Distributed weather data stream mining for bushfire hazard prediction: wireless sensor network application

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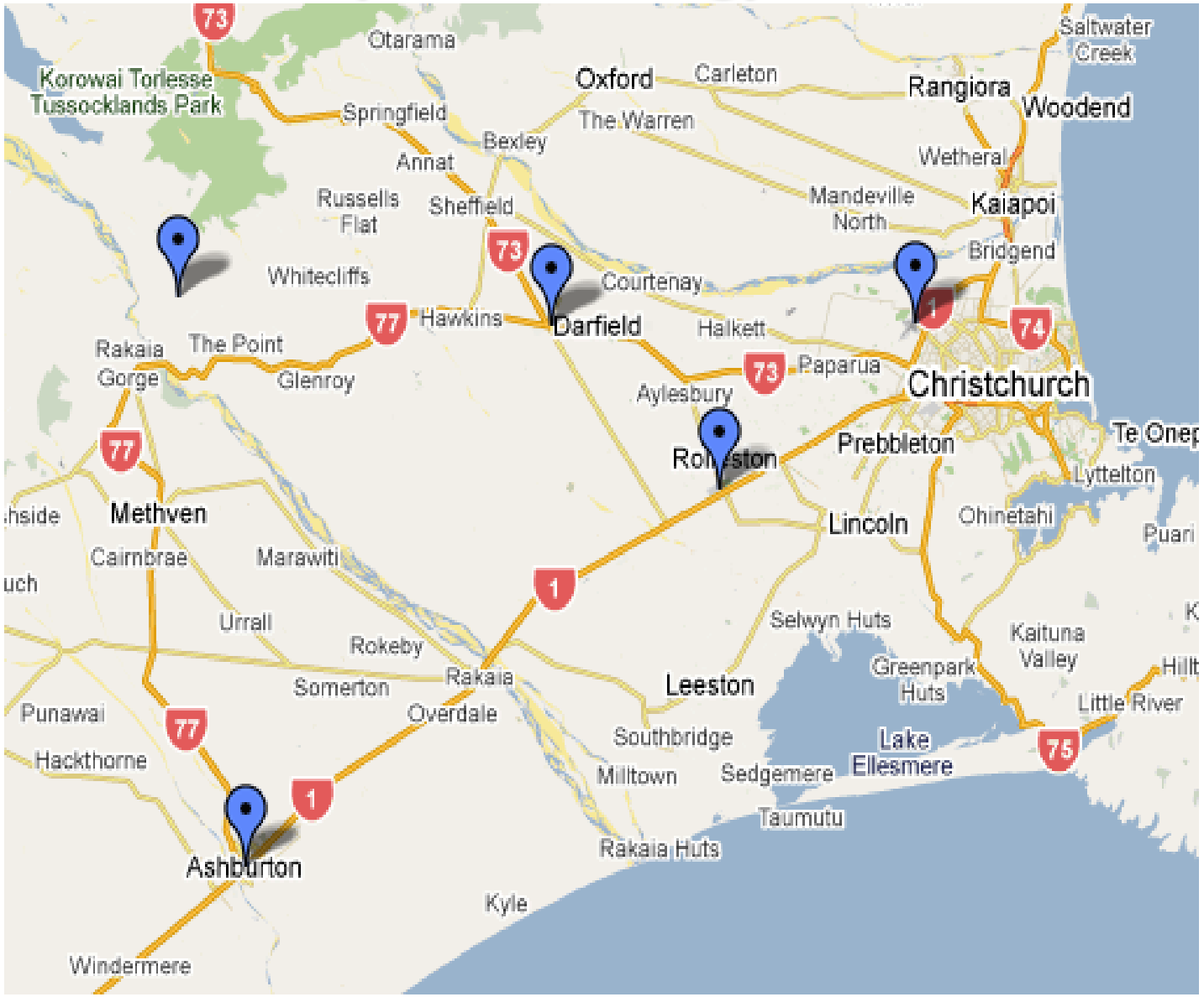
Presentation Structure

- Background
- Weather data stream
- Bushfire hazard prediction
- FWI
- WSN architecture
- Distributed weather data stream mining
- Modelling & simulation
- Results
- conclusion

Canterbury metrology stations distr.



A, Darfield
A -> B 91.3Km

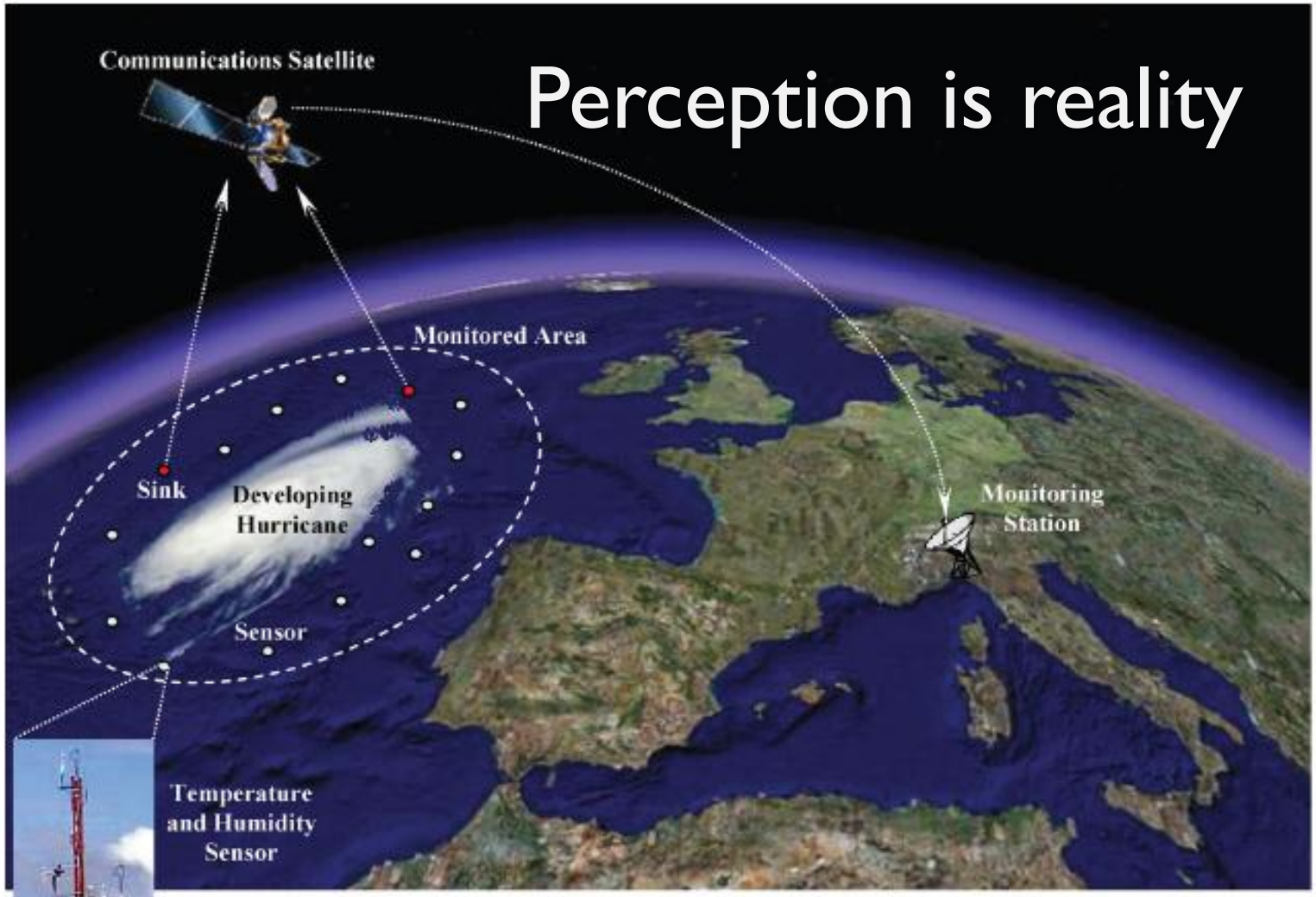
B, Ashburton
B -> C 36.7Km

C, Burnham
C -> D 27Km

D, Aero
D -> E 41Km

E, Snowdon

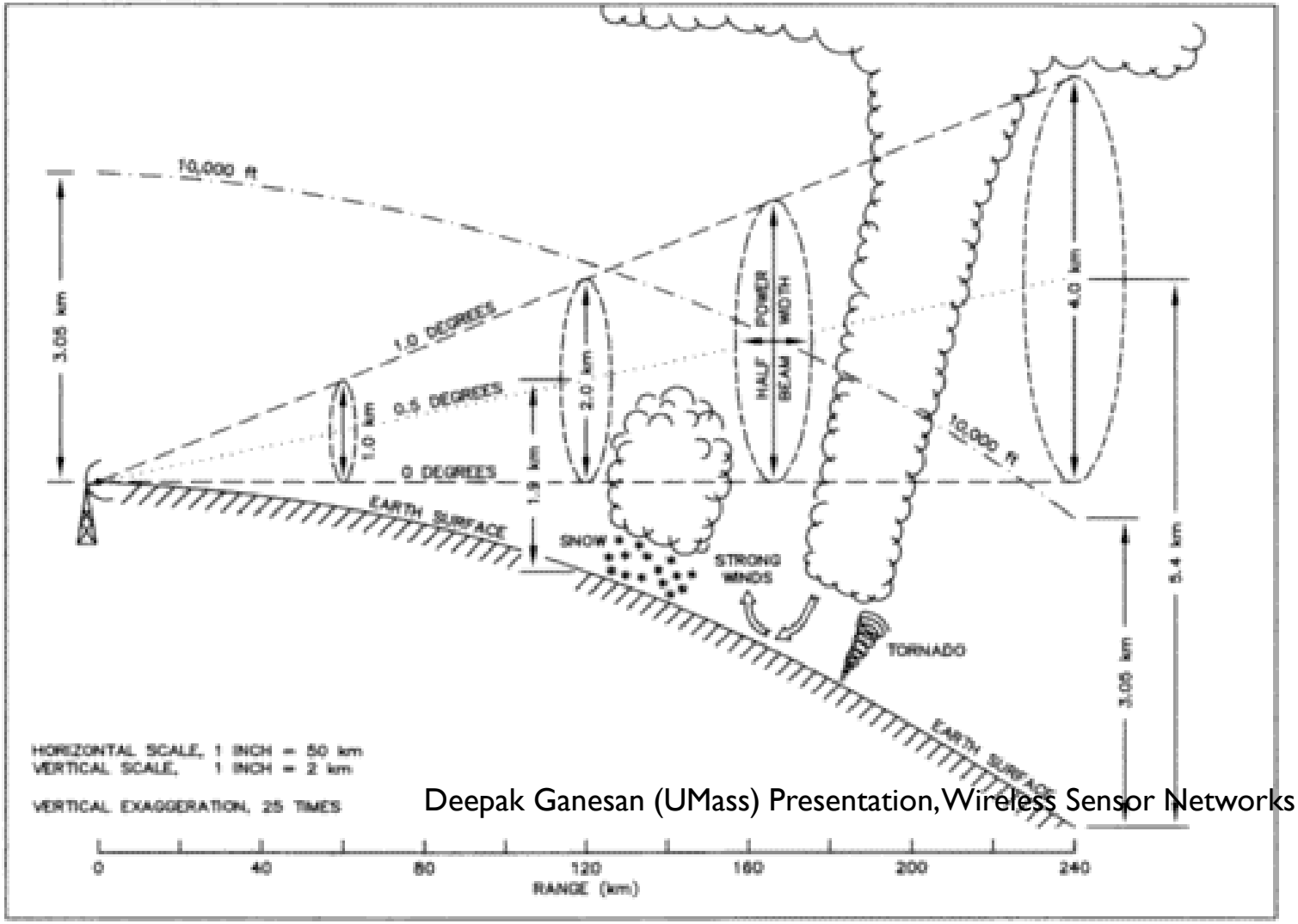
Perception is reality



BISIO AND MARCHESE: EFFICIENT SATELLITE-BASED SENSOR NETWORKS FOR INFORMATION RETRIEVAL

Example of EMS for weather prediction.

Distance means Energy



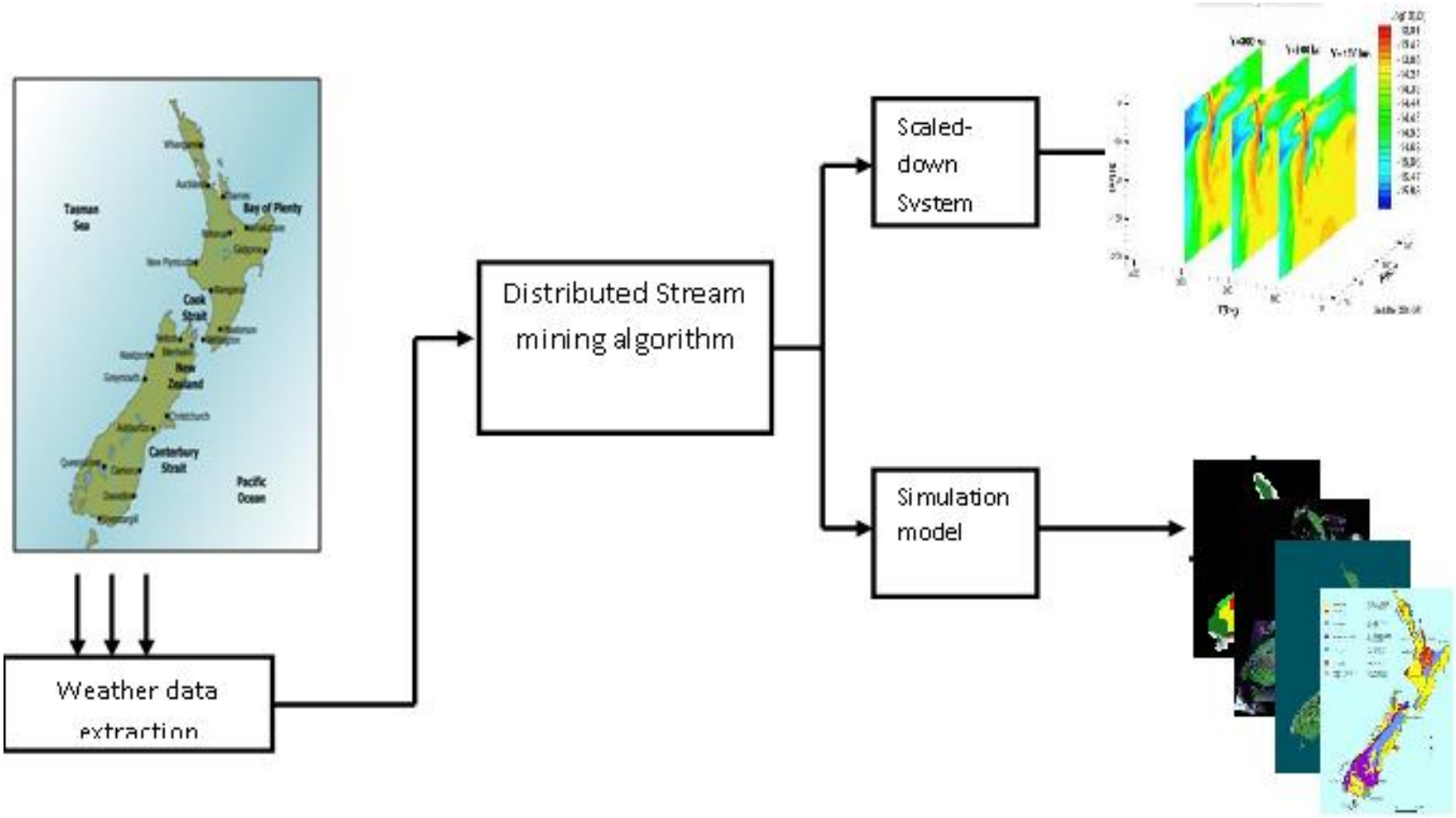
Deepak Ganesan (UMass) Presentation, Wireless Sensor Networks

Figure A-3 Diagram illustrating the effect of range and earth curvature (with standard atmospheric refraction) on NEXRAD cross-beam resolution and coverage of low-level weather phenomena. Courtesy of SRI International.

Precision Farming

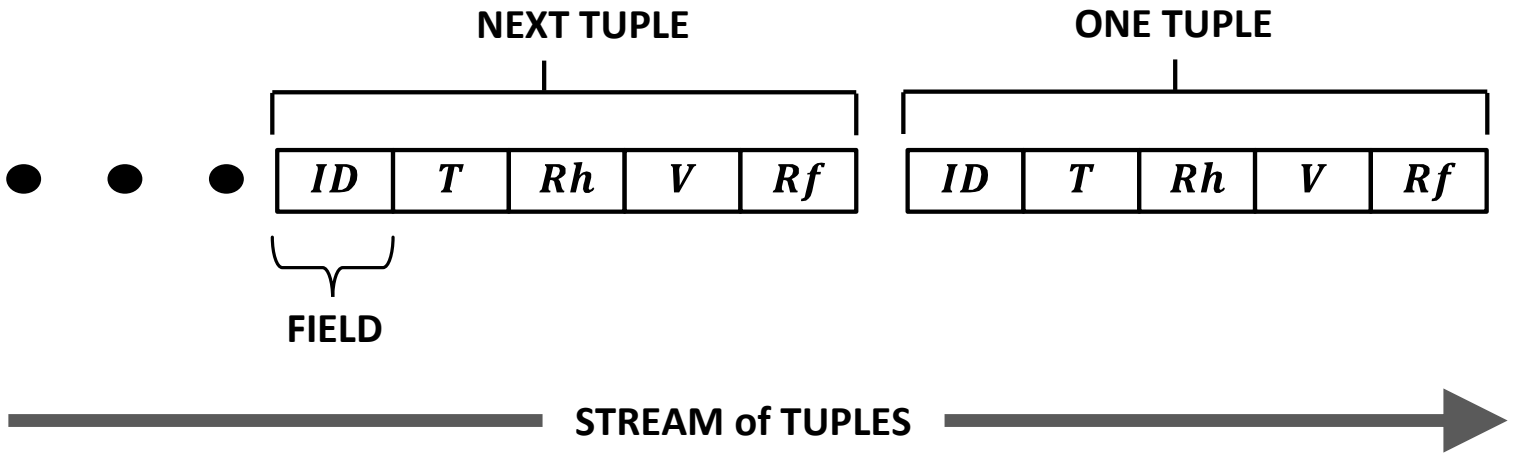
Motivation

- Direct sensing of local variable
- Local processing at the sensor level
- Facilitate In-Situation Interaction



Weather data stream

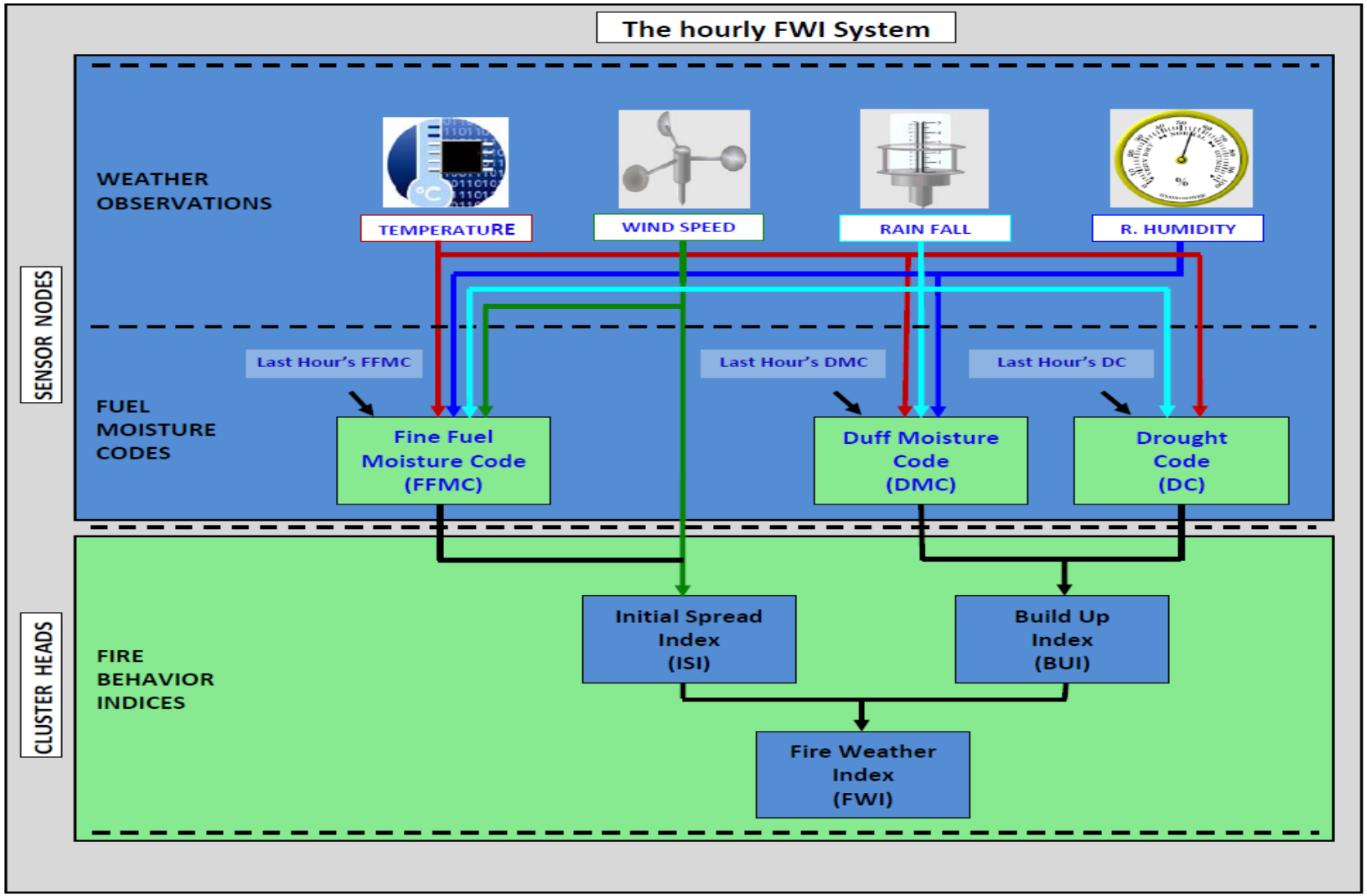
- A weather data stream is a real-time, continuous, ordered sequence of Tuples containing weather parameter fields.
- Weather parameters can related according to a model to provide information such as Bushfire hazard, climate change.
- Model processing should be able to handle continuously streaming weather parameters to be useful.



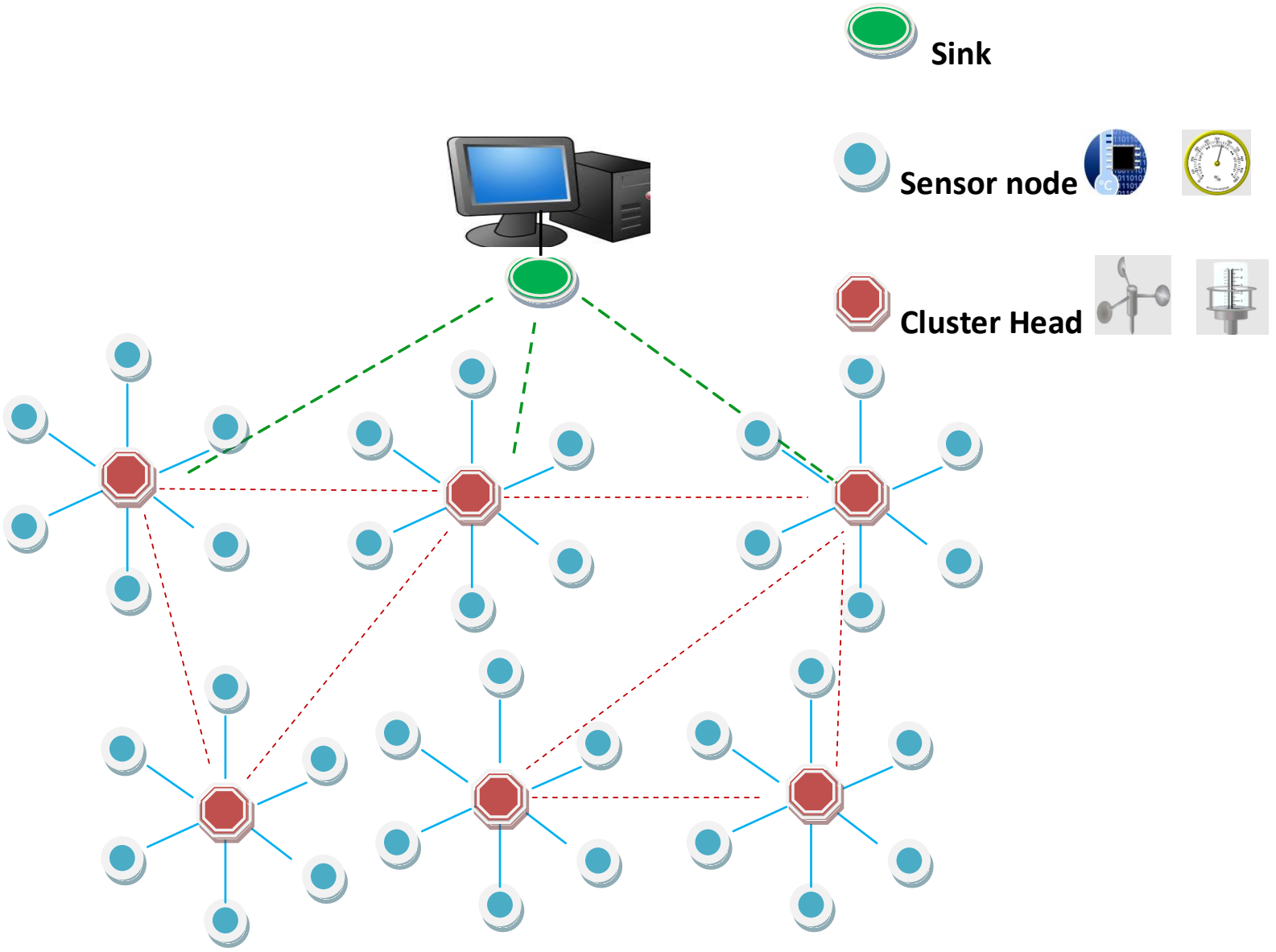
Bushfire hazard prediction

- FWI bushfire hazard modelling system
  - Relative ease of ignition. (FFMC)
  - Fuel consumption in moderate duff layers. (DMC)
  - Degree of smouldering in large logs. (DC)
  - Rate of fire spread. (ISI)
  - Difficulty of containing. (BUI)
  - General rating of fire intensity. (FWI)

FWI structure



WSN architecture



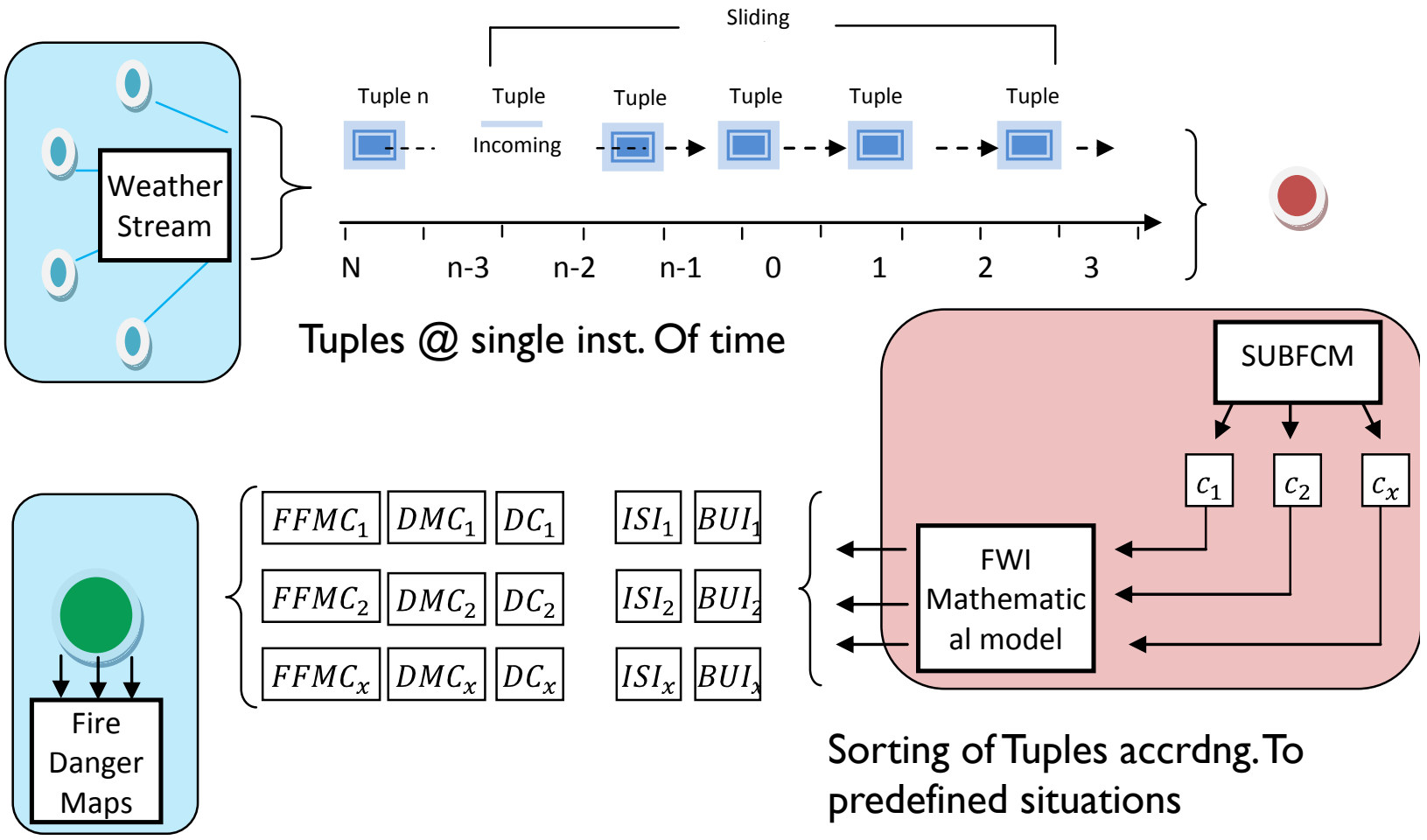
WSN architecture

- Wireless sensor nodes source weather data stream.
- Distributed weather stream source.
- Minor processing tasks.
- Clustering (GROUPING) of sensor nodes.
- Cooperative processing.
- Hierarchically organized network
- WSN drives toward low power low cost

Distributed weather data stream mining

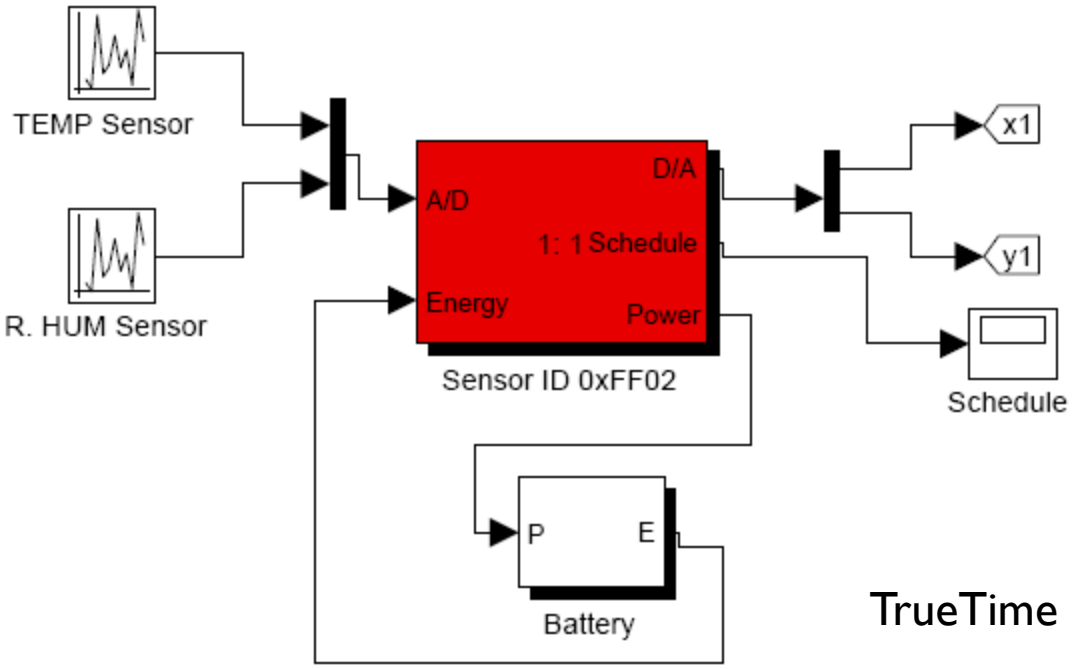
- Data stream clustering
- Incremental distributed stream clustering algorithm - SUBFCM
- Involves
  - Sensor nodes processing sub-task
  - Cluster head processing sub-task
  - Sink or coordinator processing sub-task

Distributed weather stream mining system



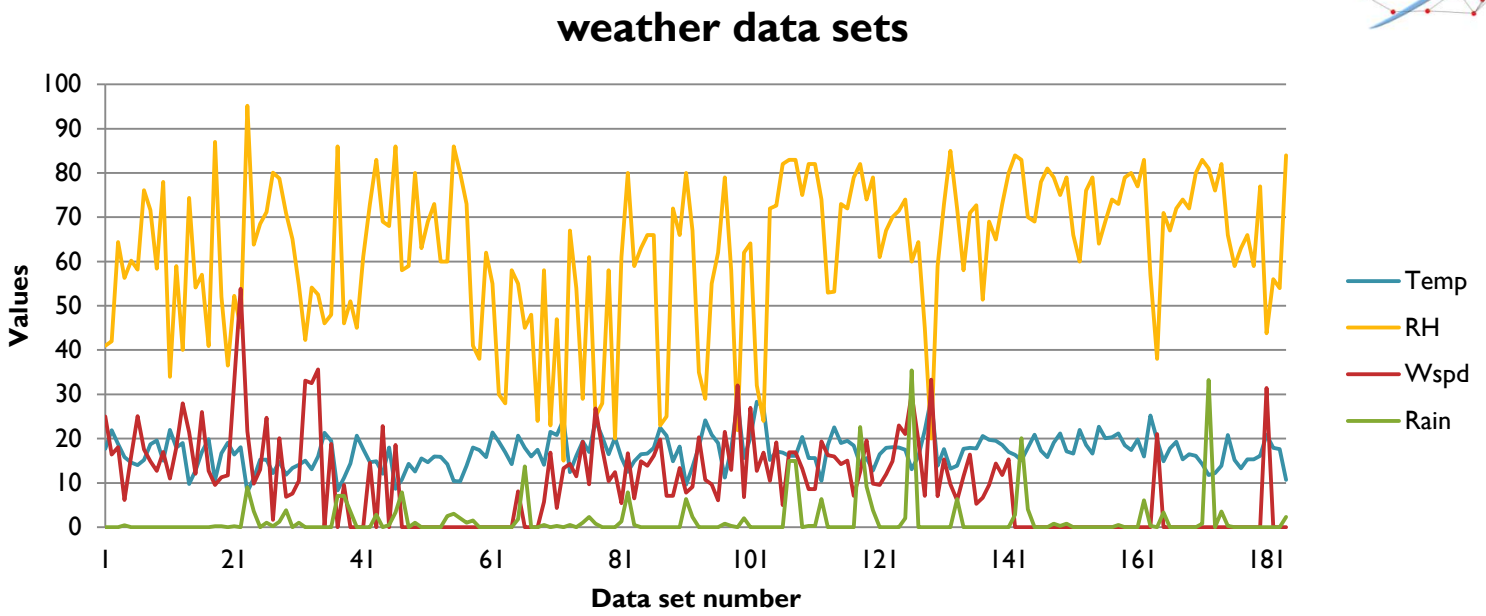
Modelling & simulation

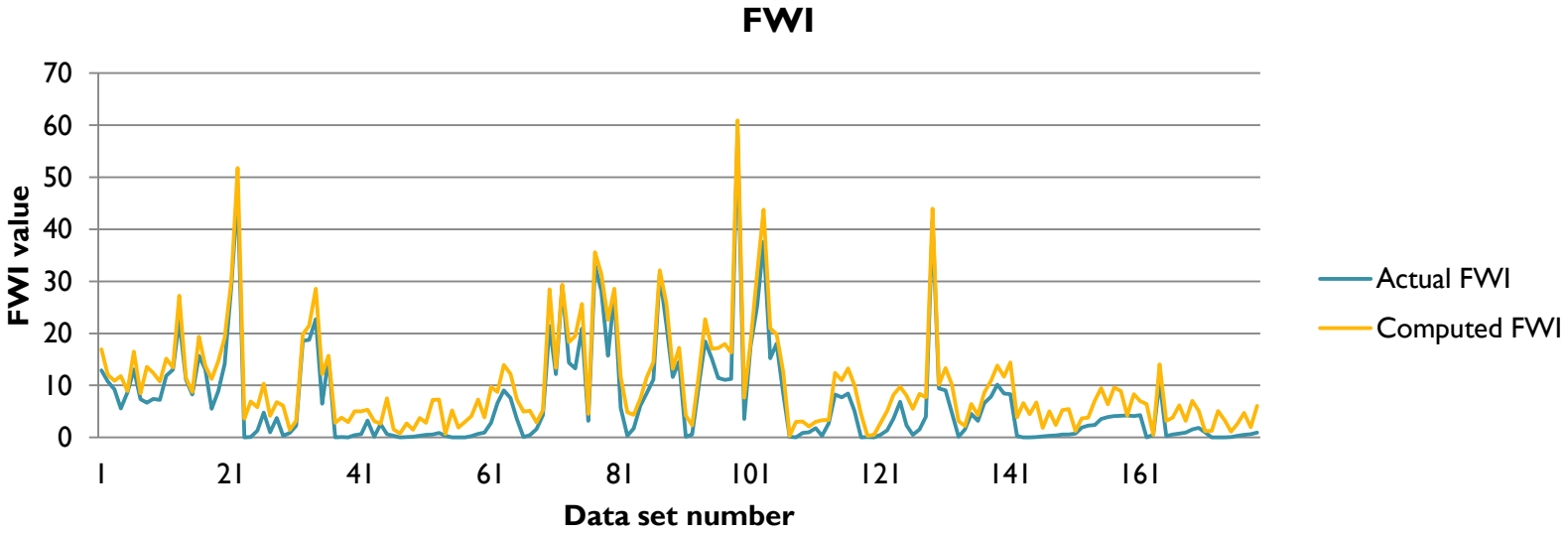
- MATLAB for sub-tasks modeling.
- TrueTime for WSN modeling.
- SIMULINK for simulating the system model.



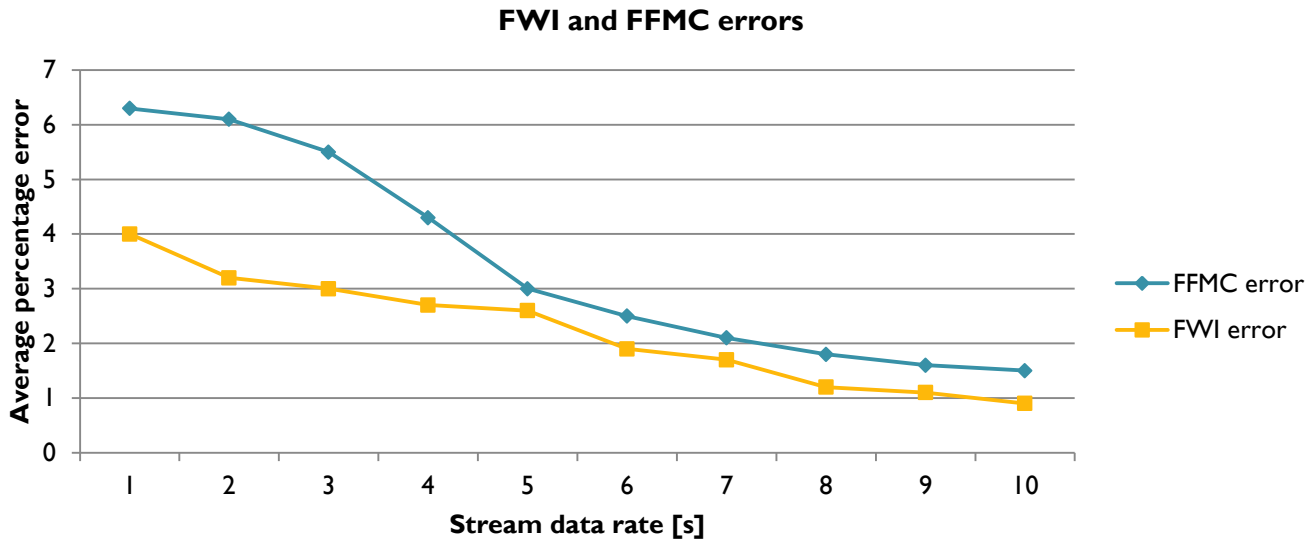
TrueTime Sensor node model

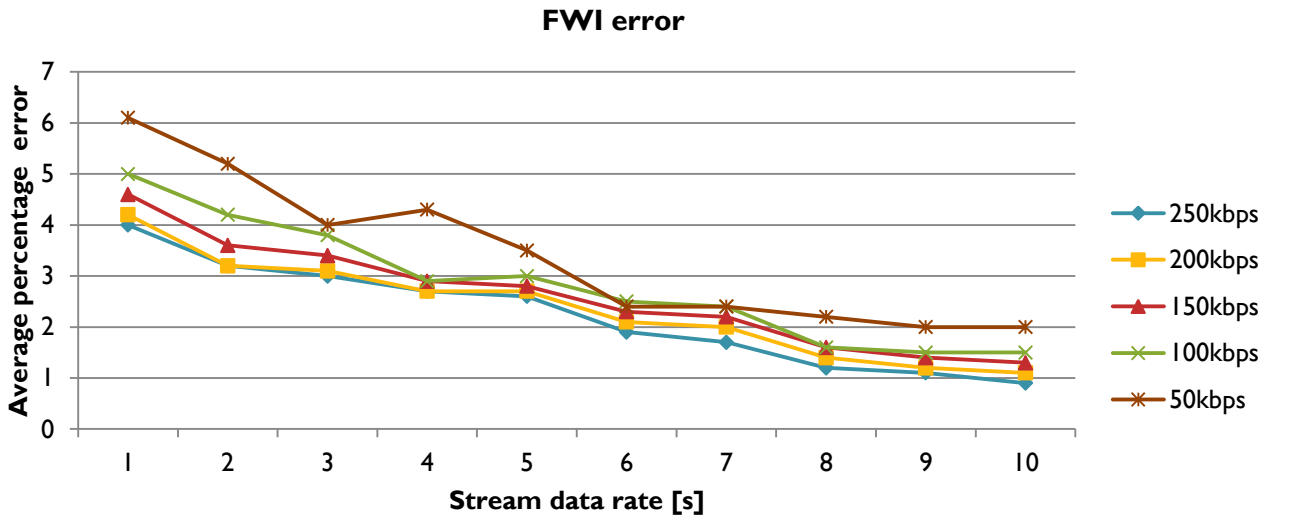
Results


weather data sets
Values
100
90
80
70
60
50
40
30
20
10
0
1
21
41
61
81
101
121
141
161
181
Data set number
Temp
RH
Wspd
Rain


FWI
FWI value
70
60
50
40
30
20
10
0
1
21
41
61
81
101
121
141
161
Data set number
Actual FWI
Computed FWI

WSN architecture





Conclusion

- High resolution spatial and temporal wildfire hazard prediction system
- The approach open the door for extending the National weather network to cater for areas of importance or hazard prone like National parks, etc
- Real weather data streams containing the weather parameter required for FWI indices computation is used to validate the model capability.
- Simulation results show that the model as is able to handle weather data streams incoming as fast as in 1 second interval with reasonable errors.
- The average error for the various simulations show that network data rate have significant consequences on model performance
- The True Time model makes use of the individual wireless sensor nodes to contribute in the computation of bushfire hazard prediction indices as given in FWI.