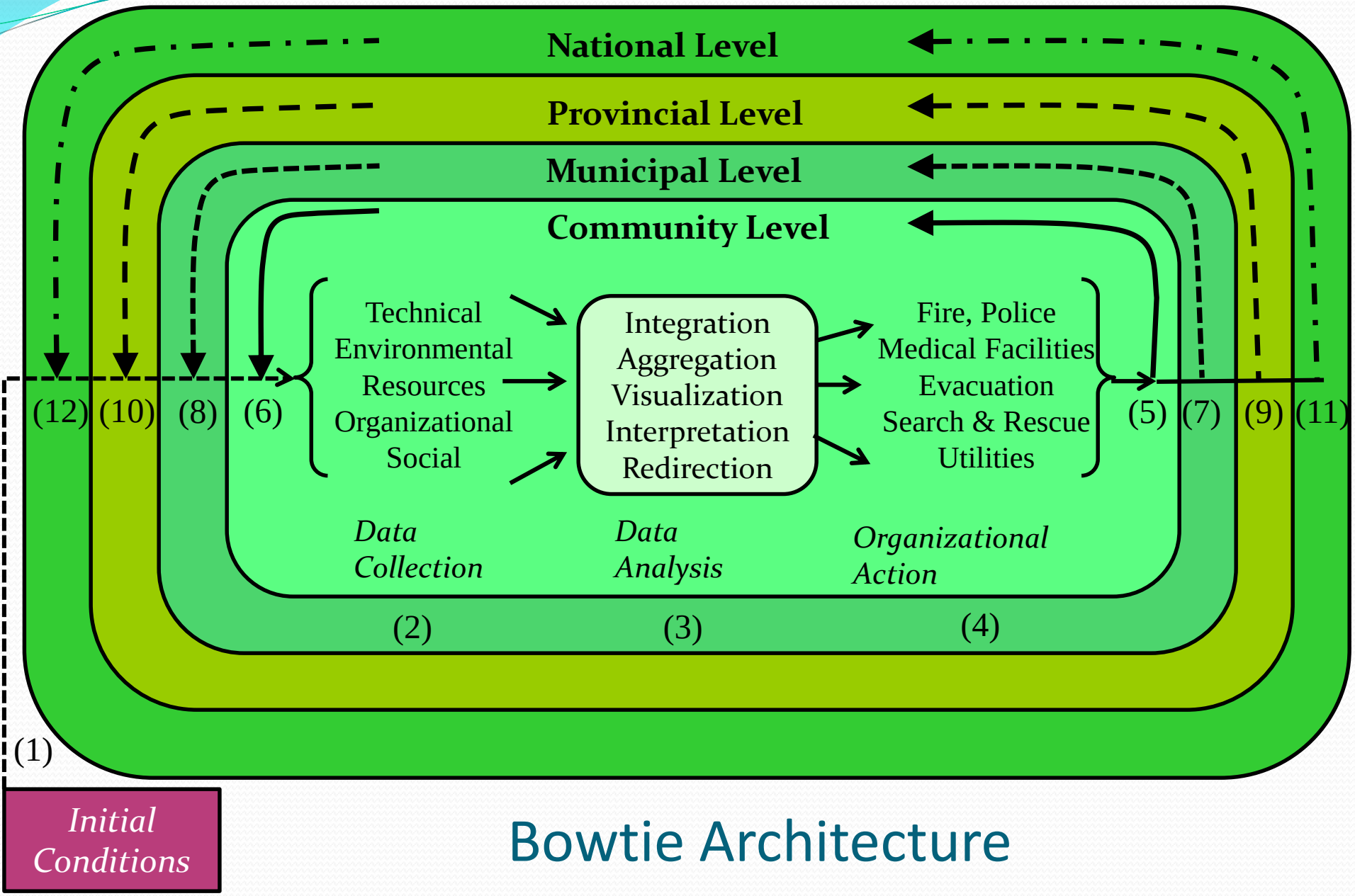
A Socially-Aware Infrastructure for Community Resilience

Dr. Taieb Znati
SEES Research Project
Computer Science Department
University of Pittsburgh

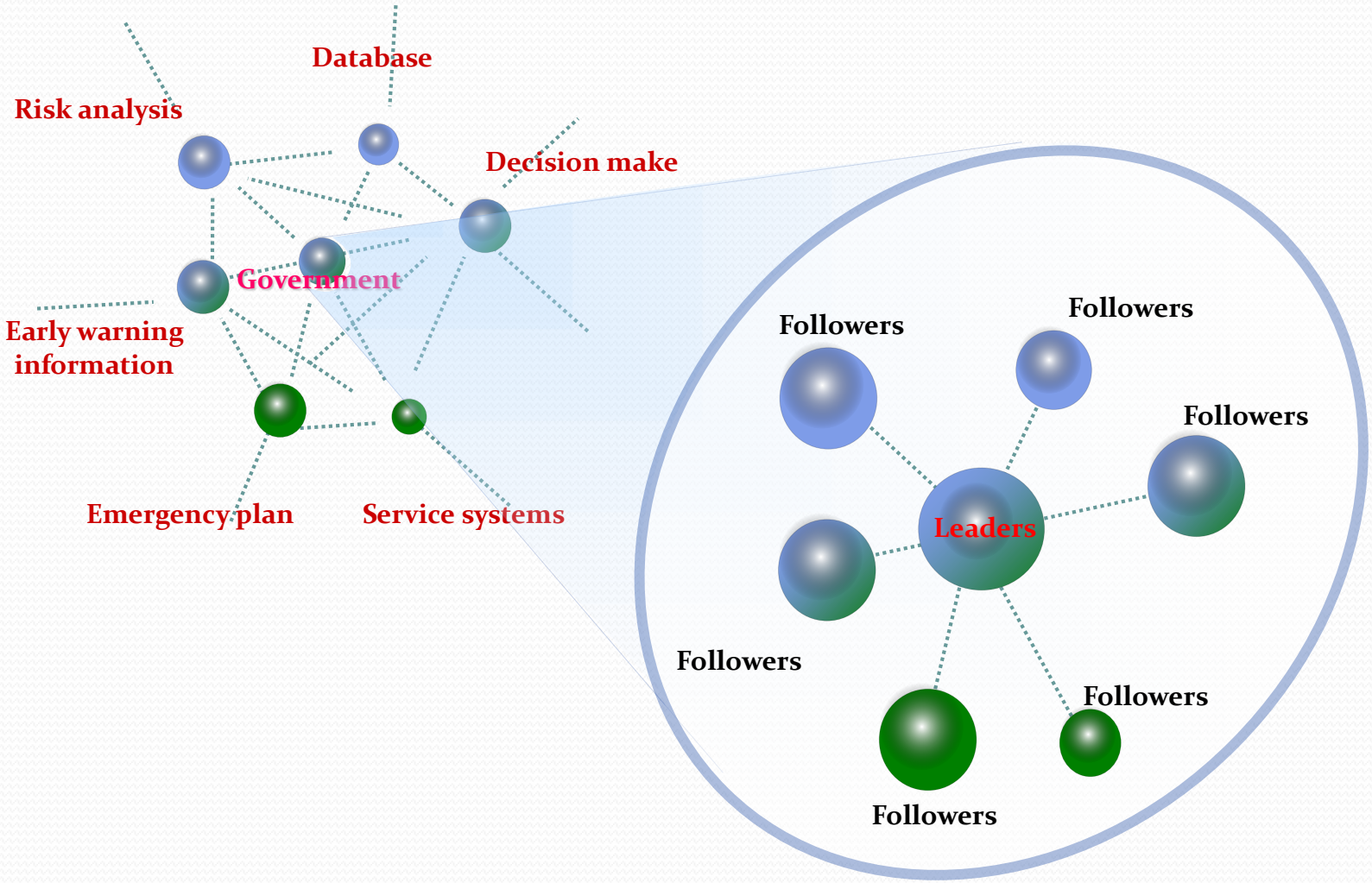
Tsunami Disaster

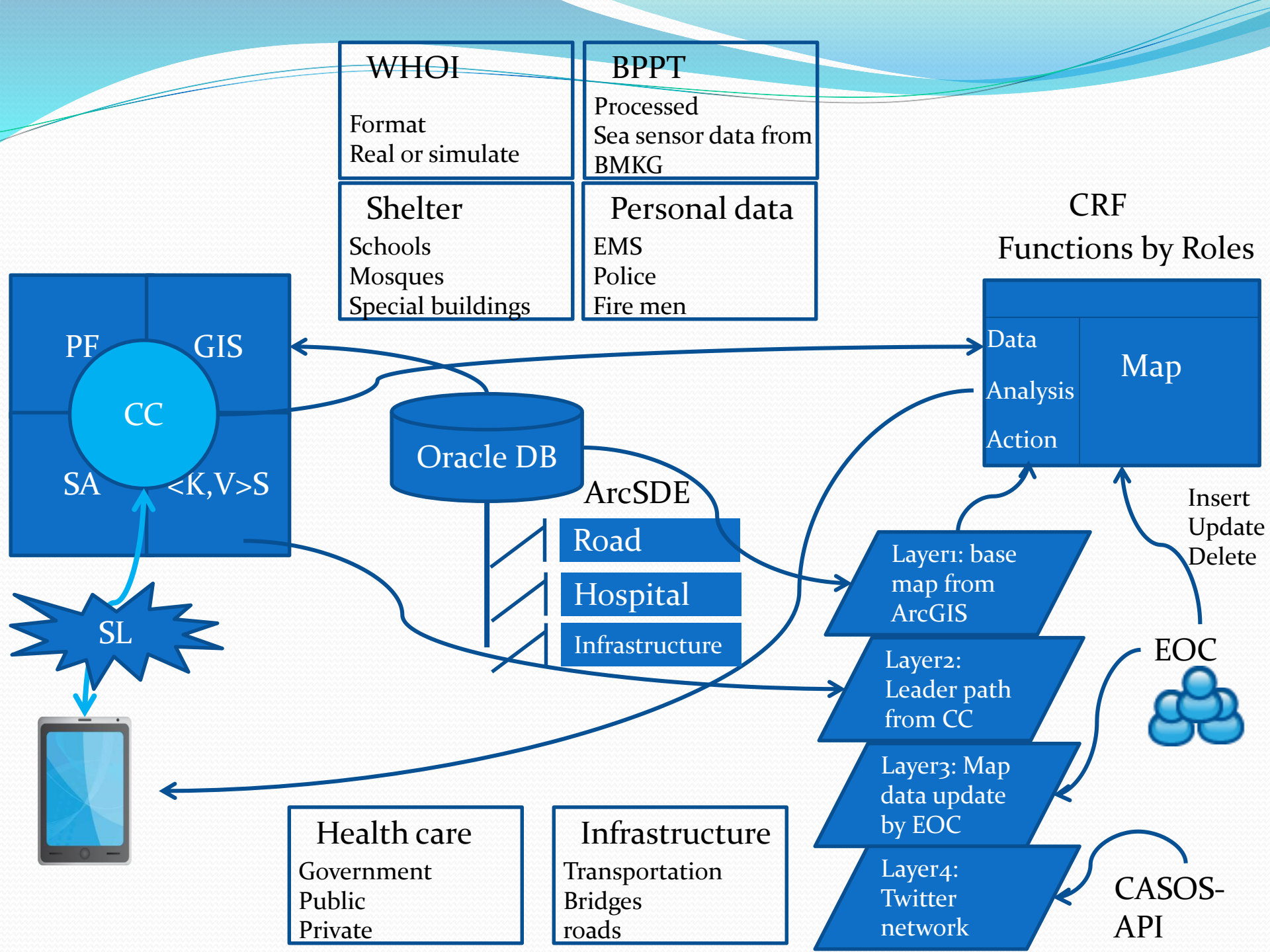
Theoretical Framework- organizational means

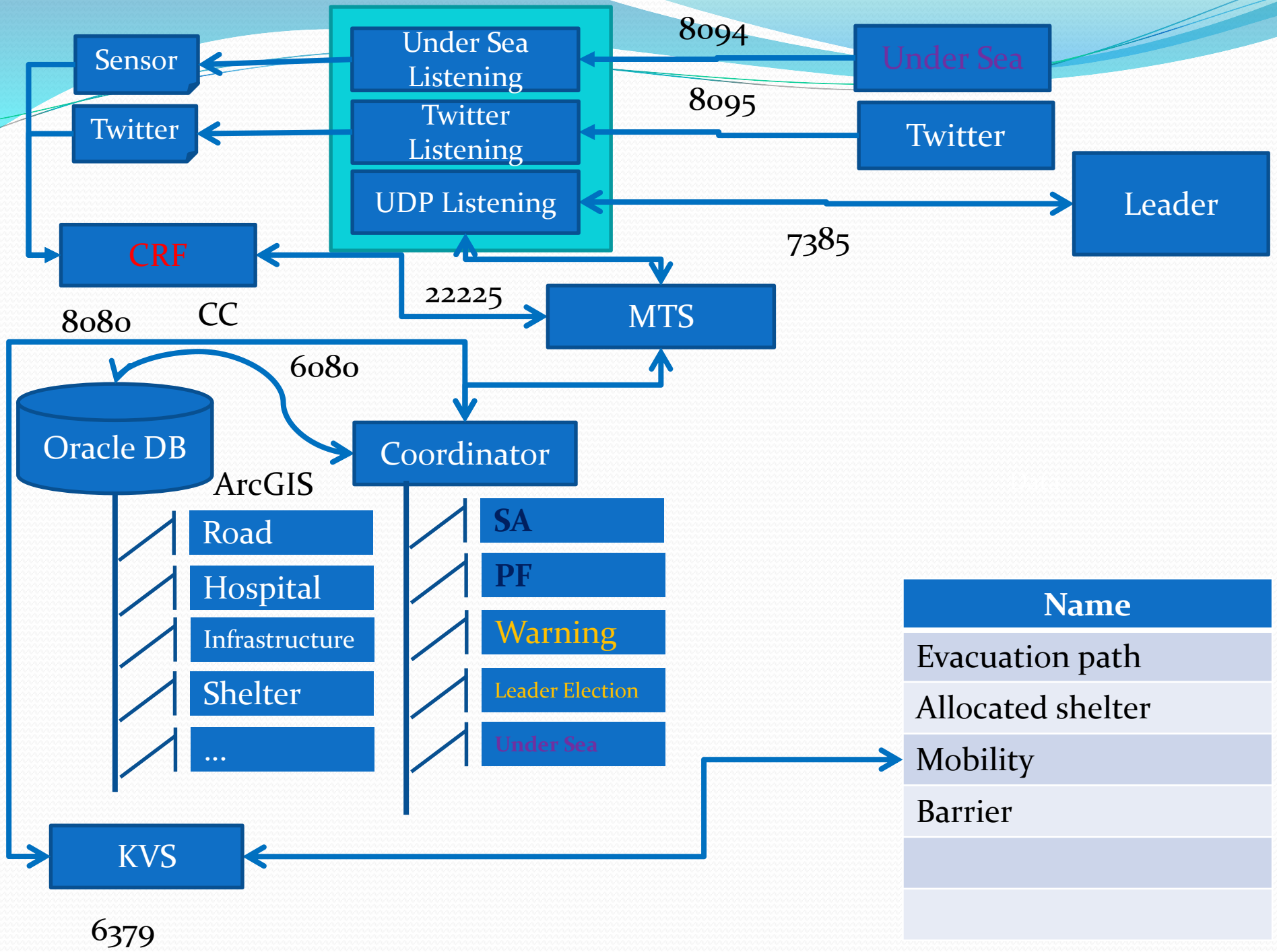


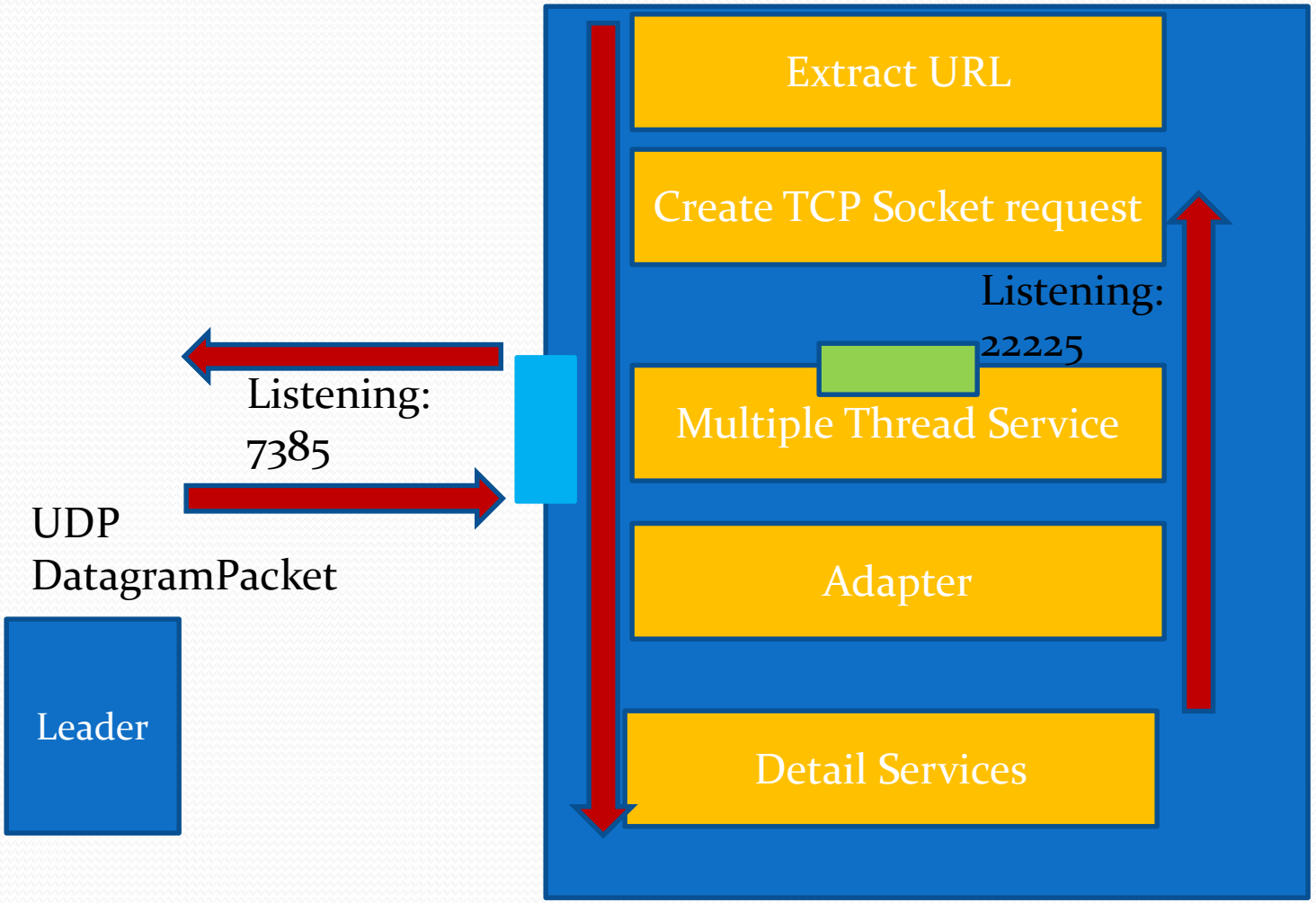
Bowtie Architecture

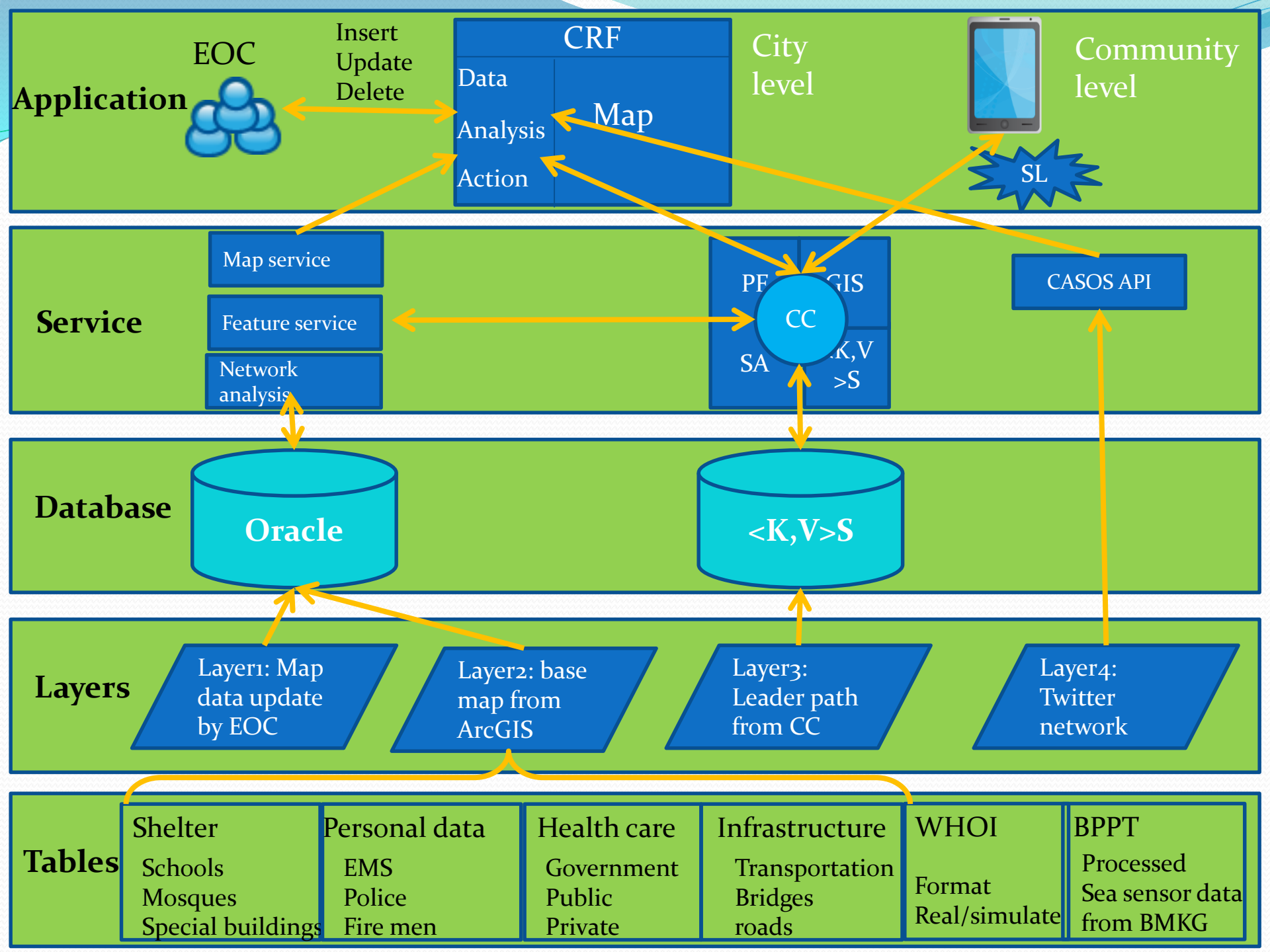
Socially-aware Structure for Resiliency




WHOI
Format
Real or simulate
BPPT
Processed
Sea sensor data from BMKG
Shelter
Schools
Mosques
Special buildings
Personal data
EMS
Police
Fire men
CRF
Functions by Roles
PF
GIS
CC
SA
<K,V>S
Oracle DB
ArcSDE
Road
Hospital
Infrastructure
Data
Analysis
Action
Map
Insert
Update
Delete
SL
Layer1: base map from ArcGIS
Layer2: Leader path from CC
Layer3: Map data update by EOC
Layer4: Twitter network
EOC
CASOS-API
Health care
Government
Public
Private
Infrastructure
Transportation
Bridges
roads

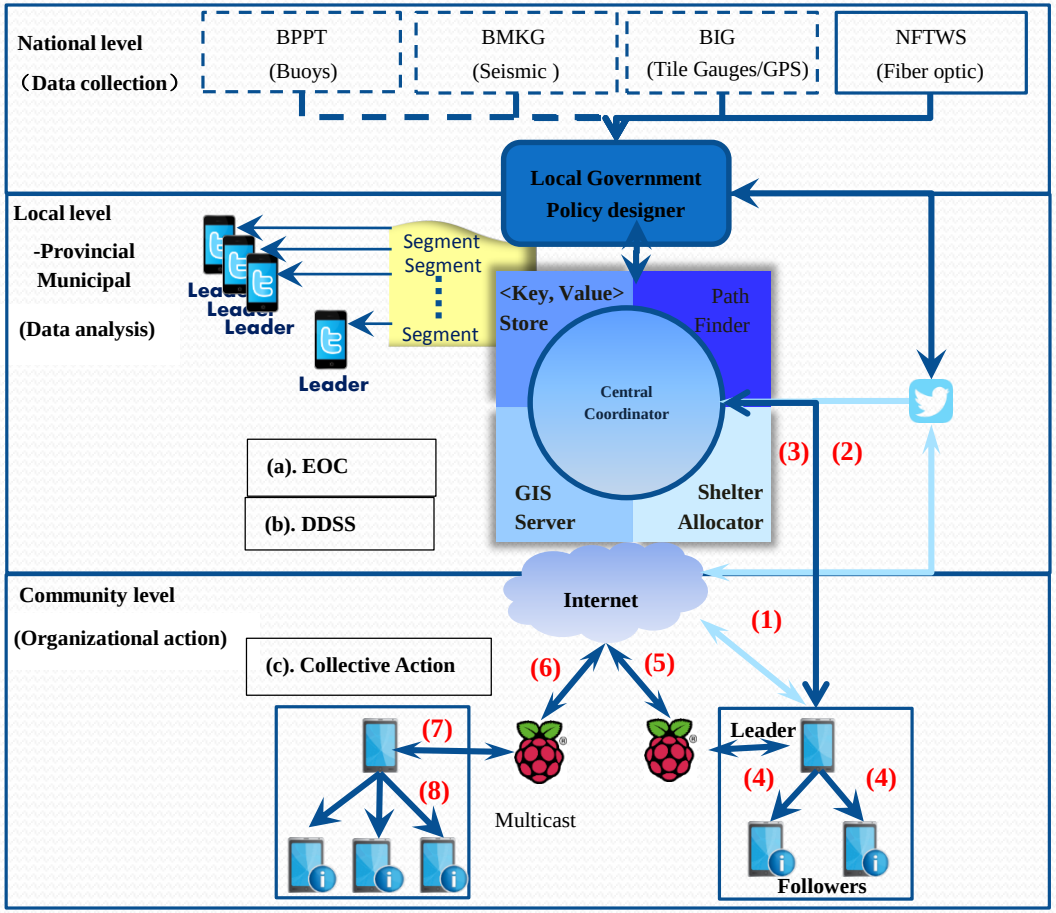

Sensor
Twitter
Under Sea Listening
Twitter Listening
UDP Listening
8094
8095
Under Sea
Twitter
Leader
7385
CRF
8080
CC
22225
MTS
6080
Oracle DB
Coordinator
ArcGIS
Road
Hospital
Infrastructure
Shelter
...
SA
PF
Warning
Leader Election
Under Sea
KVS
6379
Name
Evacuation path
Allocated shelter
Mobility
Barrier


Extract URL
Create TCP Socket request
Listening:
22225
Multiple Thread Service
Adapter
Detail Services
Listening:
7385
UDP
DatagramPacket
Leader


Application
EOC
Insert
Update
Delete
CRF
Data
Analysis
Action
Map
City level
Community level
SL
Service
Map service
Feature service
Network analysis
PF
GIS
CC
SA
K,V
>S
CASOS API
Database
Oracle
<K,V>S
Layers
Layer1: Map data update by EOC
Layer2: base map from ArcGIS
Layer3: Leader path from CC
Layer4: Twitter network
Tables
Shelter
Schools
Mosques
Special buildings
Personal data
EMS
Police
Fire men
Health care
Government
Public
Private
Infrastructure
Transportation
Bridges
roads
WHOI
Format
Real/simulate
BPPT
Processed
Sea sensor data
from BMKG

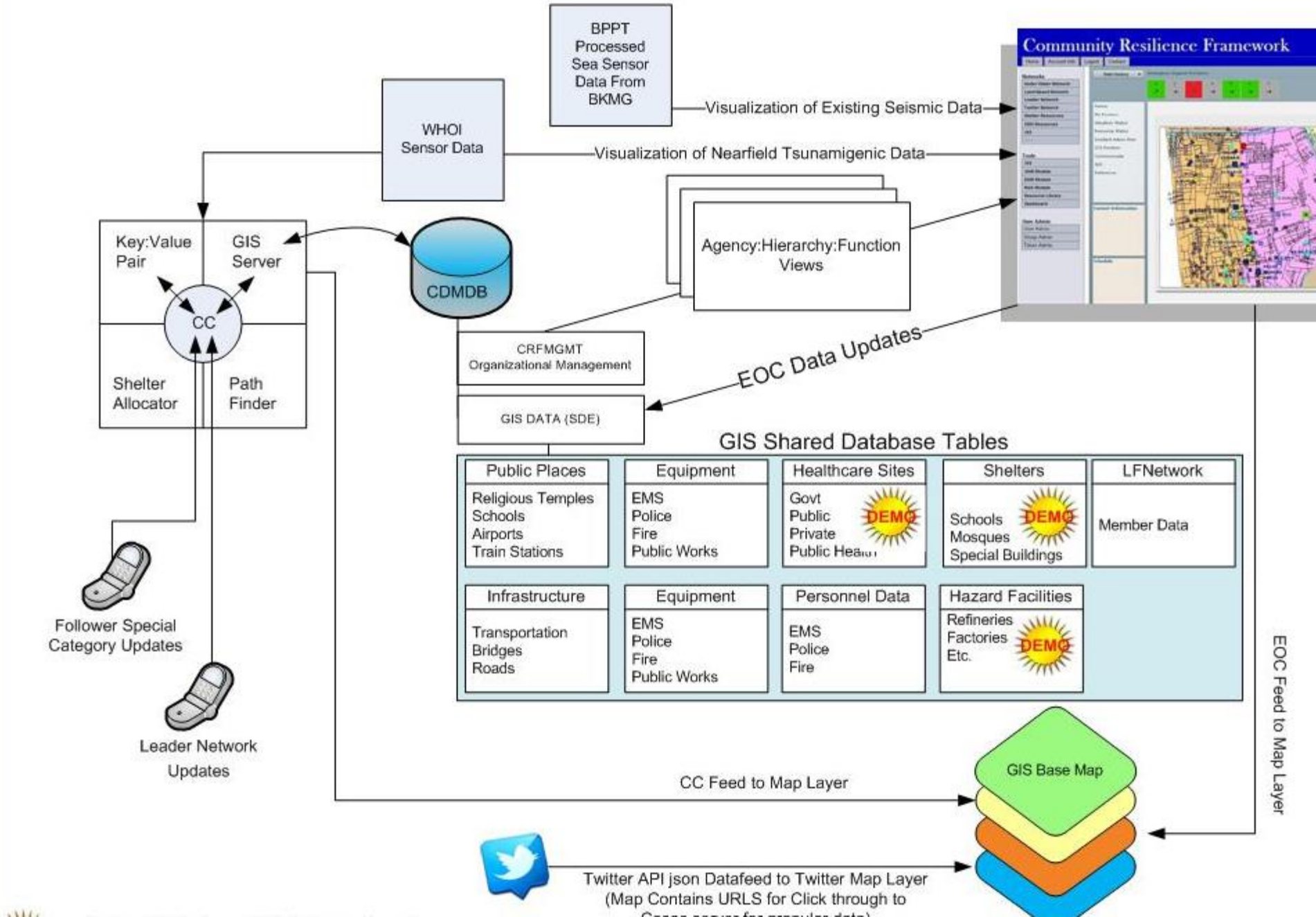
Architecture Model

- Technologies
  - GIS
  - Social media-Twitter
  - Raspberry PI based Opportunistic Routing network
- Inter-governments and actors
  - National--BMKG
  - Municipal- Emergency Manager
  - Community-Leader & Follower

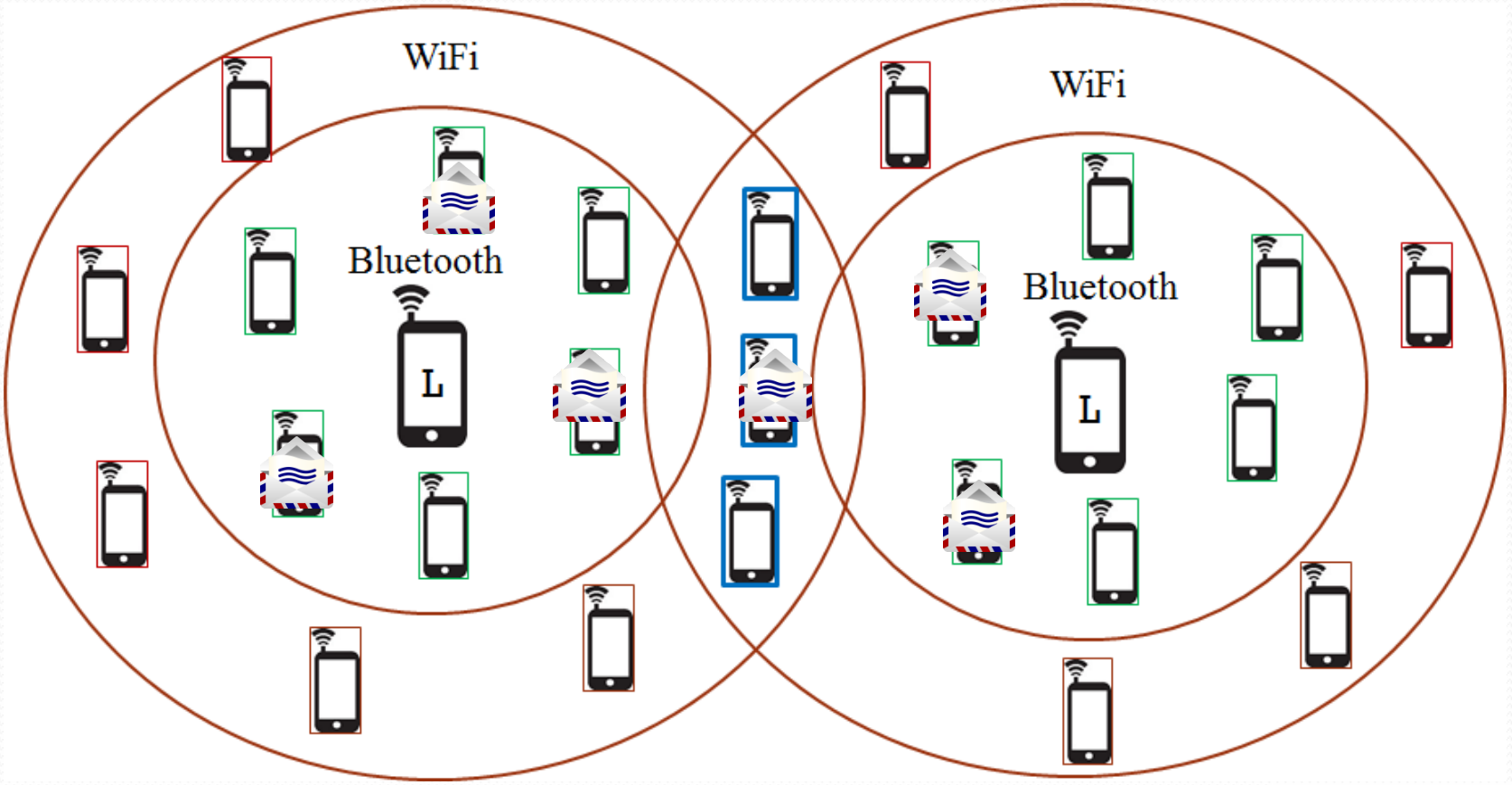


Information flow

Hazard SEES Data Flow – Leader Network and CRF



Information Dissemination

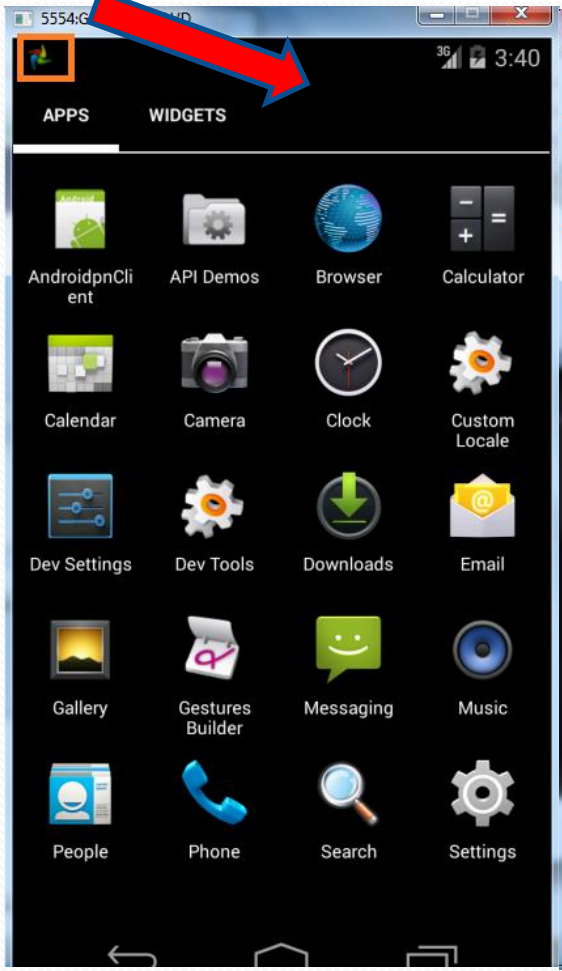


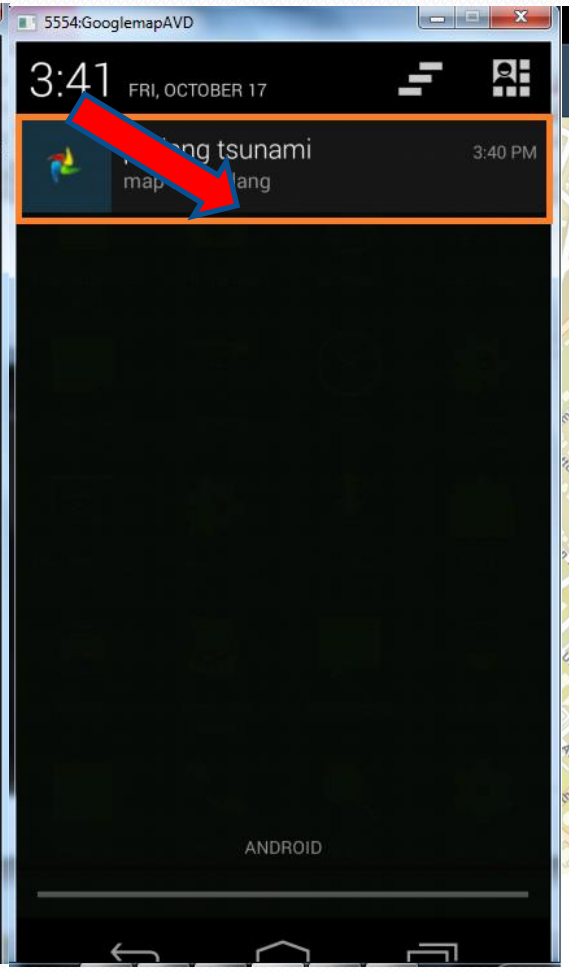
Raspberry PIs based OR network

Center for Disaster Management

University of Pittsburgh GSPIA

Tsunami Alert and Evacuation





Tasks-User/Group/Token Authority

- Groups
  - Super Admin
  - Admin
  - Regular organization user
- Access Types
  - Admin-management
  - Risk report-insert
  - Maps-view
  - Layers-View/edit
    - Third part data-twitter
    - Multiple levels data-national/provincial/city/district
  - Analysis-risk analysis/network analysis
    - Safety evacuation path/closest facilities
    - Risk community
  - Decision making
    - Send warning

Data collection

Lowest Jurisdictional Data ID	Entity category	Entity members	Source	Updated by
Region	Data Feed - Undersea Sensors	Sea Sensors	BKMG	Stream
Region	Data Feed - Land based Sensors	Seismic data	WHOI	Stream
City/Regency	Govt./Public Hospitals	Government Hospitals (beds, specialties, etc.)	HazardSEES Team	Simulator
City/Regency	Private Hospital	Private Hospitals (beds, specialties, etc.)	HazardSEES Team	Simulator
City/Regency	Infrastructure	Water, Electricity, Gas, Transportation, etc	Public/Private Orgs	Public/Private Orgs
City/Regency	Public Safety - Fire	Fire Apparatus and Personnel Data	HazardSEES Team	Simulator
District	Public Health Center	PH Centers (beds, specialties, etc.)	HazardSEES Team	Simulator
Sub District	Shelters	Schools, special buildings, mosques	HazardSEES Team	CC
Sub District	Public Safety - EMS	EMS Apparatus and Personnel Data	HazardSEES Team	Simulator
Sub District	Public Safety - Police	Police Vehicles and Personnel Data	HazardSEES Team	Simulator
Sub District	Data Feed - Twitter	Twitter feed of population density (1%)	Casos	API
SSD	Positions	Leaders and followers	CC	CC
SSD	Person Attribute	Attribute tables for leader special skillsets	HazardSEES Team	N/A
SSD	Person Attribute	Attribute tables for follower/leader special needs/conditions	HazardSEES Team	N/A

Multi-threaded Service Infrastructure

- Multiple threads services-deal with many tasks at the same time.
  - Export the multiple thread service java into one Jar file -- MultiThreadService.jar, and it could be run like ”java –jar MultiThreadService.jar”
- Dispatchers- distribute all requests to different services and send feedback response, write logs.
- Services
  - GIS services-map/feature/Network analysis
  - <K,V>S service-report/update/delete
  - Third parts services-CASOS Twitter, BPPT

Control Center

- Service
  - Information flow in Center Coordinator, PF, SA and GIS with MTS
  - Optimization of PF and SA
  - Notification/warning/alert from CC
  - <K,V>S modify-insert/update/delete—redis -server
- Data
  - Leader's evacuation path in <K,V>S

CRF – Control Center

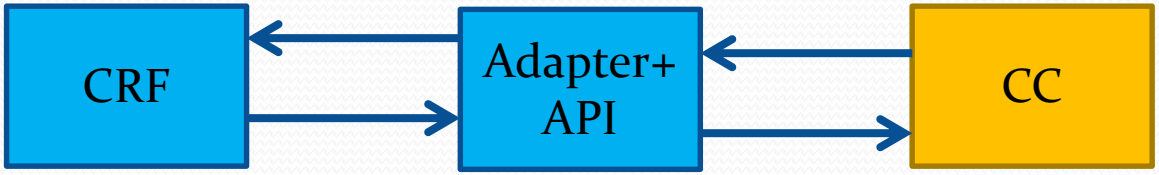
- Data
  - Visualization –map
  - Which layers show on left list.
- Analysis
  - Integrate policy design
- Actions
  - Different departments have different operations， based on the multiple levels of departments-national, provincial, municipal, community.
  - Dynamic data create/update/delete simulation-shelter attributes, hospital condition. Info from WHOI, BPPT and other departments.
  - Cooperation, coordination, control

Community communication

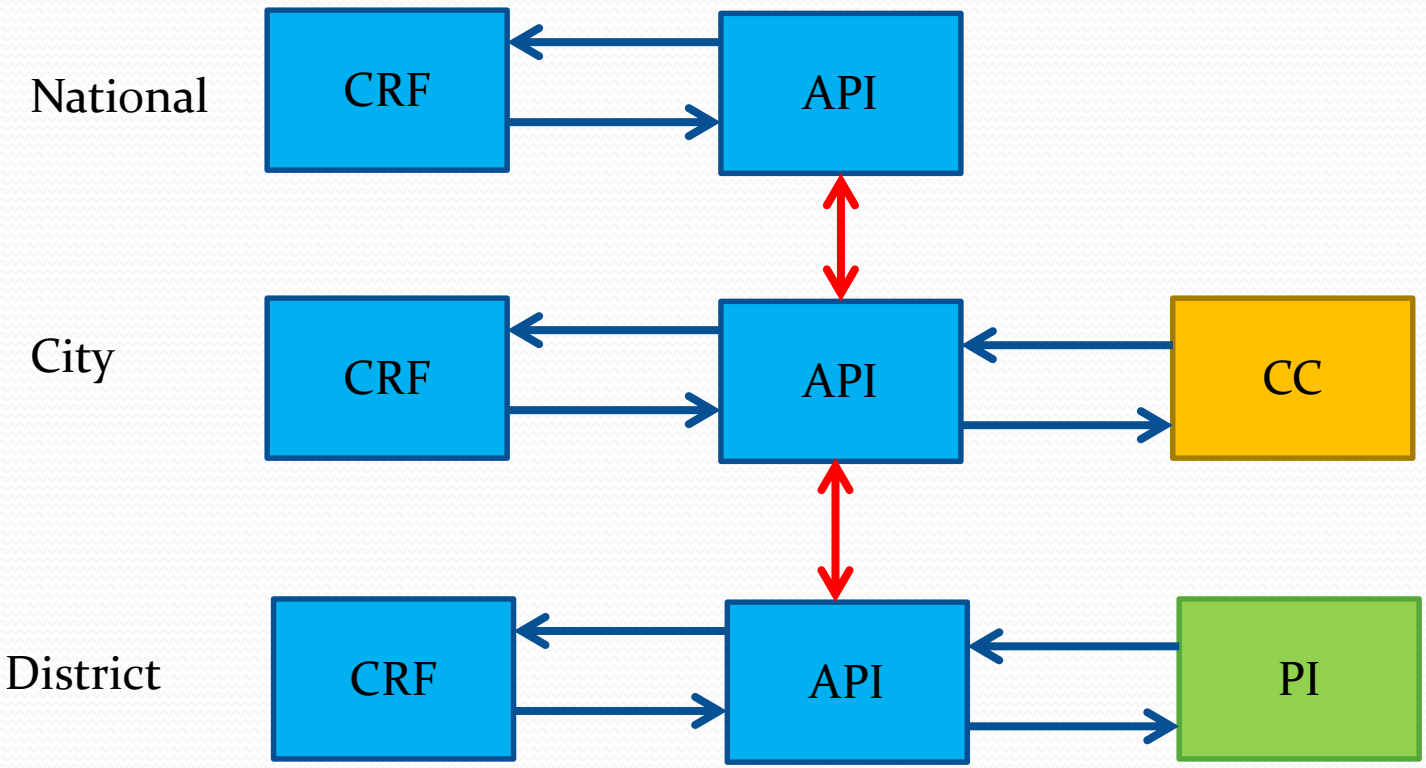
- Data
  - Multiple actors could report risk
  - Information format when info flow
- Analysis
  - Offline network analysis
- Actions
  - Leader broadcast evacuation path to his followers
  - Follower report risk to his leader
  - Leader double check follower's risk report, and report to EOC

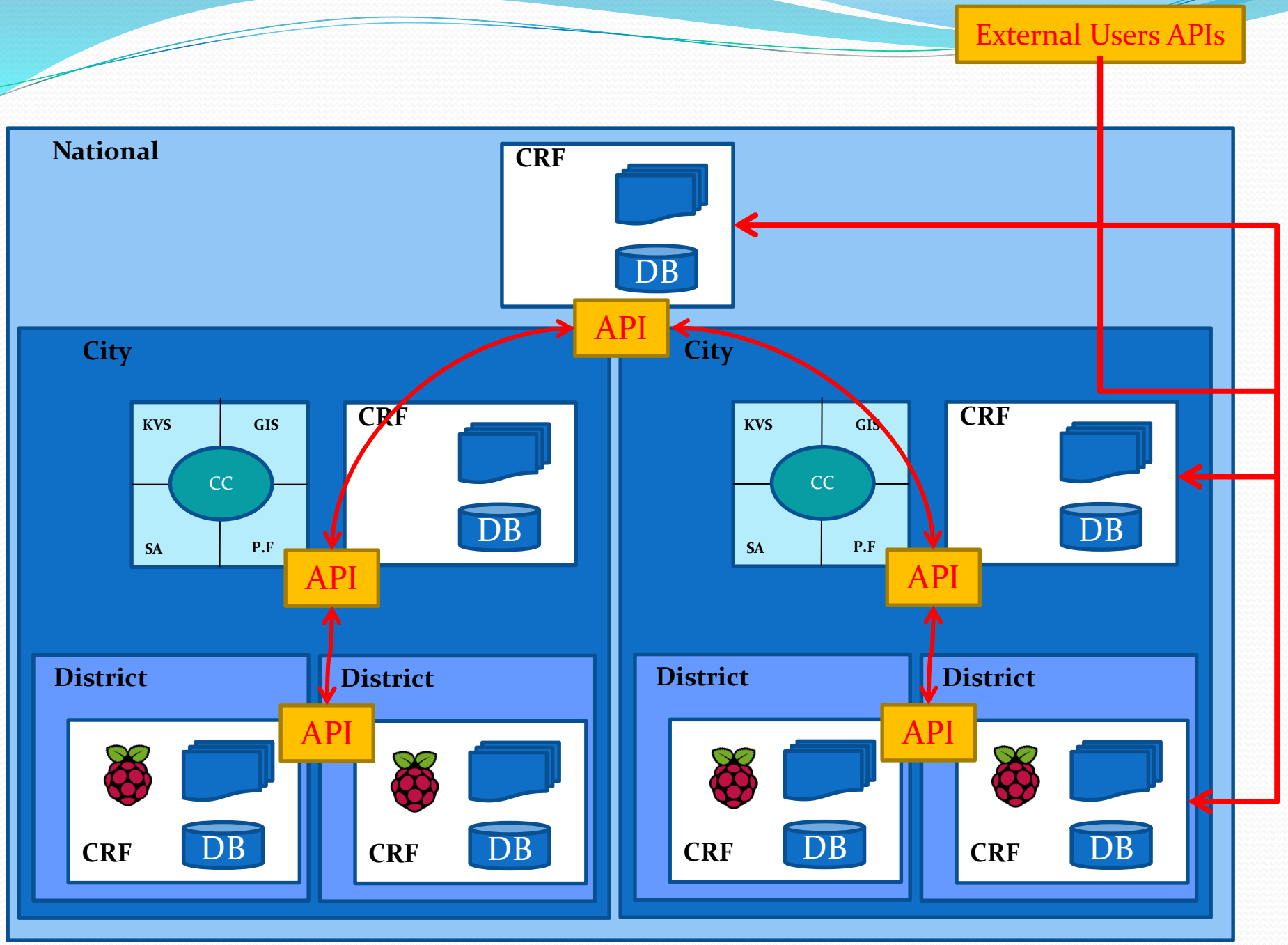
CC-CRF communication

- CRF+ Adapter in the same Server, CC in another Server
- Adapter setting web.xml to access any other service
- CRF Javascript send XMLHttpRequest to Adapter, Adapter redirect the request to target service, like CC, return response to CRF

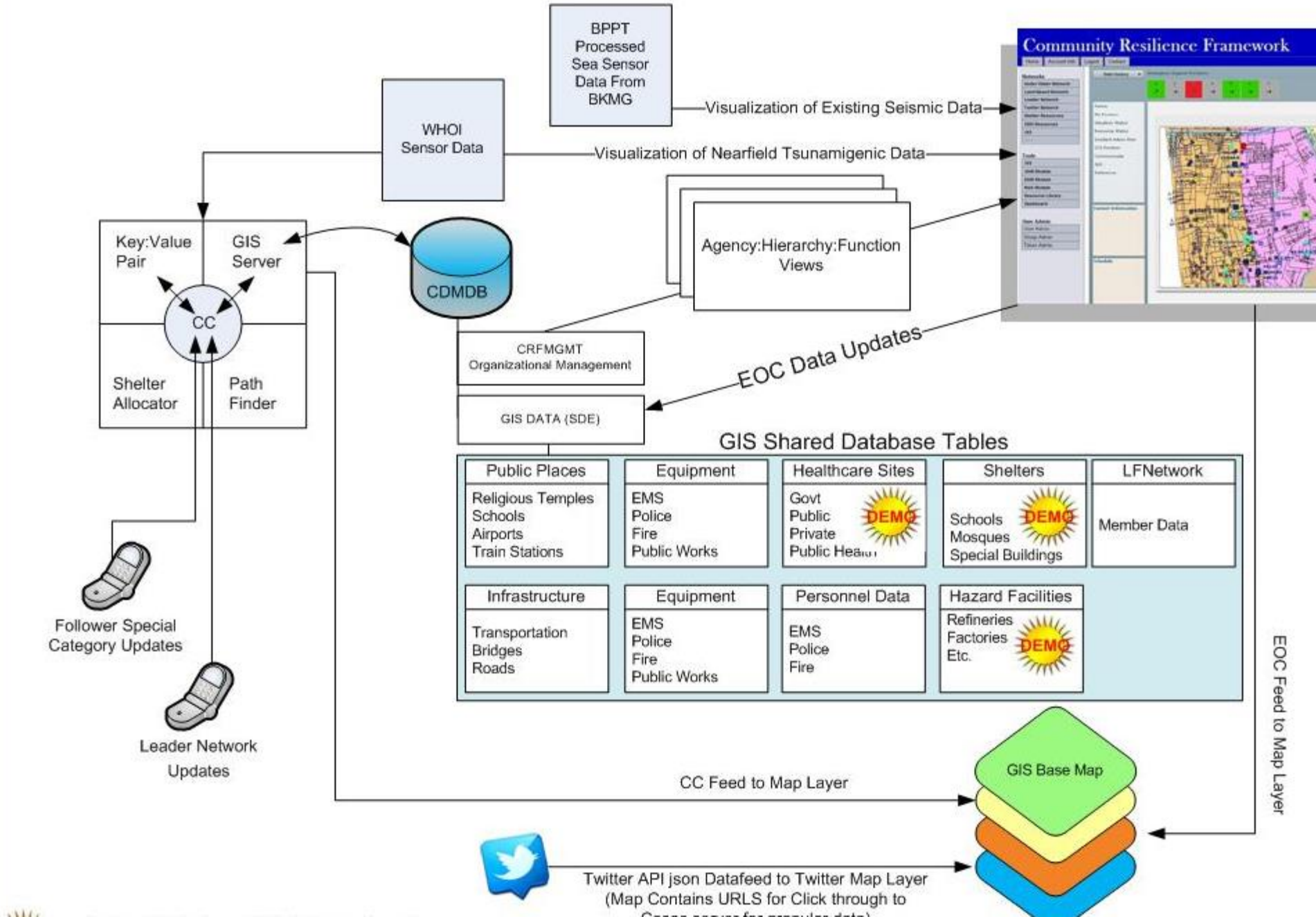


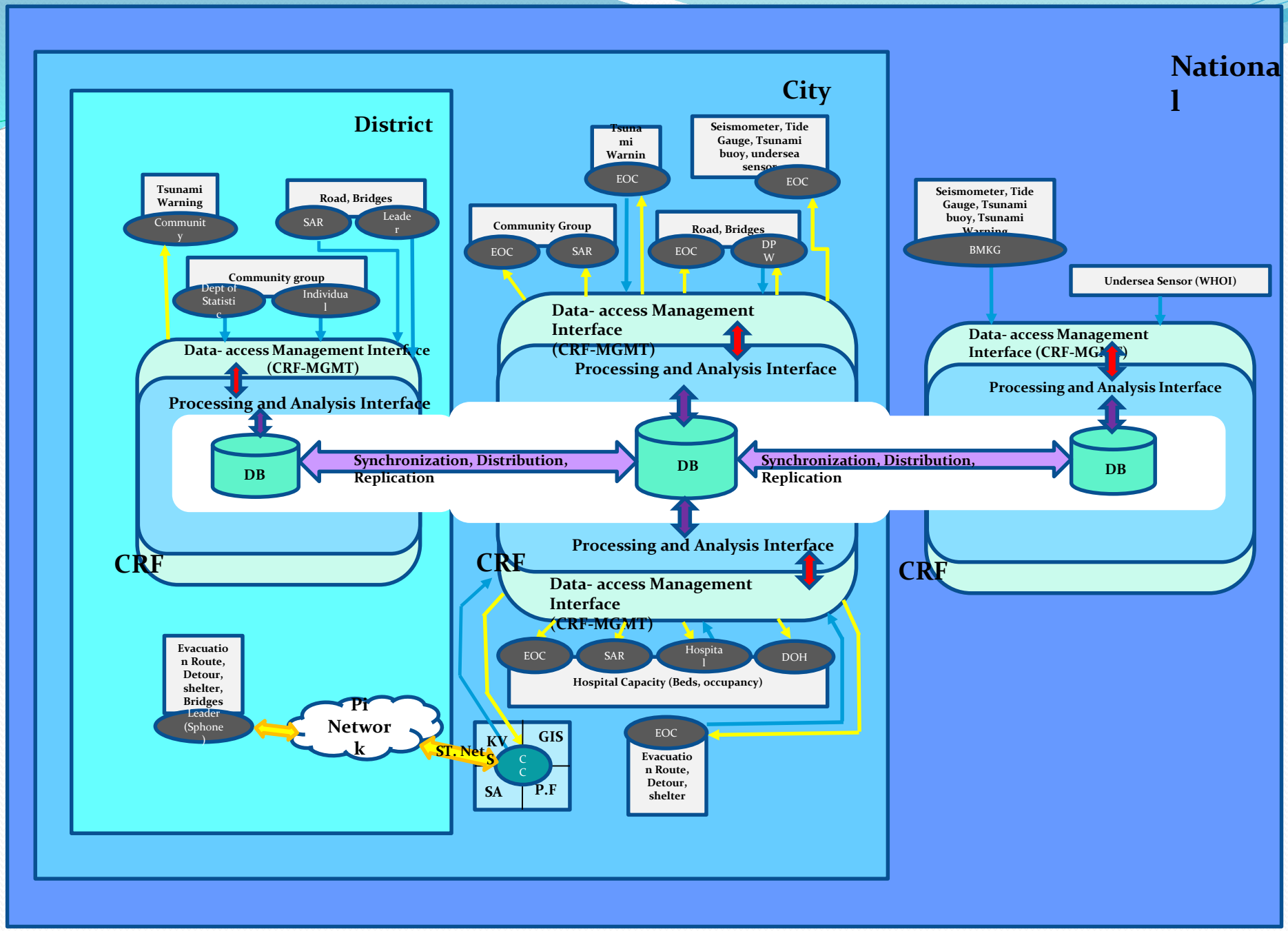
Tasks – Multiple levels communication

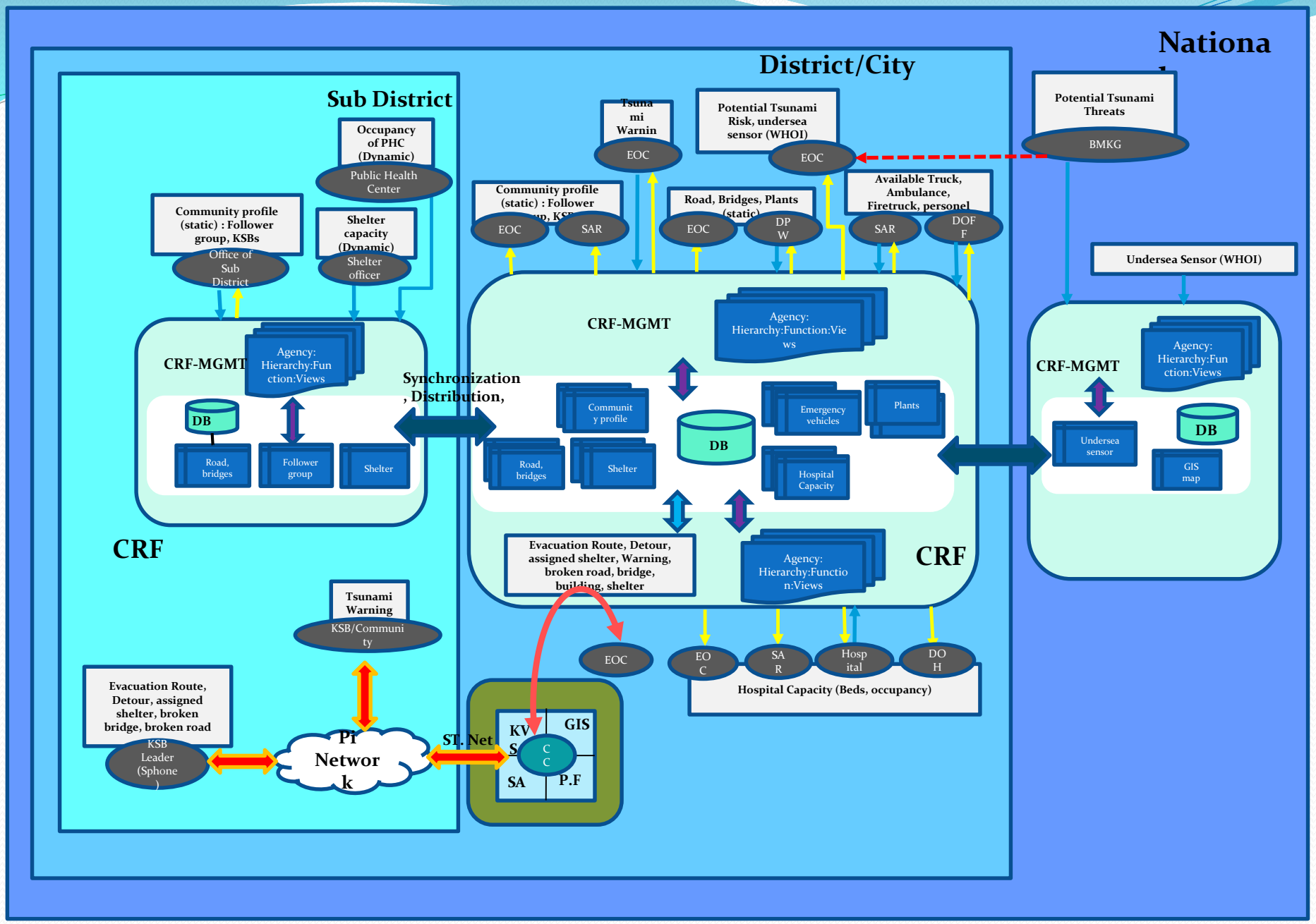



External Users APIs
National
CRF
DB
API
City
KVS
GIS
CC
SA
P.F
CRF
DB
API
City
KVS
GIS
CC
SA
P.F
CRF
DB
API
District
District
API
CRF
DB
CRF
DB
District
District
API
CRF
DB
CRF
DB

Hazard SEES Data Flow – Leader Network and CRF




National
City
District
Tsunami Warning
Community
Road, Bridges
SAR
Leader
Community group
Dept of Statistic
Individual
Data- access Management Interface (CRF-MGMT)
Processing and Analysis Interface
DB
CRF
Tsunami Warnin
EOC
Seismometer, Tide Gauge, Tsunami buoy, undersea sensor
EOC
Community Group
EOC
SAR
Road, Bridges
EOC
DPW
Data- access Management Interface (CRF-MGMT)
Processing and Analysis Interface
DB
Synchronization, Distribution, Replication
Processing and Analysis Interface
Data- access Management Interface (CRF-MGMT)
CRF
EOC
SAR
Hospital
DOH
Hospital Capacity (Beds, occupancy)
Seismometer, Tide Gauge, Tsunami buoy, Tsunami Warning
BMKG
Undersea Sensor (WHOI)
Data- access Management Interface (CRF-MGMT)
Processing and Analysis Interface
DB
Synchronization, Distribution, Replication
CRF
Evacuation Route, Detour, shelter, Bridges
Leader (Sphone)
PT Network
ST. Net S
KV
GIS
CC
SA
P.F
EOC
Evacuation Route, Detour, shelter


Nationa
District/City
Sub District
Occupancy of PHC (Dynamic)
Public Health Center
Community profile (static) : Follower group, KSBs
Office of Sub District
Shelter capacity (Dynamic)
Shelter officer
CRF-MGMT
Agency: Hierarchy:Function:Views
DB
Road, bridges
Follower group
Shelter
CRF
Synchronization , Distribution,
Tsuna mi Warnin
EOC
Potential Tsunami Risk, undersea sensor (WHOI)
EOC
Potential Tsunami Threats
BMKG
Community profile (static) : Follower
EOC
SAR
Road, Bridges, Plants (static)
EOC
DP W
Available Truck, Ambulance, Firetruck, personel
SAR
DOF F
Undersea Sensor (WHOI)
CRF-MGMT
Agency: Hierarchy:Function:Views
Communit y profile
Road, bridges
Shelter
DB
Emergency vehicles
Plants
Hospital Capacity
Evacuation Route, Detour, assigned shelter, Warning, broken road, bridge, building, shelter
Agency: Hierarchy:Functio n:Views
CRF
CRF-MGMT
Agency: Hierarchy:Fun ction:Views
Undersea sensor
DB
GIS map
Tsunami Warning
KSB/Communi ty
EOC
EO C
SA R
Hosp ital
DO H
Hospital Capacity (Beds, occupancy)
Evacuation Route, Detour, assigned shelter, broken bridge, broken road
KSB Leader (Sphone)
Pi Networ k
ST. Net
KV S
GIS
C C
SA
P.F

Android studio+ arcgis android 10.2.7

- https://developer.android.com/sdk/installing/index.html?pkg=studio