



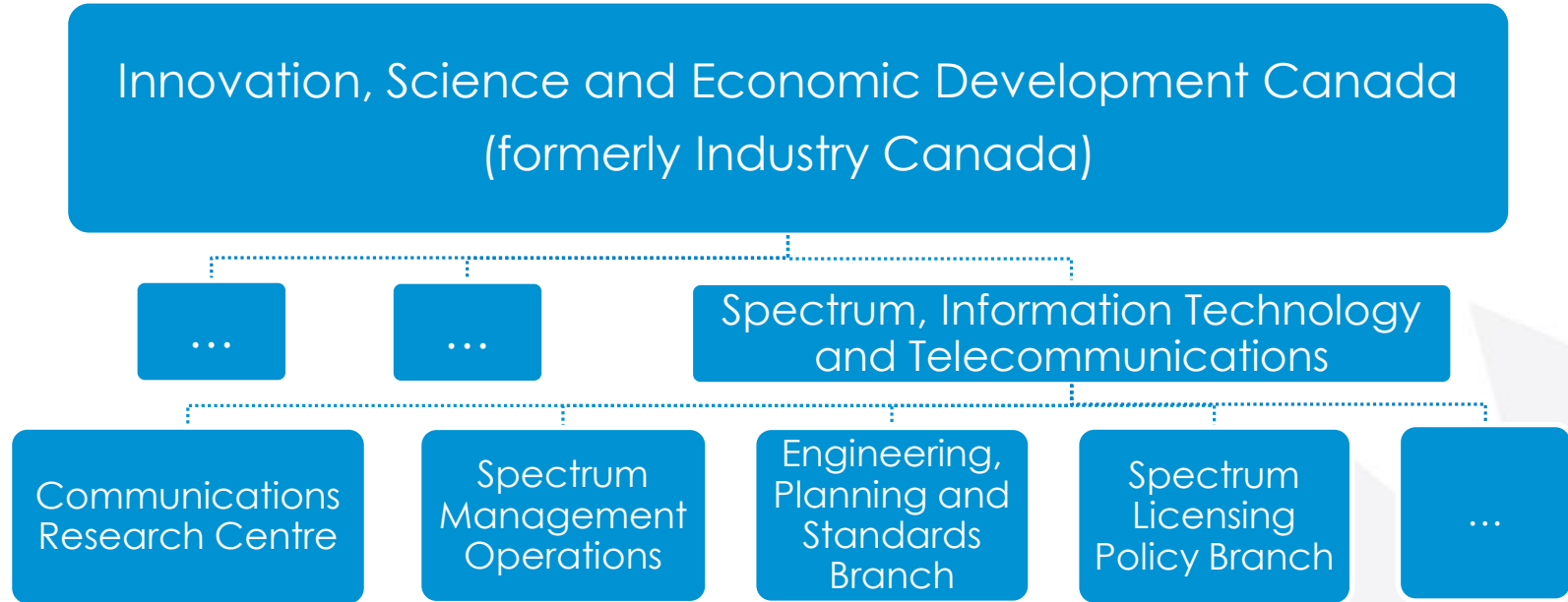
# Spectrum Environment Awareness (SEA) System Innovative Spectrum Monitoring Solution

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## August 2, 2016

Source: Communications Research Centre Canada

# Organisational chart



# Background - Monitoring

- Pre-1990: Manual operation using receivers and handheld direction finding equipment
- >1990: radio spectrum getting more congested, interference cases more frequent and complex
- Creation of Integrated Spectrum Observation Centres (ISOC)

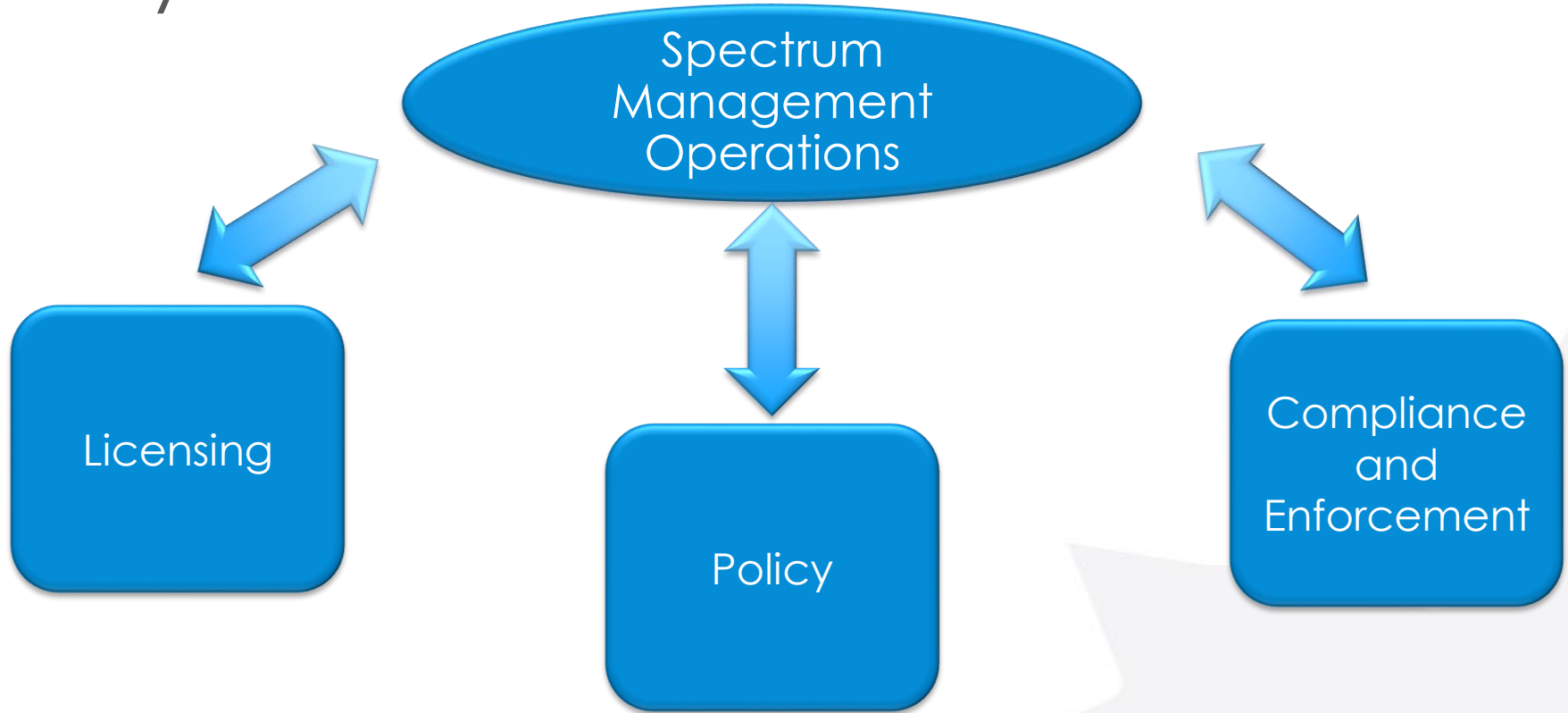


# Current Monitoring Infrastructure

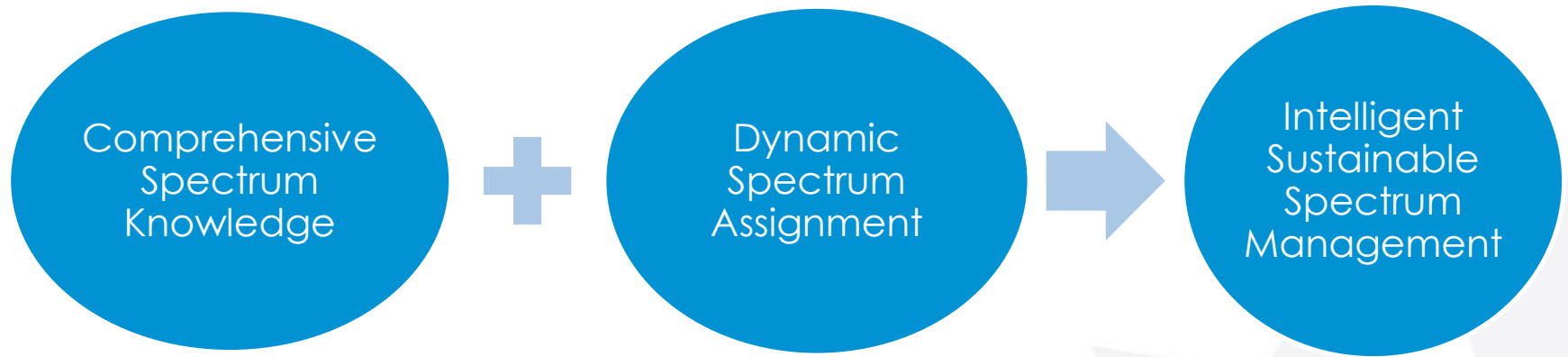
- Infrastructure
  - 80 Fixed monitoring sites (ISOC)
  - 50 mobile monitoring vehicles
  - 8 monitoring trailers
  - 2 specialty vehicles



# Why Monitor ?

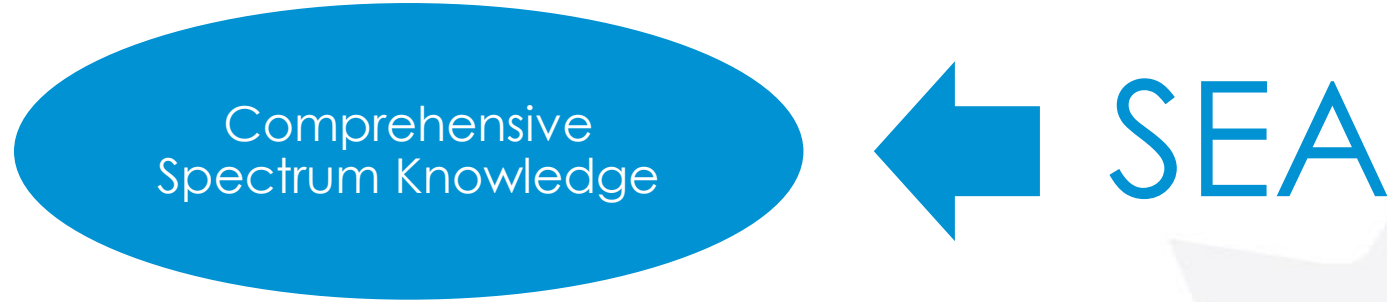


# Our Vision as a Canadian Regulator



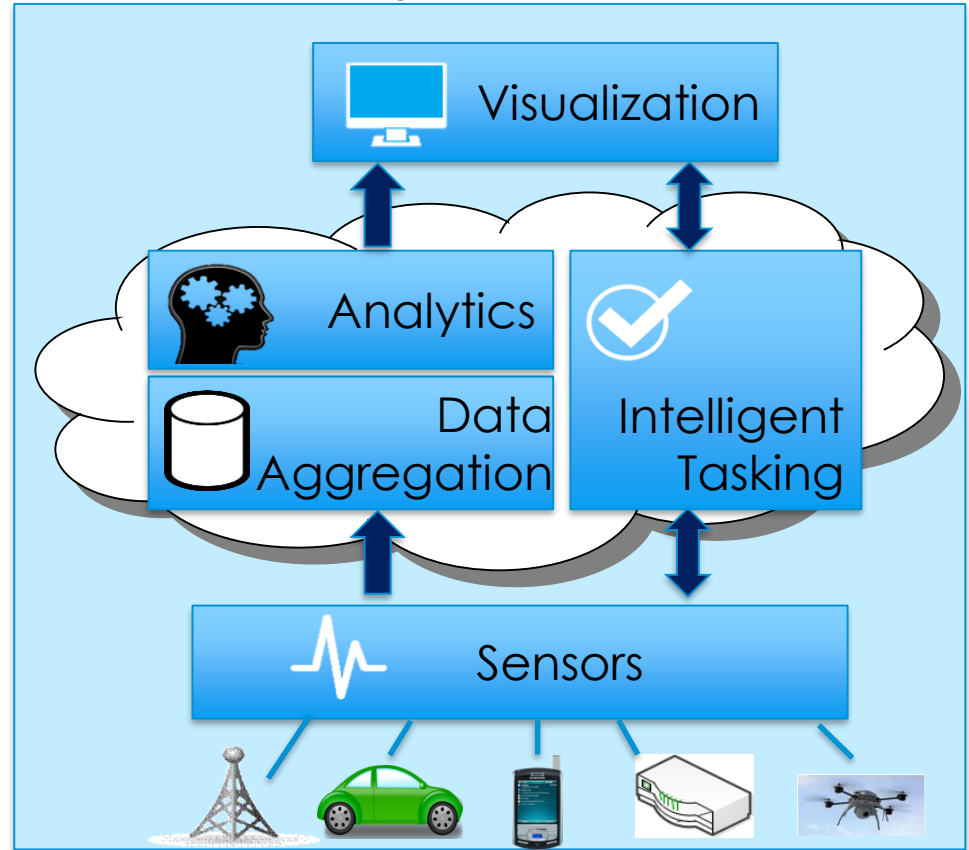
# Spectrum Environment Awareness (SEA)

- Using spectrum knowledge to enable more effective management and to maximize the use of spectrum



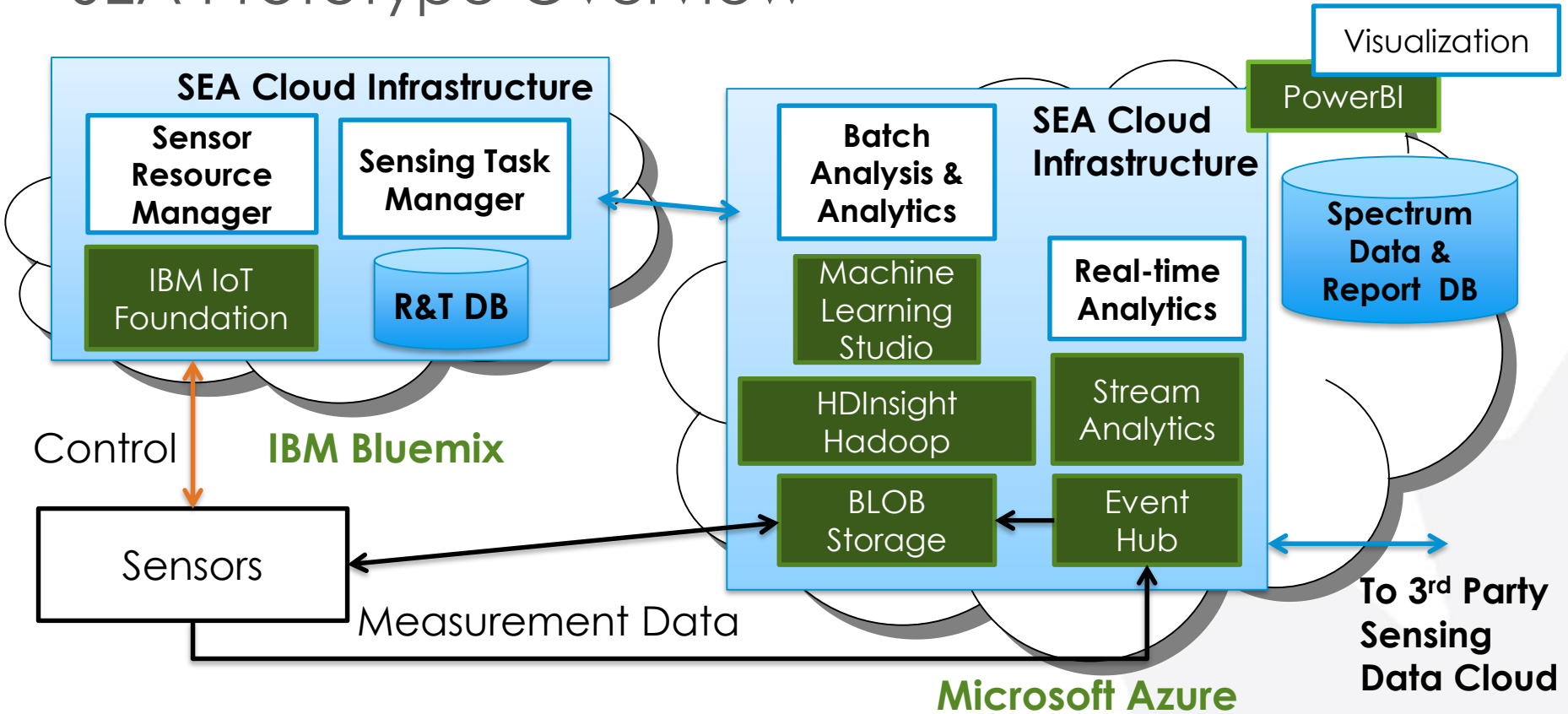
# SEA System and Functional Concept

- *Reporting right information at right time*
- *Scalable & cost effective big data analysis architecture*
- *Heterogeneous & expandable smart sensing system*





# SEA Prototype Overview



# Sensors in The Prototype

- *Spectrum coverage*
  - From 70 MHz to 6GHz, LMR, LTE, WiFi
- *In-house, COTS, 3rd party collaboration*
  - CRC USRP, Rohde & Schwarz, Cognitive System Ltd.
- *The new and the legacy, the stationary and the mobile sensors*
  - Stationary sensors in buildings, houses and mobile sensors in taxis
  - Department's legacy LMR sensing stations



Low Cost Spectrum Scanner



WiFi Sniffer



Amera Sensor Cloud



Dedicated LTE Sensor R & S

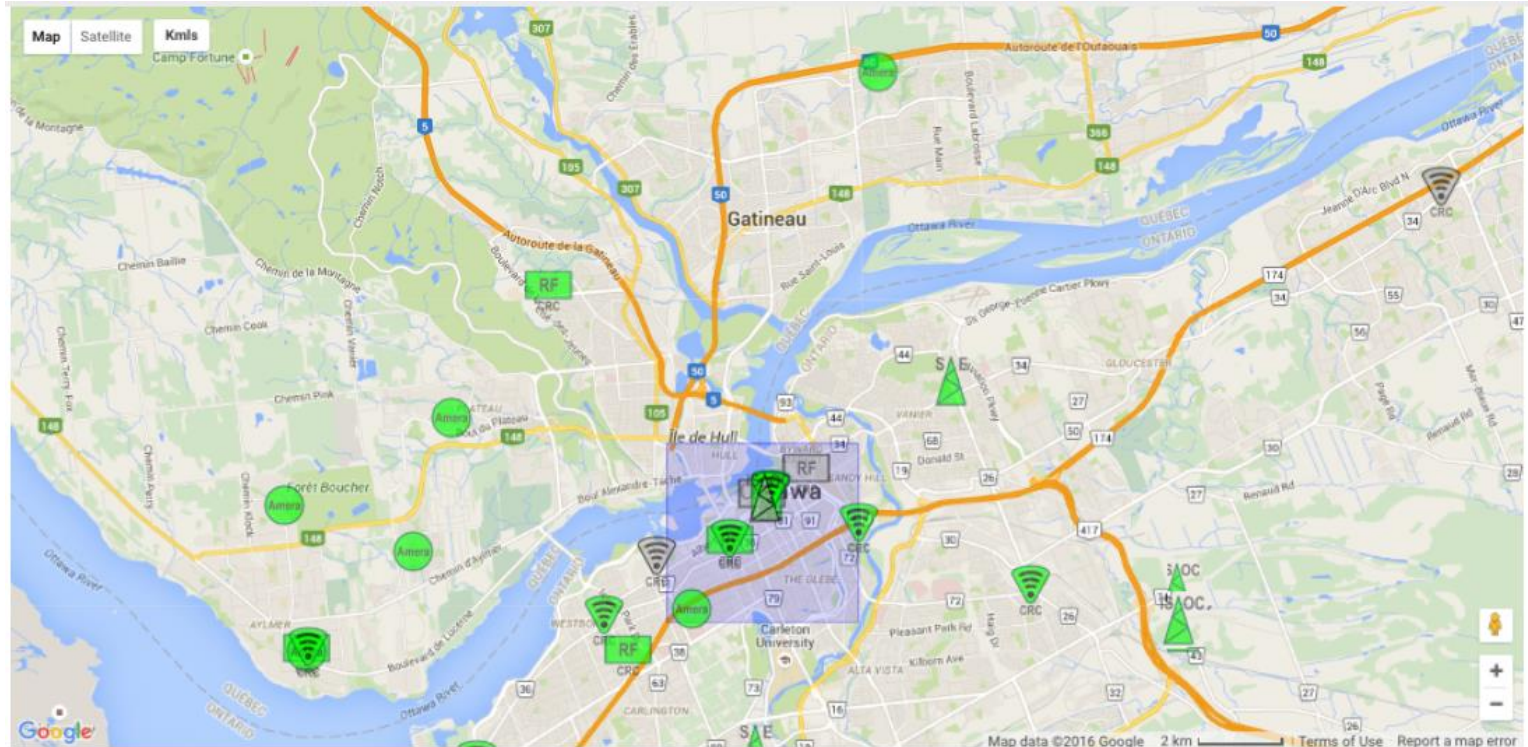


Spectrum Explorer



Crowdsourcing App

# Sensing & Tasking



Count

87

LMR

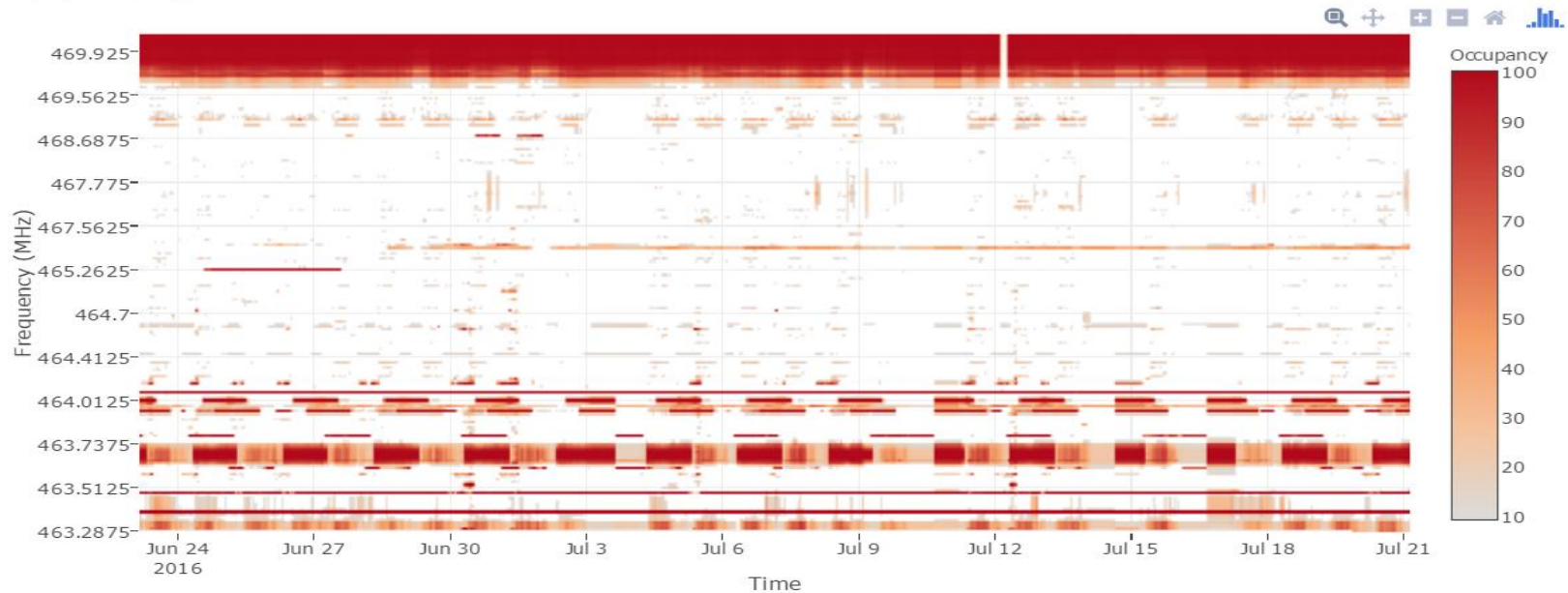
LTE

WiFi



☐ Auto-Refresh (off)

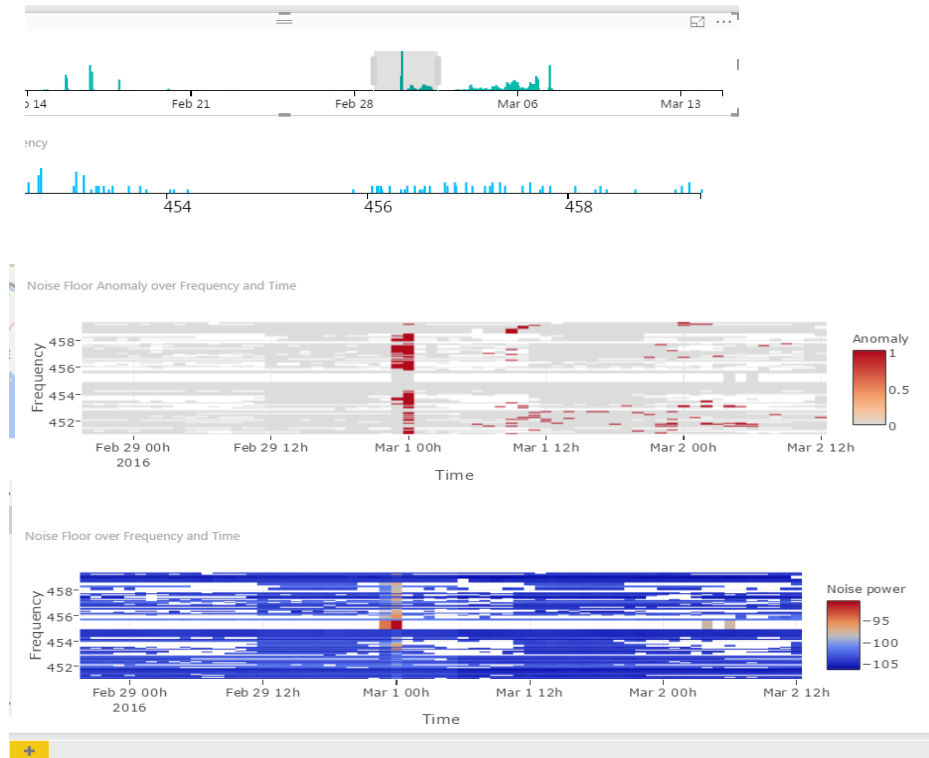
# Generating Spectrum Metrics



- *Use case defined spectrum metrics*
  - *Signal power, noise floor, band/time occupancy, off-set, loading/congestion, user experience, technology info. etc*

# Spectrum Data Analytics

- *Machine Learning & Analytics*
  - *Clustering*
  - *Time series analysis*
  - *Anomaly detection*



Anomaly Detection of Noise Power

# Intelligence for Spectrum Management

Commercial Mobile  
Spectrum Holdings [MHz]

AWS

BRS

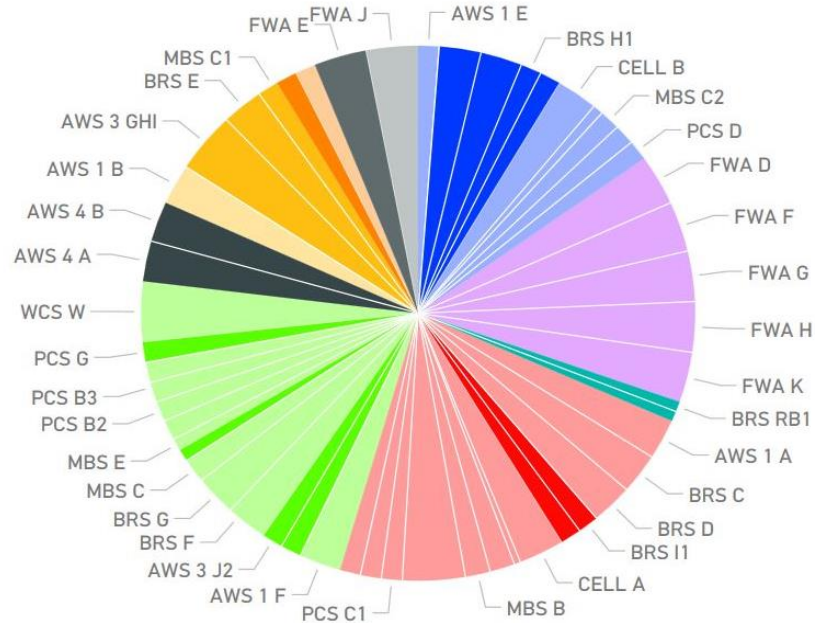
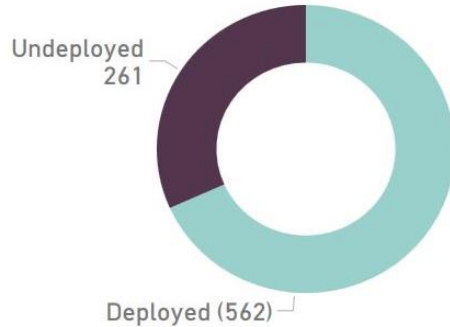
CELL

FWA

MBS

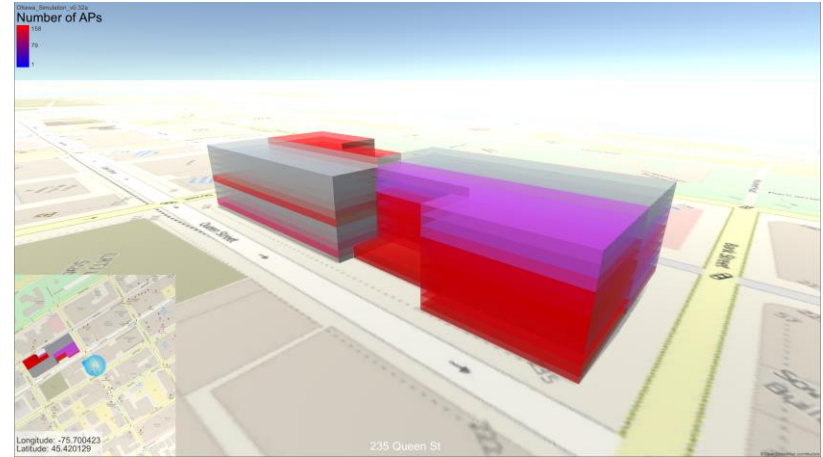
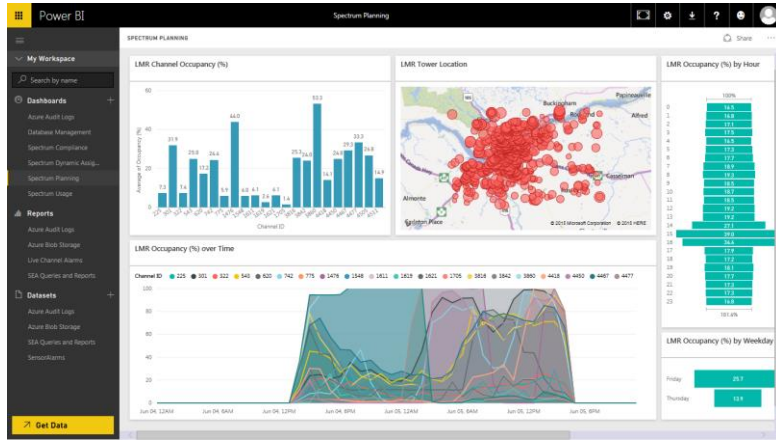
PCS

WCS



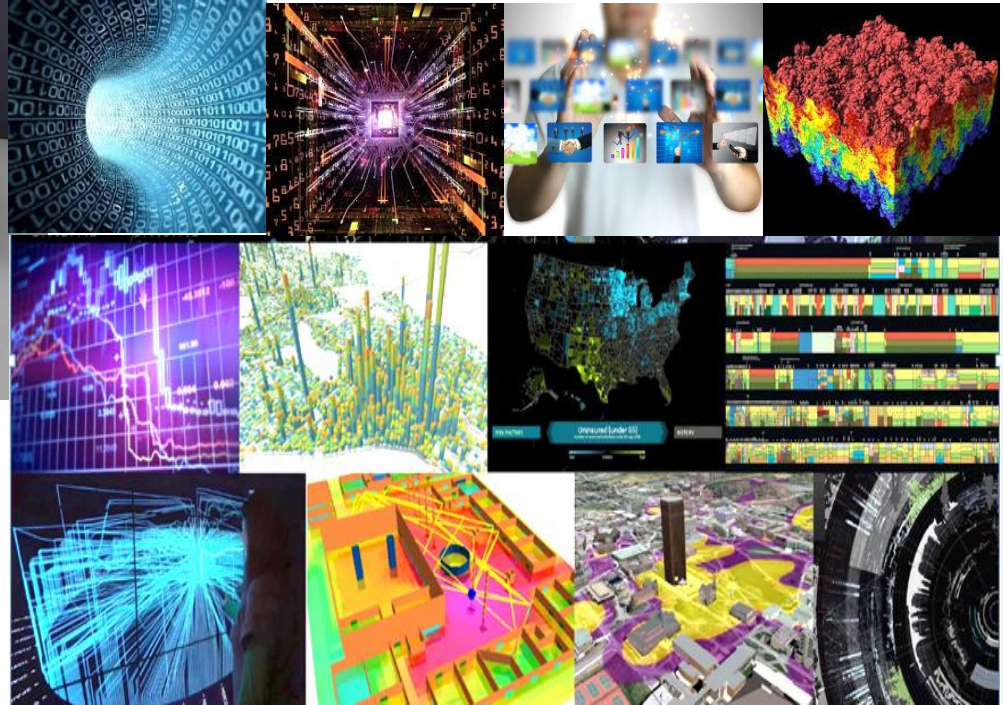
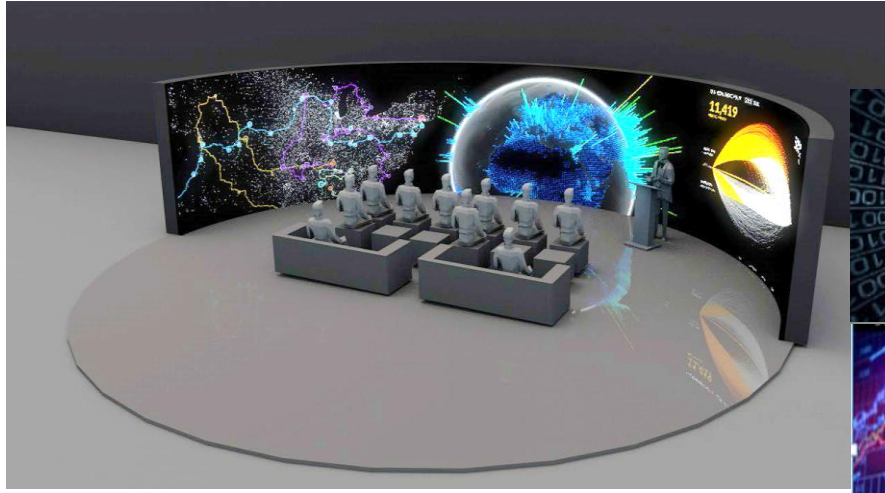


# Data Science for Spectrum Management



- Near realtime spectrum intelligence correlated and visualized
- Big data science based spectrum management

# Big Data Analytic Centre at CRC





# The SEA Experience

- New way for acquiring and using the spectrum knowledge
- Game changer to spectrum regulator
- Spectrum management for 5G



Canada