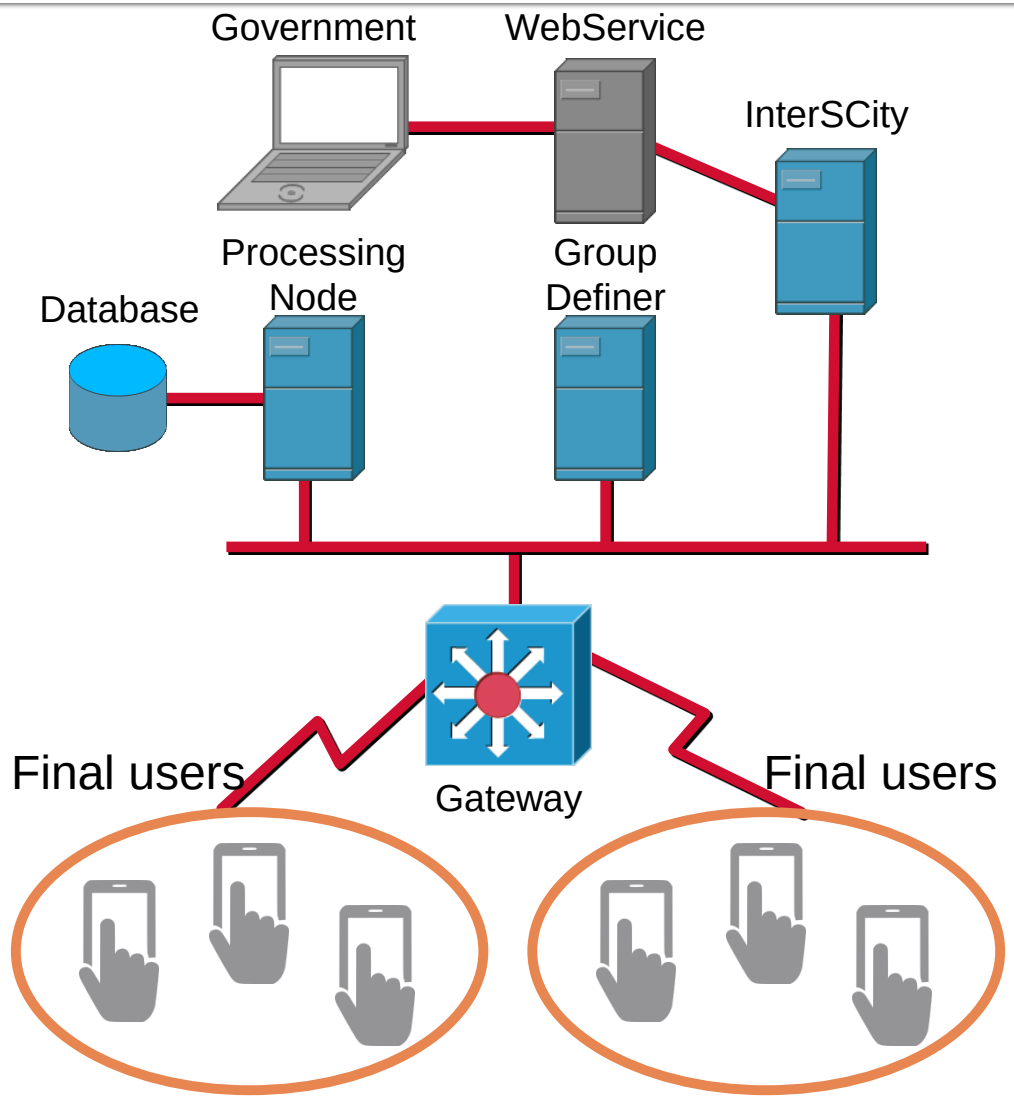
- 3 actors
  - City Offices (transportation, weather forecast, etc.)
  - Third-party companies
  - Final users

Case study: RegionAlert



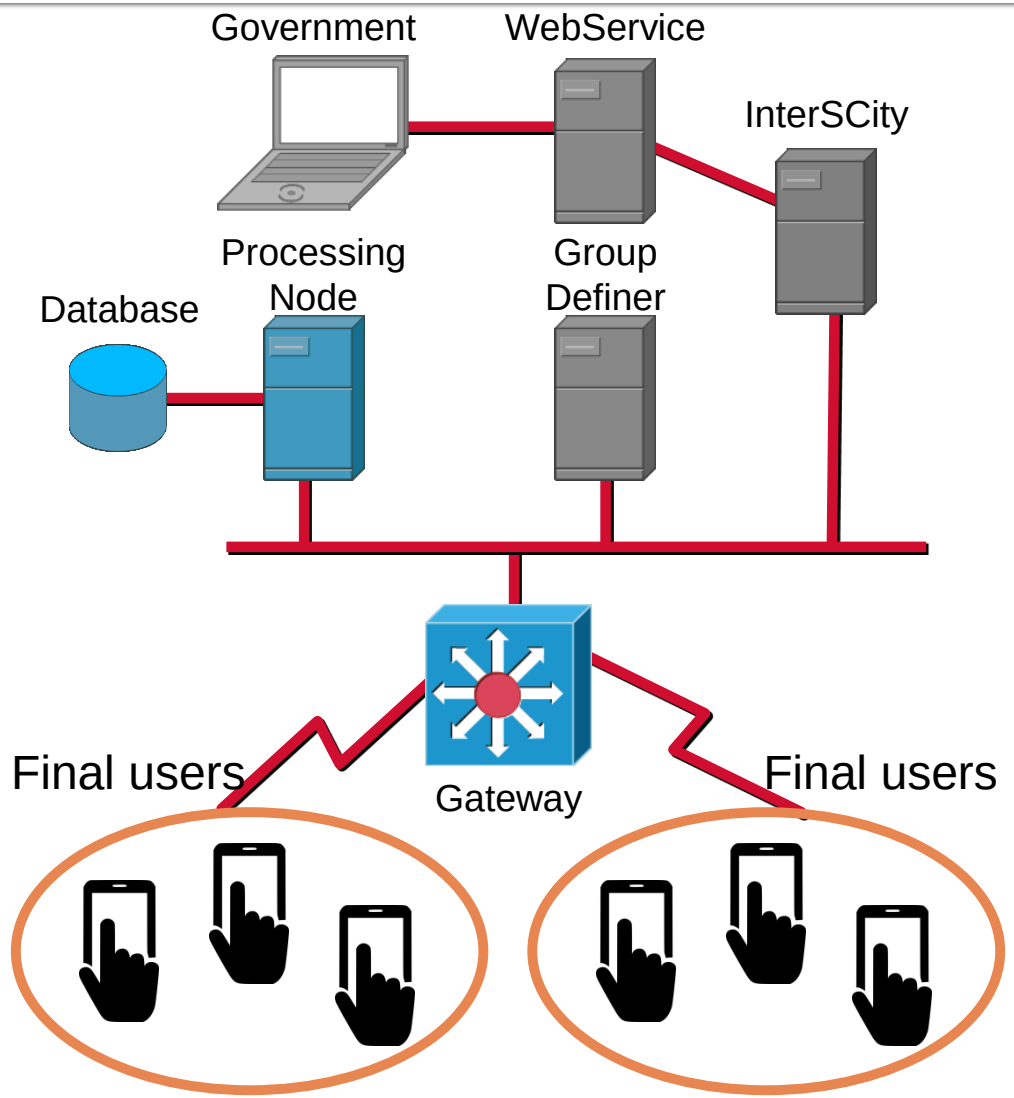
- City offices
  - The city offices create a pub/sub topic to publish information about a new alert
  - City offices use the webservice to create and store new alerts in the InterSCity
  - In addition to storing the information in InterSCity, city offices publish the information in the InterSCity broker pub-sub

Case study: RegionAlert



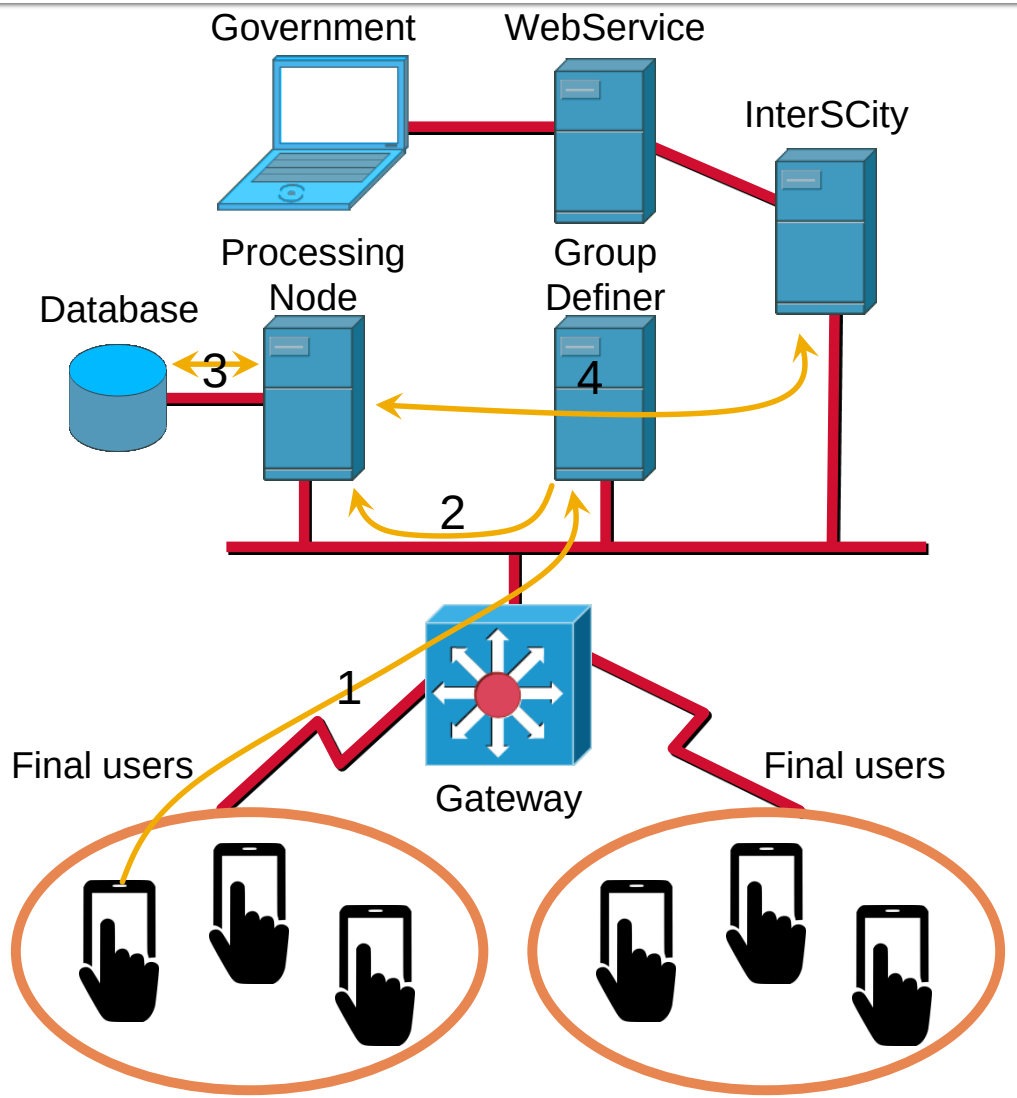
- Third-party company
  - The company subscribes to be notified when an alert is created
  - The company stores user preferences (areas of interest) in its database (not the government's InterSCity)
  - Can read from, but cannot write to the government's InterSCity
  - Every time a new alert is created, the company notifies users by area (location & interest)
  - Every time a user enters an area with a valid alert, the company notifies the user

Case study: RegionAlert



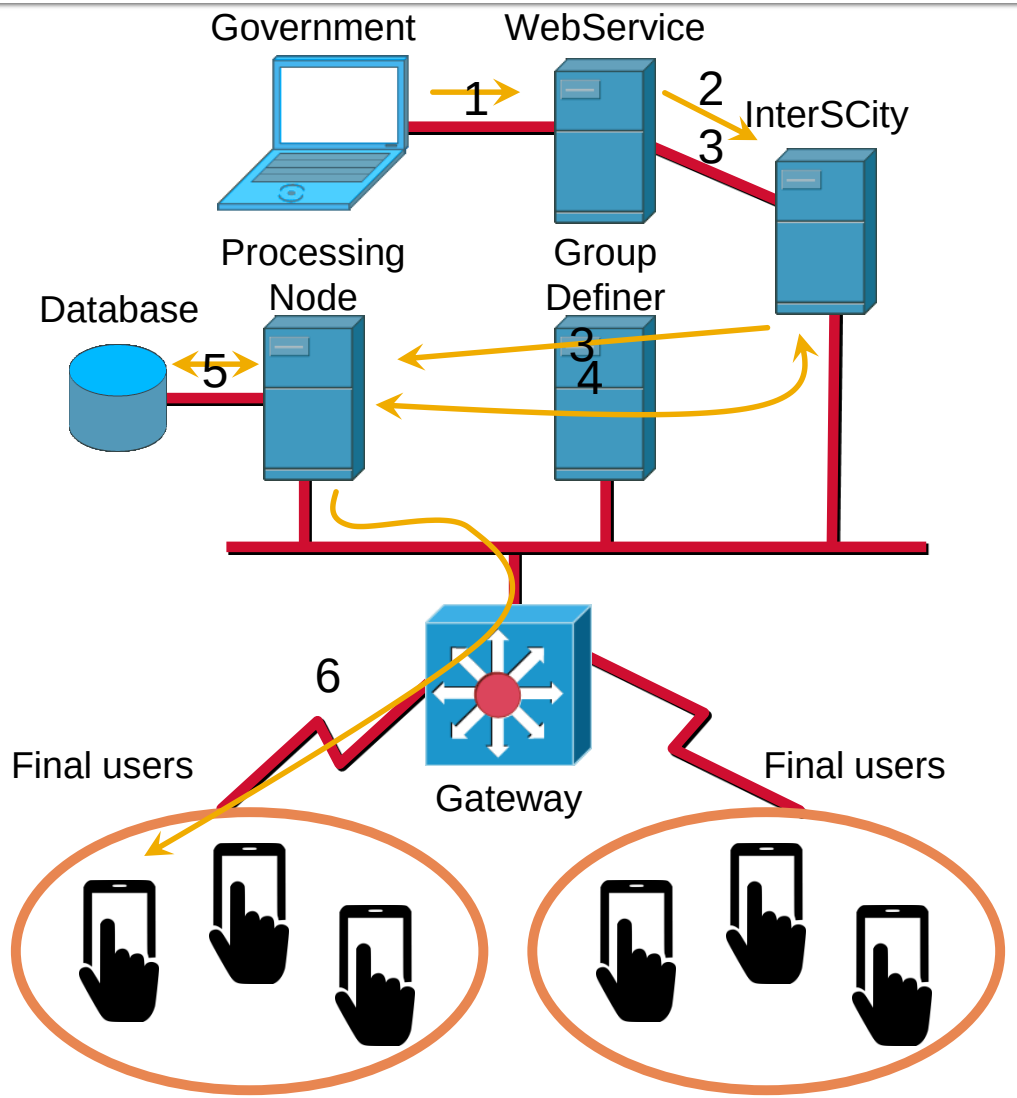
- Final Users
  - Run third-party application and Mobile-Hub in their smartphones
  - Register their areas of interest
  - Receive alert when a new alert is created and:
    - The alert is related to their interest area
    - OR the alert is about the area where they are located
  - (can be use to collect information from sensors in the city)

REGIONALert Application



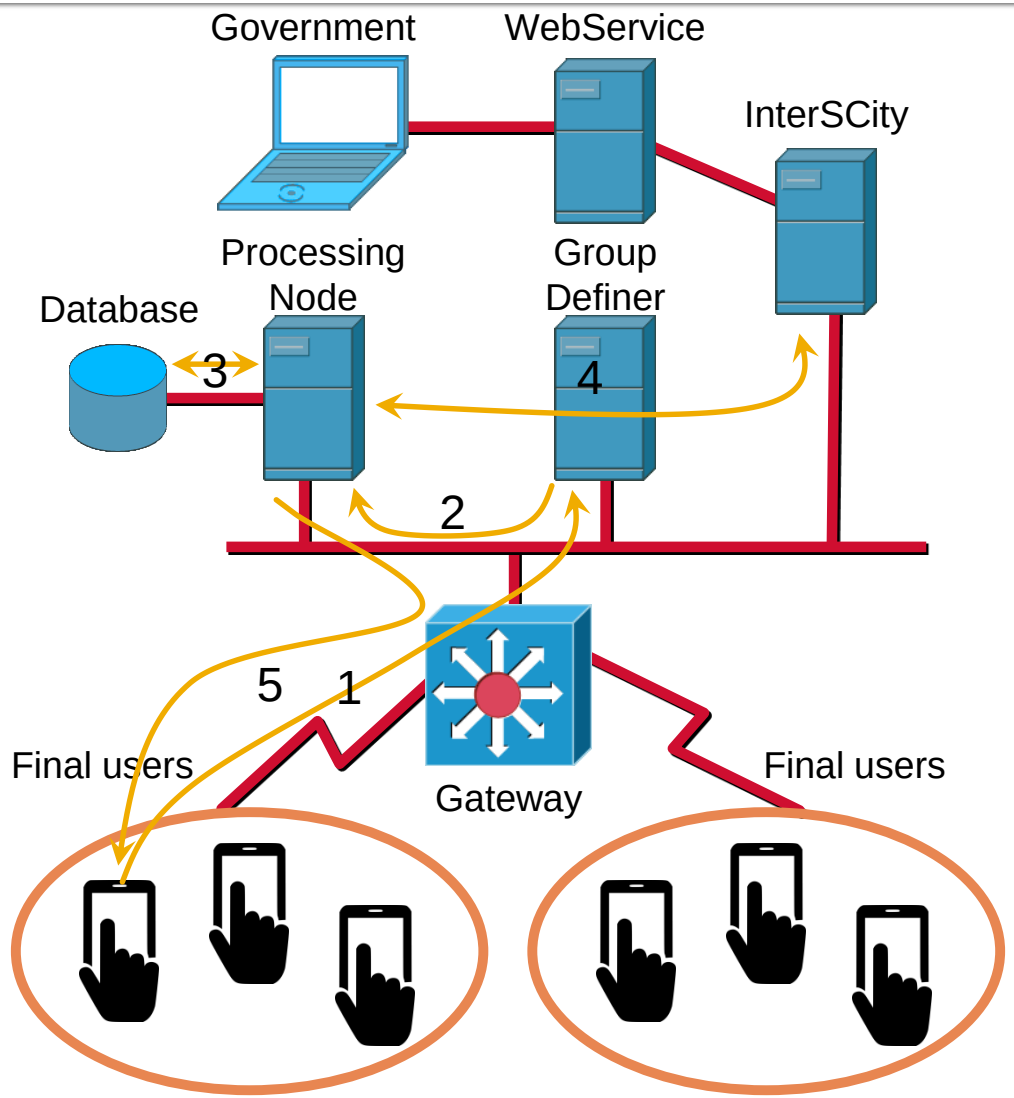
1. User enters region “R”
2. GroupDefiner sends user position to Processing Node
3. Processing Node queries database for user’s interest
4. Processing Node queries InterSCity for alerts

REGIONALert Application



1. Government creates a notification
2. The webservice stores the notification in the InterSCity
3. The web service notifies the Processing Node
4. The Processing Node queries InterSCity for new notification
5. The Processing Node queries database for users' interest
6. The Processing Node sends unicast and groupcast messages to users

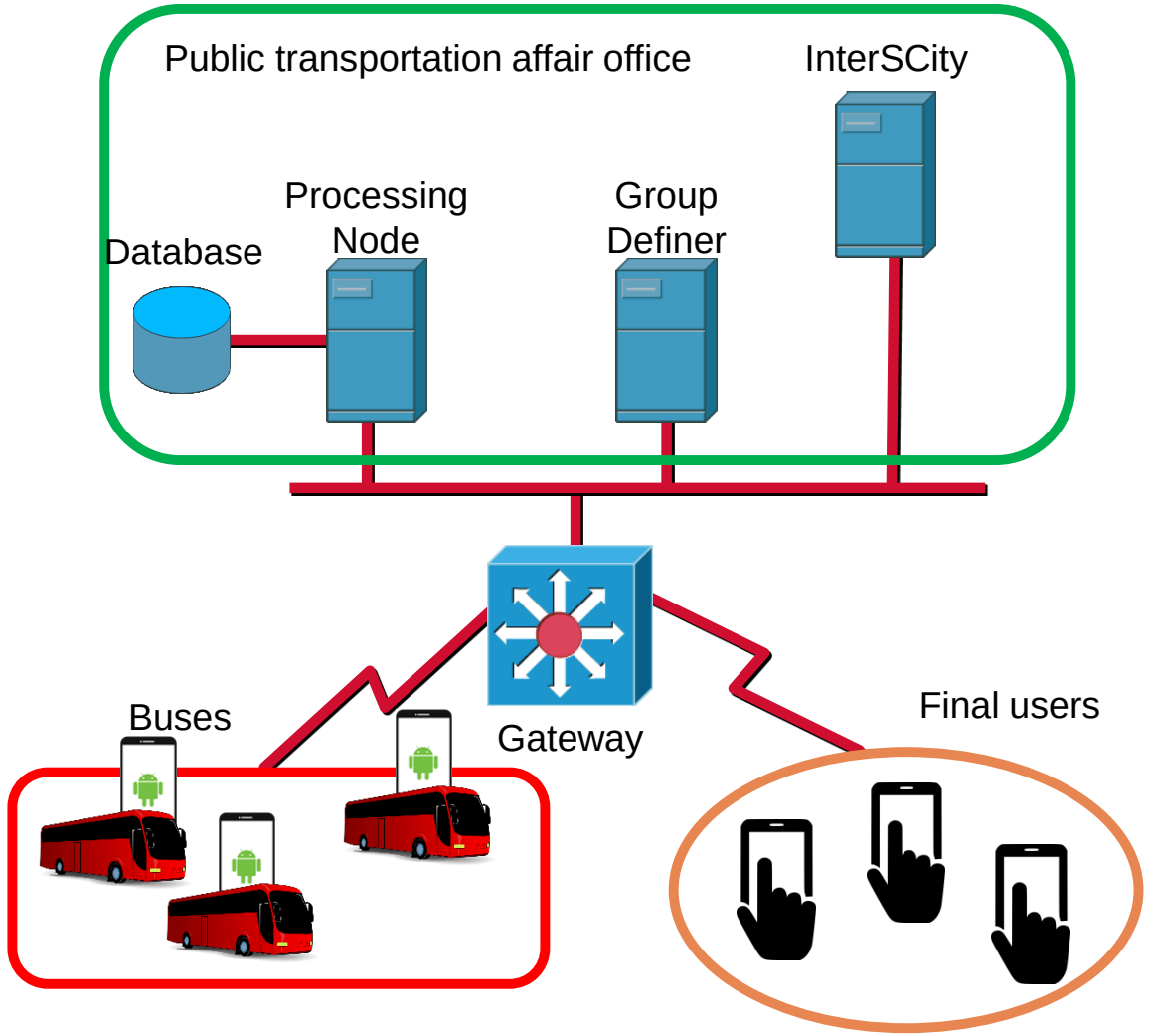
REGIONALert Application



1. User re-enters region “R”, sends position and message ID
2. GroupDefiner sends user position to Processing Node
3. Processing Node queries database for user’s interest
4. Processing Node queries InterSCity for alerts
5. Processing Node sends new alerts (new IDs) to user

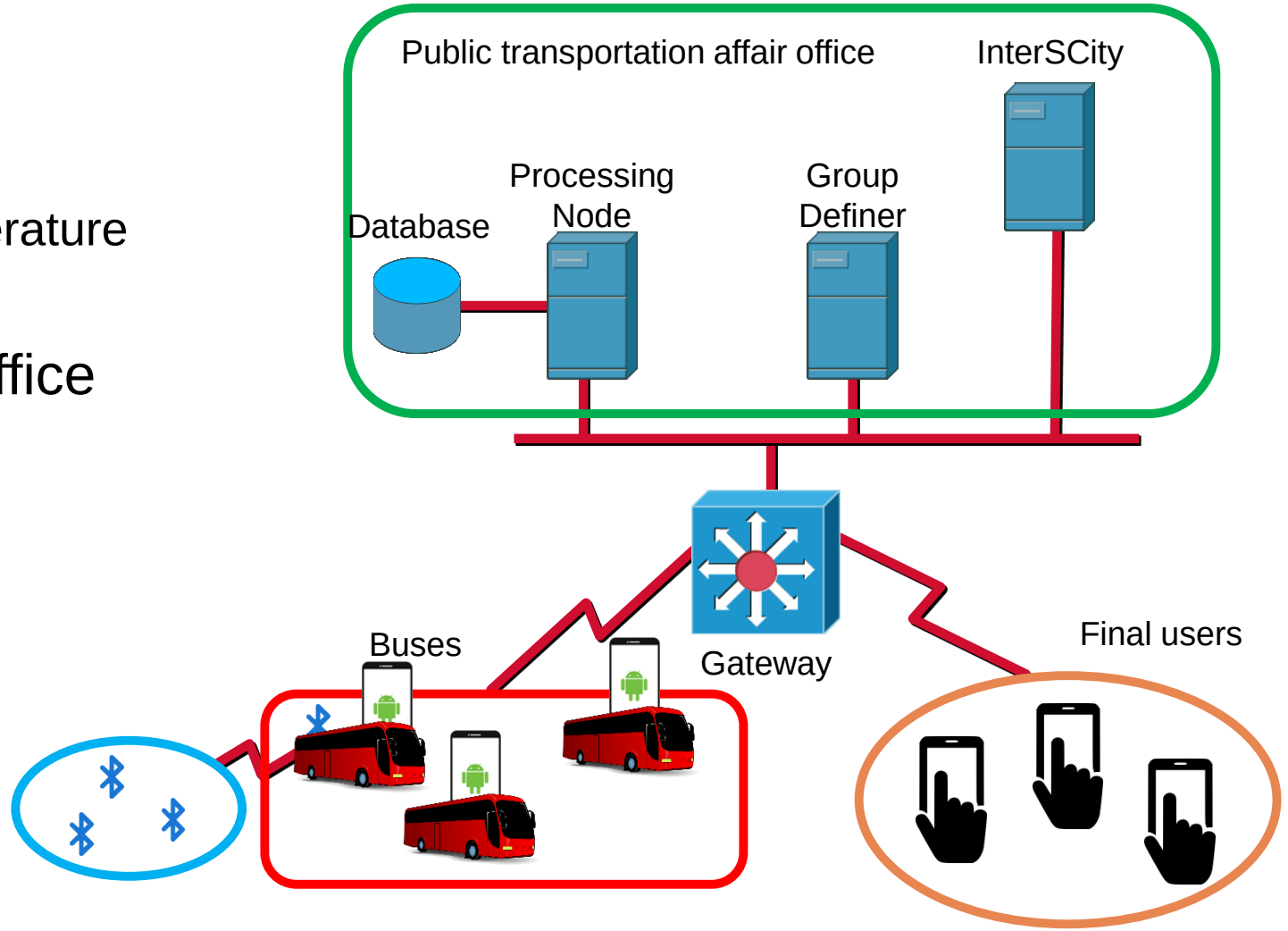
Bus Application

- Actors:
  - Buses
    - Send information to MUSANet
  - Public transportation affair office
    - Manage InterSCity
    - Create areas in the city
  - User
    - Registry into system
    - Query system
    - Receive alerts

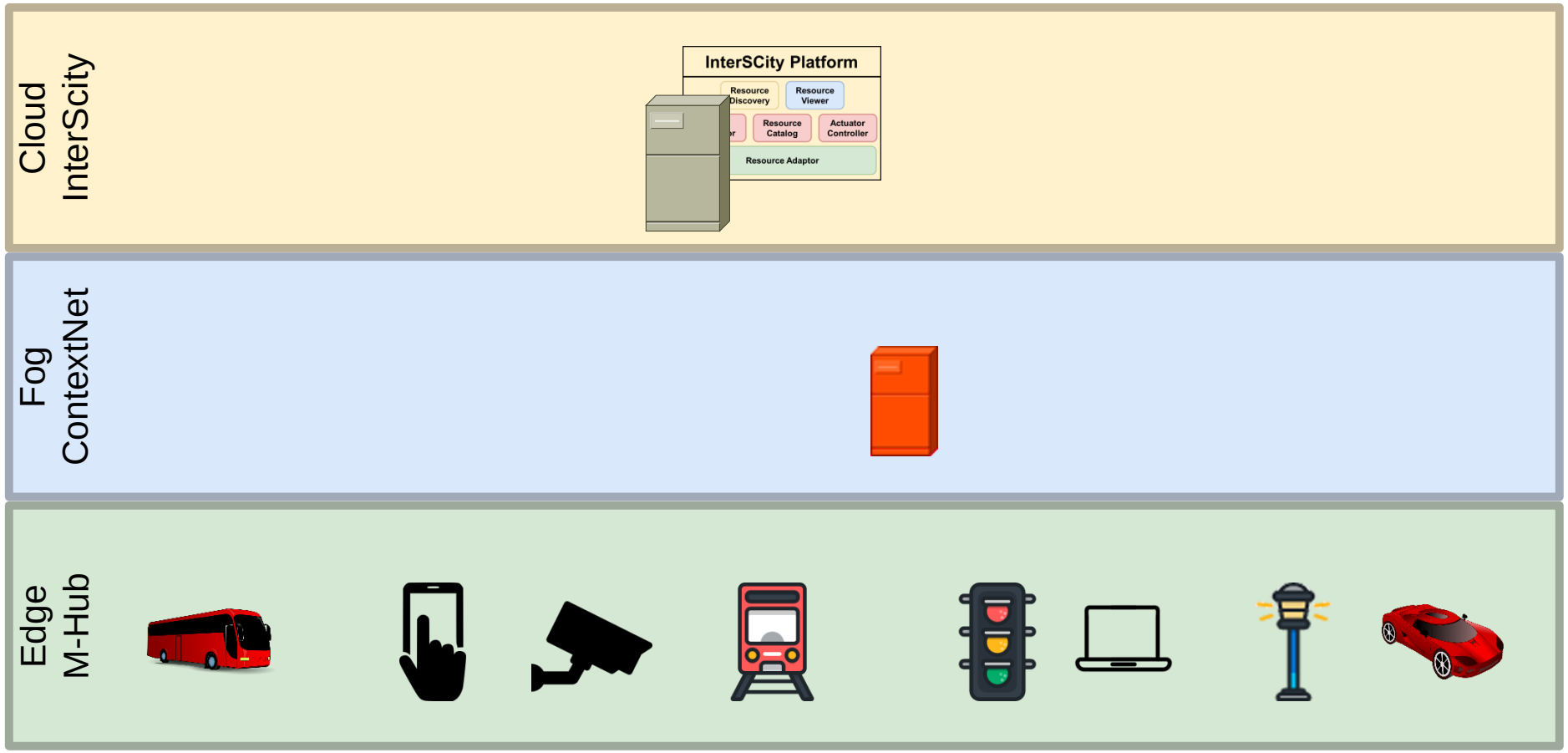


Heat Island Application

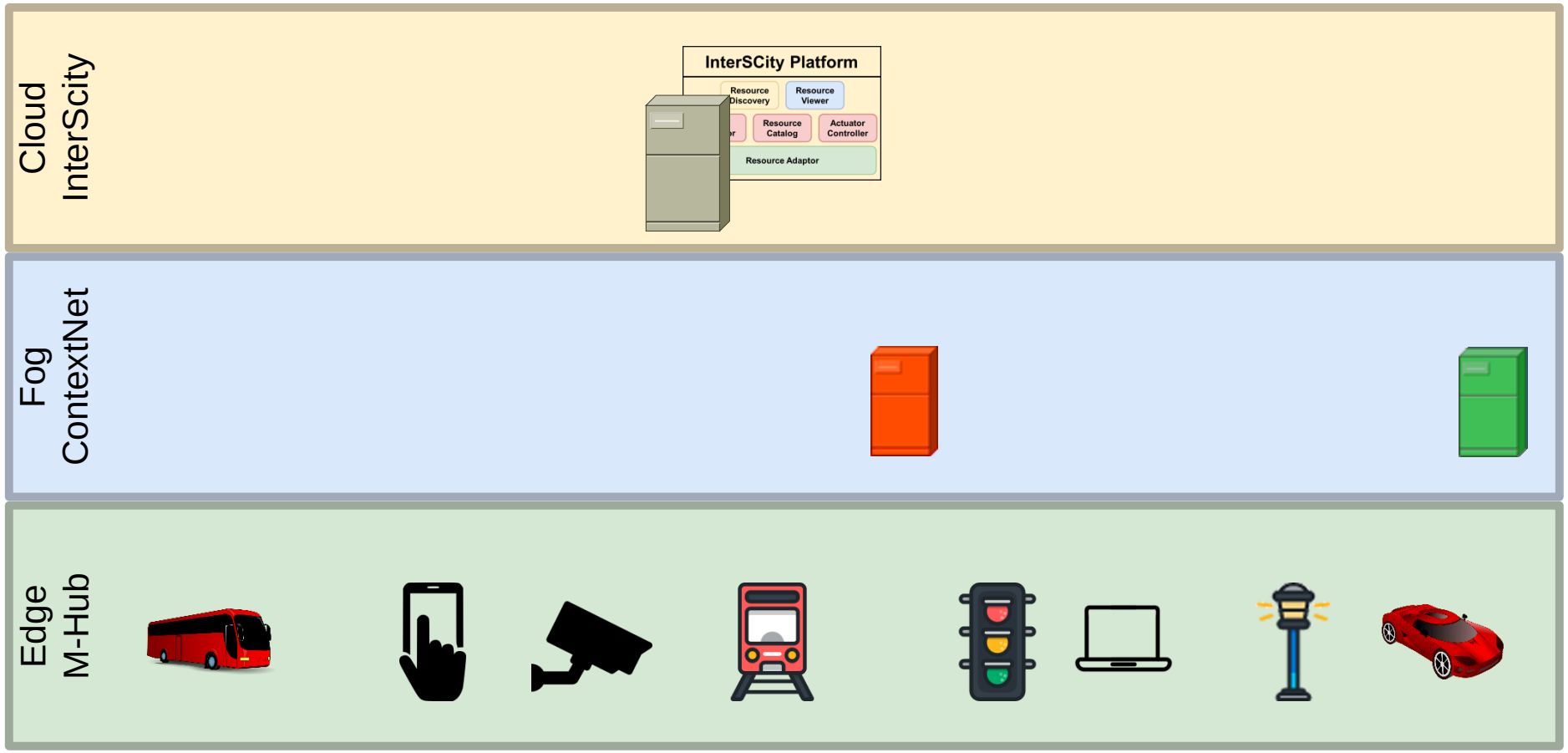
- Actors
  - Buses
    - Collect information about temperature
    - Send information to MUSANet
  - Public transportation affair office
    - Manage InterSCity
    - Create areas in the city
  - User
    - Registry into system
    - Receive alerts



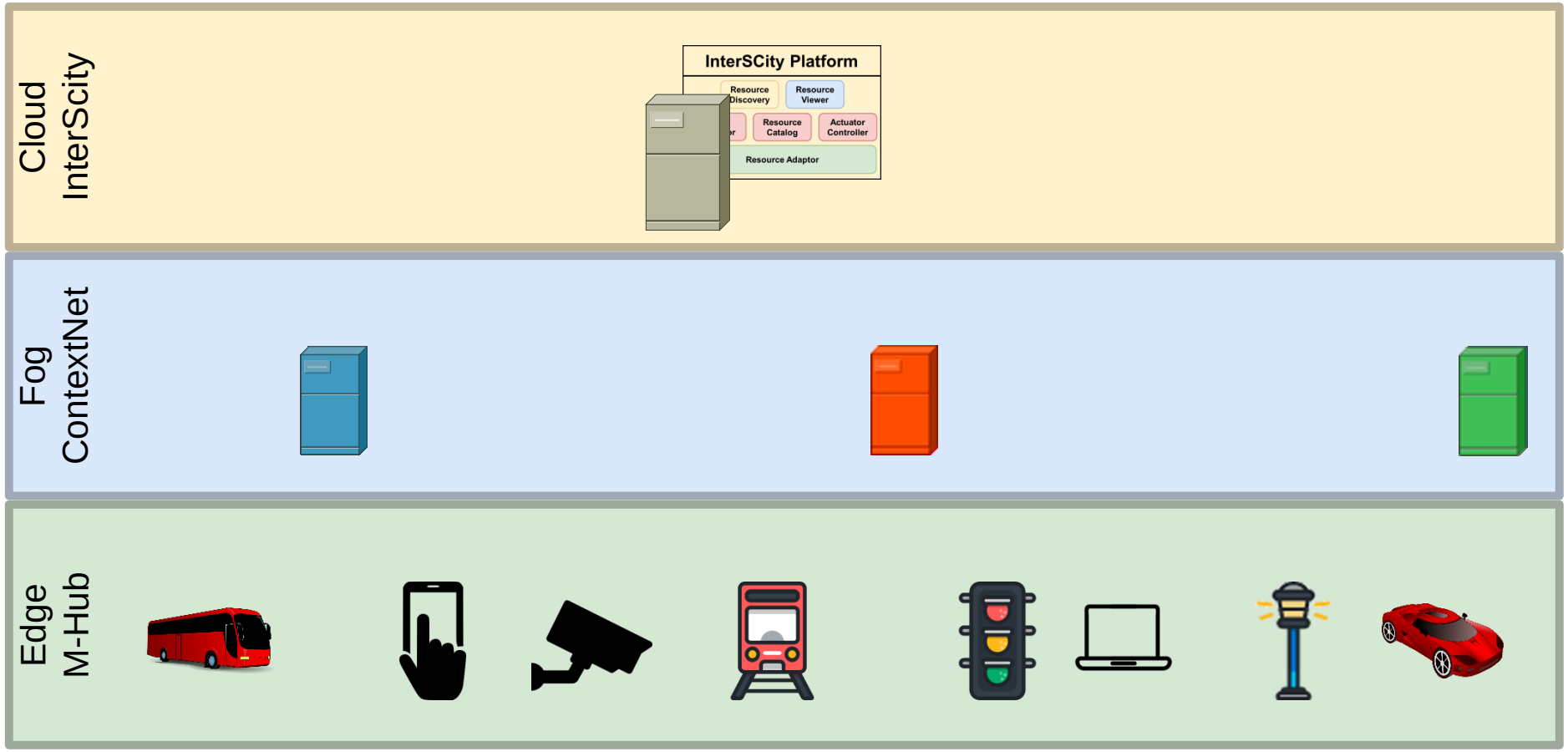
Deploying New Applications



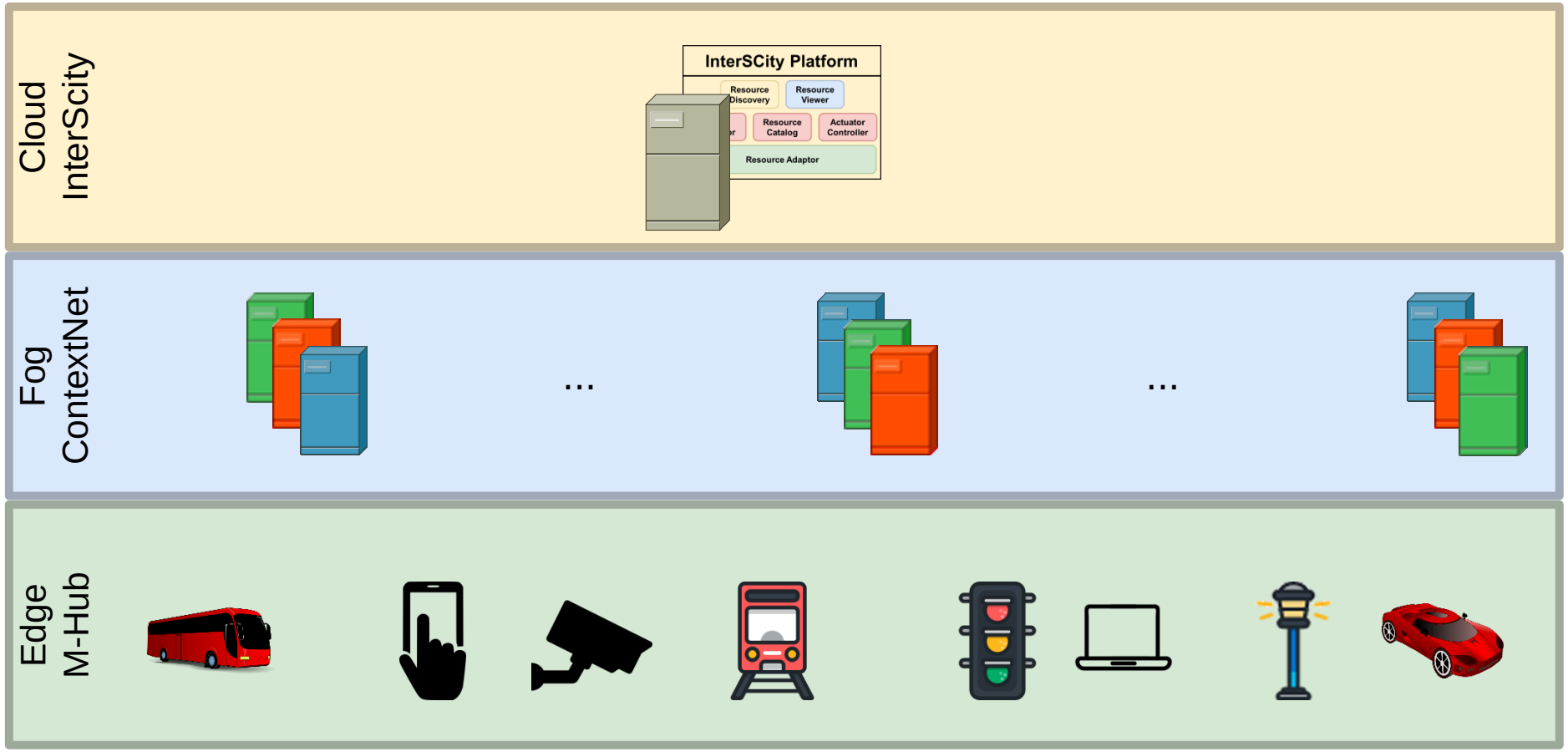
Deploying New Applications



Deploying New Applications



Deploying New Applications



Next steps

- Develop new applications based on data streams
  - Automatic license plate recognition
  - Face detection
  - Face recognition
- Test fault tolerance of each application
  - Drop a slice
  - Drop Internet connection


thank you
danke
謝謝
ngiyabonga
рахмат
teşekkür ederim
Баярлалаа
спасибо
mersi
kia ora
barka
welalin
tack
spas
faafetai lava
vinaka
blagodaram
dank je
misaotra
paldies
grazzi
mahalo
tapadh leat
спасибі
matondo
gracias
kiitos
dankie
nanni
nandri
dhanyavad
mauruuru
хвала
asante
manana
bedankt
hvala
köszönöm
dankon
aciu
obrigada
tenki
murakoze
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mercé
мерси
kam sah hamnida
rahmat
xièxie
তোমাকে ধন্যবাদ
감사합니다
merci

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