

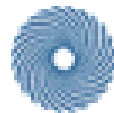
# Agent-Based Alerting for Forecasters

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*Open agent architectures for intelligent distributed decision making.*



**Bureau of Meteorology**

**RMIT**  
UNIVERSITY

Computer Science and  
Information Technology



**Agent  
Oriented**

Agent Oriented Software, Inc.

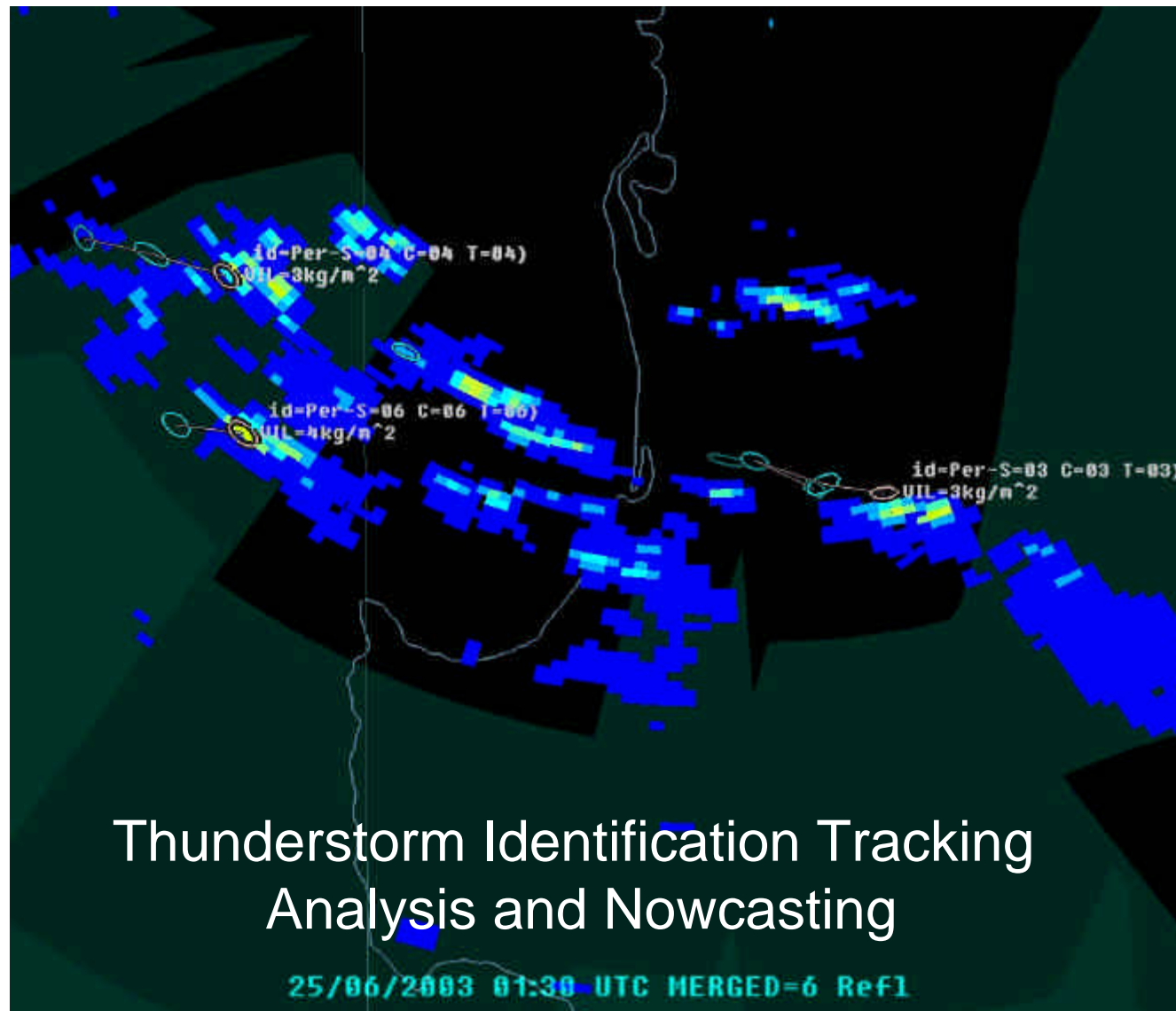
# Automated Weather Station (AWS)

- Generate regular readings
  - Temperature
  - Pressure
  - Wind direction
  - Wind speed
  - ...



# Titan Radar System

Provides current thunderstorm information



## Volcanic Ash message from email list



FVAW22 KGWC 260435

VOLCANIC ASH ERUPTION ALERT

VOLCANO: ULAWUN 0502-12

LOCATION: 5.04S 151.34E AREA: NEW BRITAIN

SUMMIT ELEVATION: 7658 FT (2334 M)

1. DETECTION SOURCE: NASA MODIS IMAGERY.

2. ERUPTION DETAILS: ASH/STEAM PLUME

DETECTED ON 26/0005Z TERRA MODIS IMAGERY.

TRAJECTORY: ASH/STEAM TO FL120 SHOULD  
MOVE TO THE SW AT 5-10 KNOTS.

3. REMARKS: MODIS IMAGERY SHOWS THE  
ASH/STEAM PLUME IS MOVING SW AND THEN  
MOVING S.

FOR METSAT ANALYSIS AND PUFF MODEL  
FORECAST BASED ON GFS DATA SEE:

HTTPS

[://WEATHER.AFWA.AF.MIL/ENVIRONMENTAL\(UND  
ERSCORE\)EVENTS.HTML](https://weather.afwa.af.mil/environmental(underscore)events.html)

(LOWER-CASE ONLY).

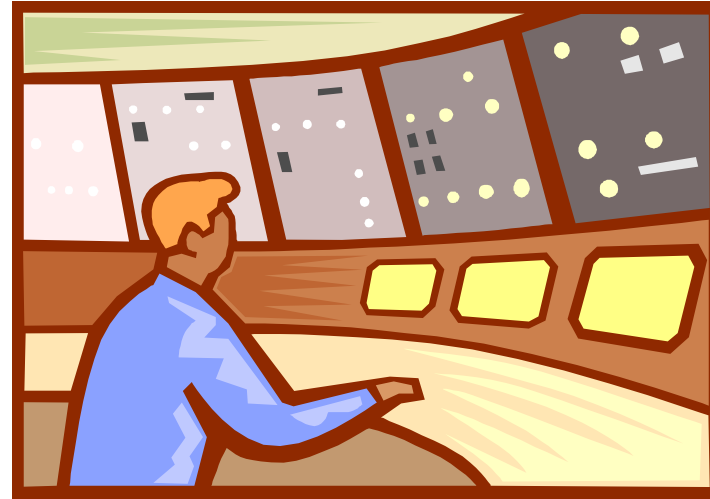
4. NO FURTHER INFORMATION IS AVAILABLE AT  
THIS TIME.

5. THIS BULLETIN WILL BE UPDATED EVERY SIX  
HOURS FOR CONTINUOUS ERUPTIONS AND/OR  
ERUPTIONS ABOVE FL300.

PREPARED BY LAING/KIENZLE

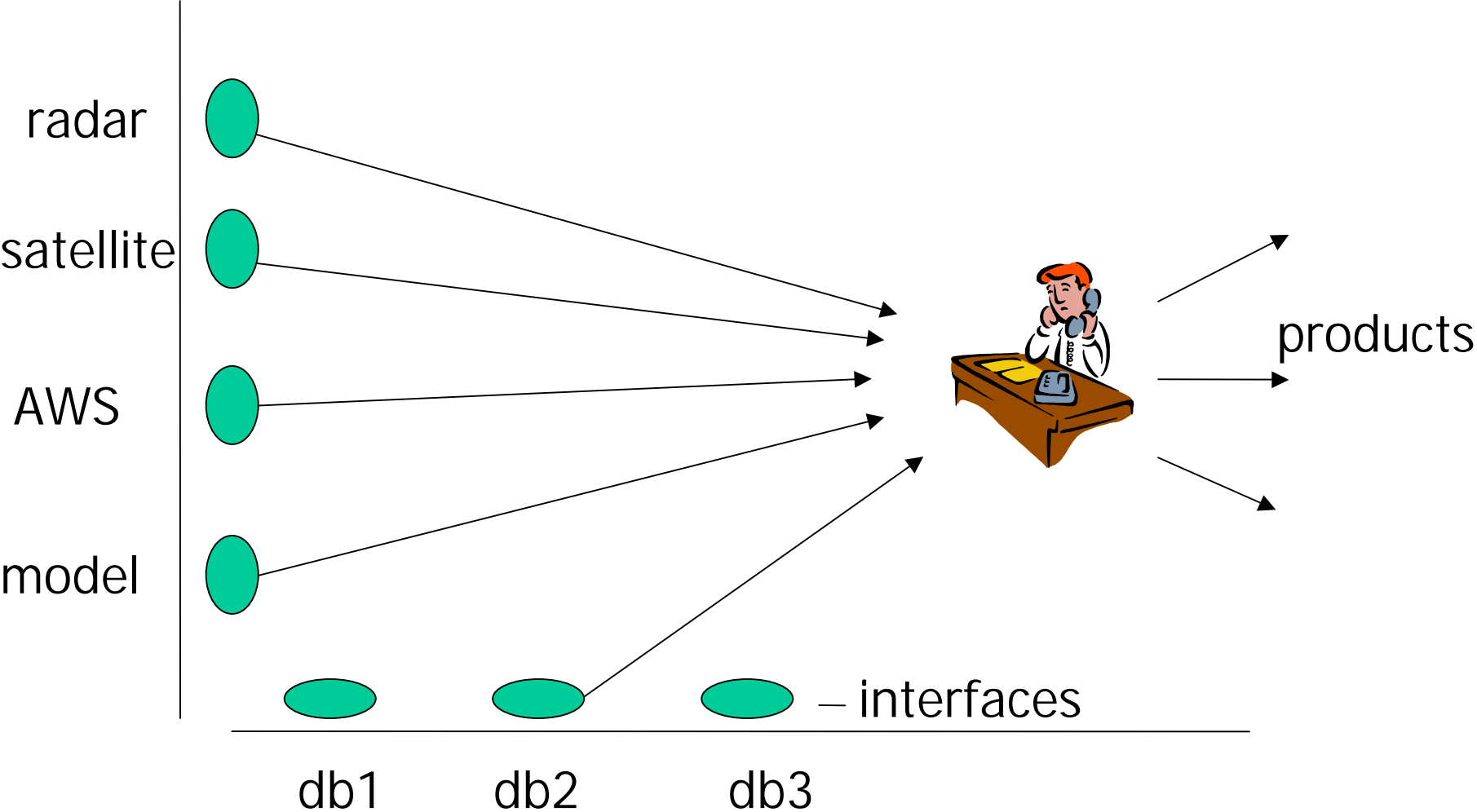
# Terminal Aerodrome Forecasts (TAF)

- Forecast conditions at an airport
- In compressed format for historical reasons (lack of bandwidth)



```
TAF YMML 122218Z 0024  
24006KT 9999 FEW025 BKN030  
FM02 18015KT 9999 SCT040  
FM17 25006KT 9999 BKN025  
T 15 19 20 16 Q 1028 1026 1025  
1026
```

# Problem: Forecasters overwhelmed



# Solution: Intelligent Alerts

Aims to reduce cognitive overload

- Minimise repetitive alerts
- Automatic recognition
  - Weather element alerts, e.g. temp extremes
  - Alerts from inconsistency between Forecast / Guidance / Observations
  - Severe weather event alerts, e.g. hail

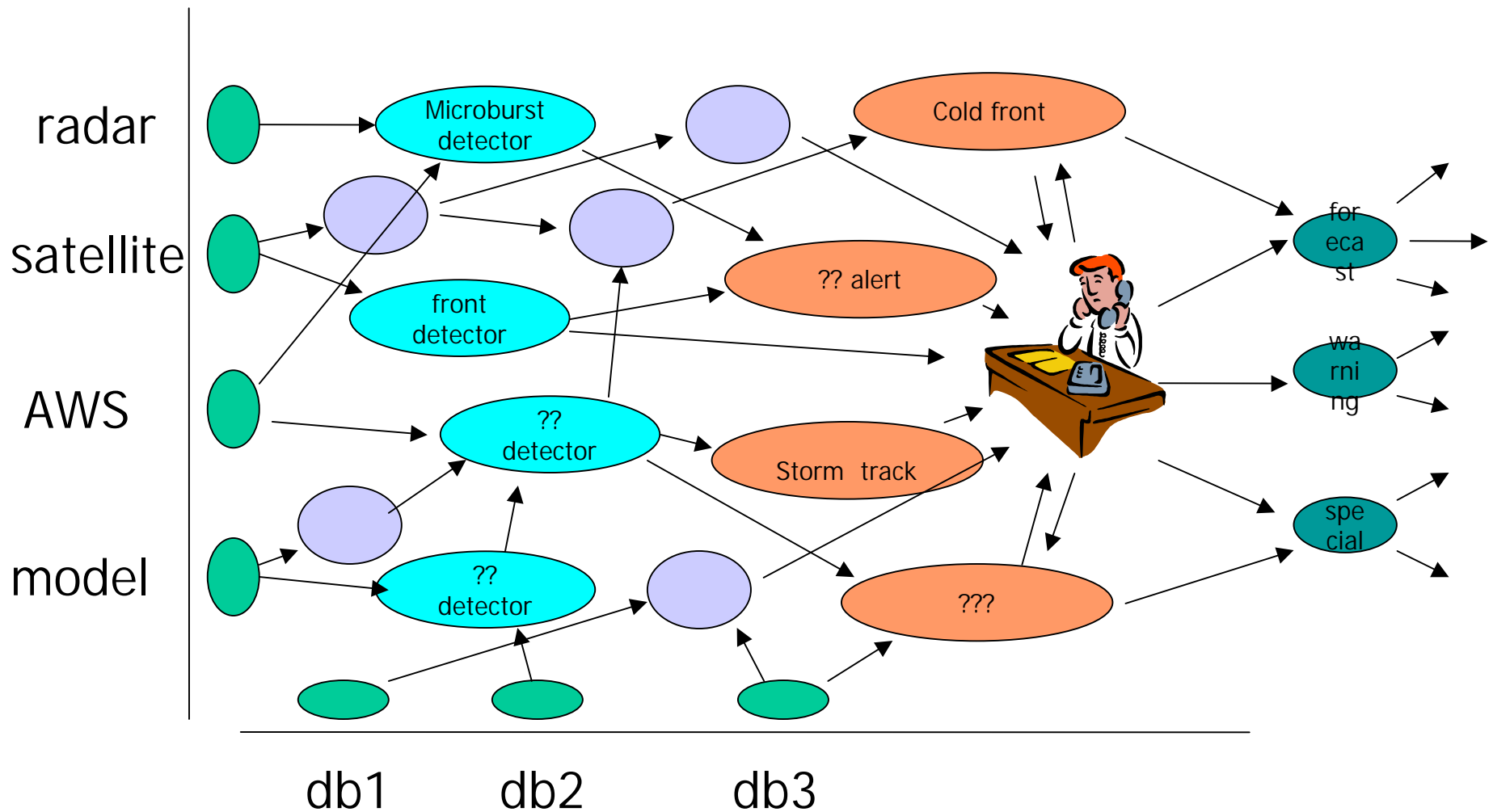
# Issues: System must be ...

- Robust
- Scalable
  - Software
  - Human: avoid “alert pollution”
- Able to deal with dynamic environment
  - Information sources come and go
- Extensible
  - By different people ... hence open!
  - Open: software written by independent groups inter-operates
    - E.g. web
    - Crucial role played by standards

# Technologies

- Agents
- Subscribe-Publish pattern
  - Leasing provides self-healing
- XML – TTable
- Floating Thresholds reduces alert pollution

# System Structure (vision)



# Agents

- Agent: software that is **autonomous**, **situated** in an environment
- An intelligent agent is **proactive**, **reactive**, **social**
- Also flexible, robust, rational

# Agents vs. Objects

- Agents are autonomous
  - Own thread of control
  - Own decision making (can say “no”!)
- Agents are proactive
  - Have goals (multiple!)
  - Balance proactive and reactive behavior
- Agents are flexible, robust

# Why Agents?

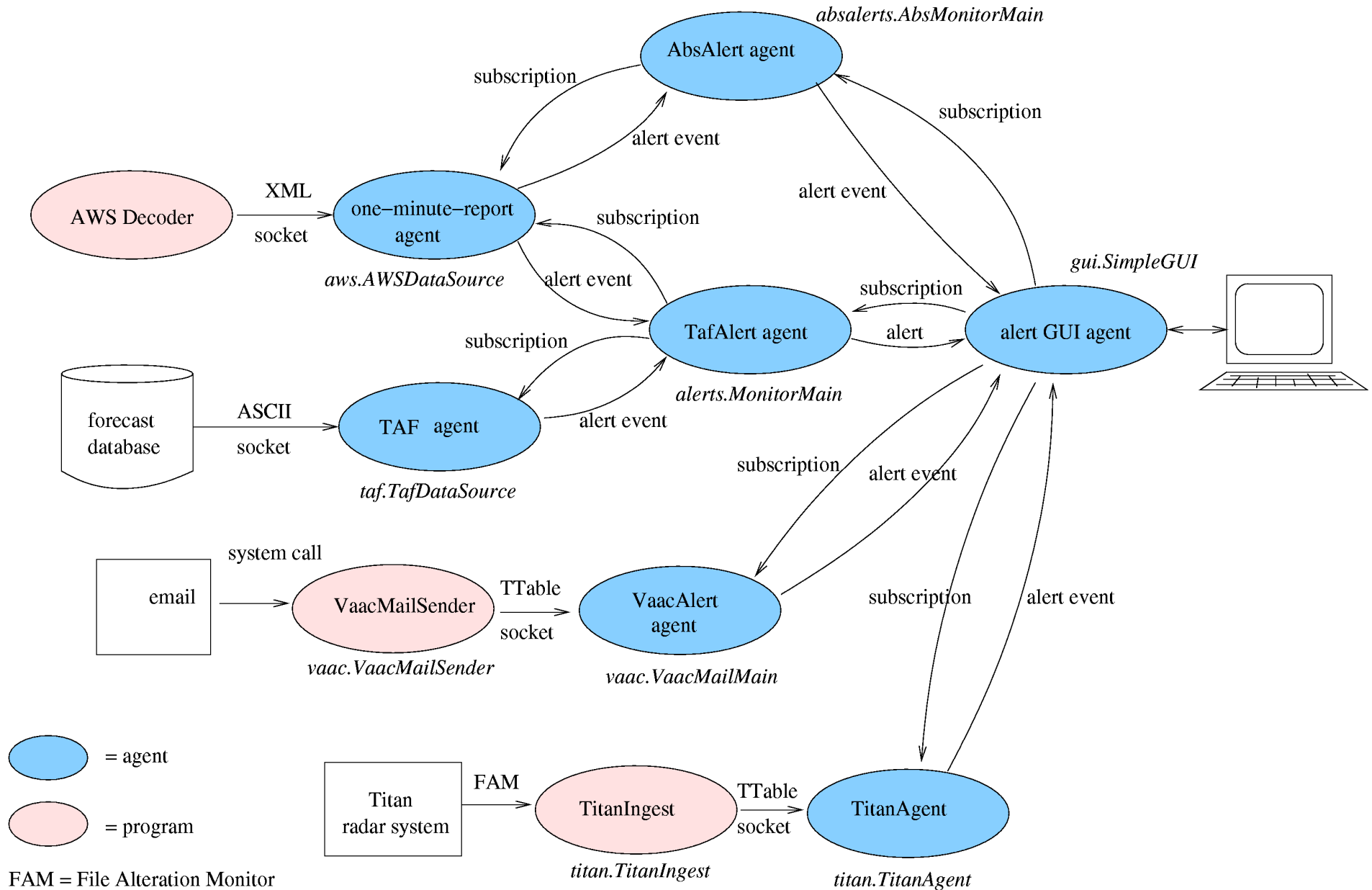
## From Software Engineering Perspective

- Reduce coupling
  - Autonomous
  - Encapsulate invocation
- Unit for building open distributed systems
- Plan-based agents
  - Easy to add new behaviours

# The Prototype System

- Receives information from a range of sources (AWS, METARS, TAF, TITAN, VAAC)
- Checks for inconsistencies between sources and for extreme weather conditions (e.g. high wind speed, thunderstorms)
- Issues warnings to forecasters
- Structured as a (distributed) collection of agents that subscribe to events of interest

# System Structure (actual)



# The Prototype GUI

The screenshot shows a window titled "INTELLIGENT ALERTS 1.6 - alertGui sandy titandev2.ho.bom.gov.au 10520". The window contains a menu bar with "File", "Options", and "Help". The "Options" menu is open, showing "Alert Types", "Alert Sounds", and "Info Pane". Below the menu is a table with columns for "Seq #", "Alert Types", "Location", "Reason", and "Reason". The table lists various alerts with their sequence numbers, locations (YMES, Kurnell, YMAV), and reasons (one-minute-report, Titan, Storm 59 exceeds thresholds, etc.). Below the table is a text pane containing the following text:

```
text =  
TAF YMAV 252305Z 0018  
36015KT 9999 FEW030  
FM08 36015G28KT 9999 FEW035  
FM15 35015G30KT 9999 -RA FEW020 BKN040 BKN100  
FM08 MOD TURB BLW 5000FT  
T 08 14 15 11 Q 1019 1016 1013 1012  
  
header = TAF  
aviation_id = YMAV  
issue_time = 20030625230537  
start_time = 20030626000000  
end_time = 20030626180000  
temp = 8, 14, 15, 11  
qnh = 1019, 1016, 1013, 1012
```

At the bottom of the window, a status bar displays: "Jun 26 0232 Z | Receiving (re)subscription acknowledgement from VaacAlert".

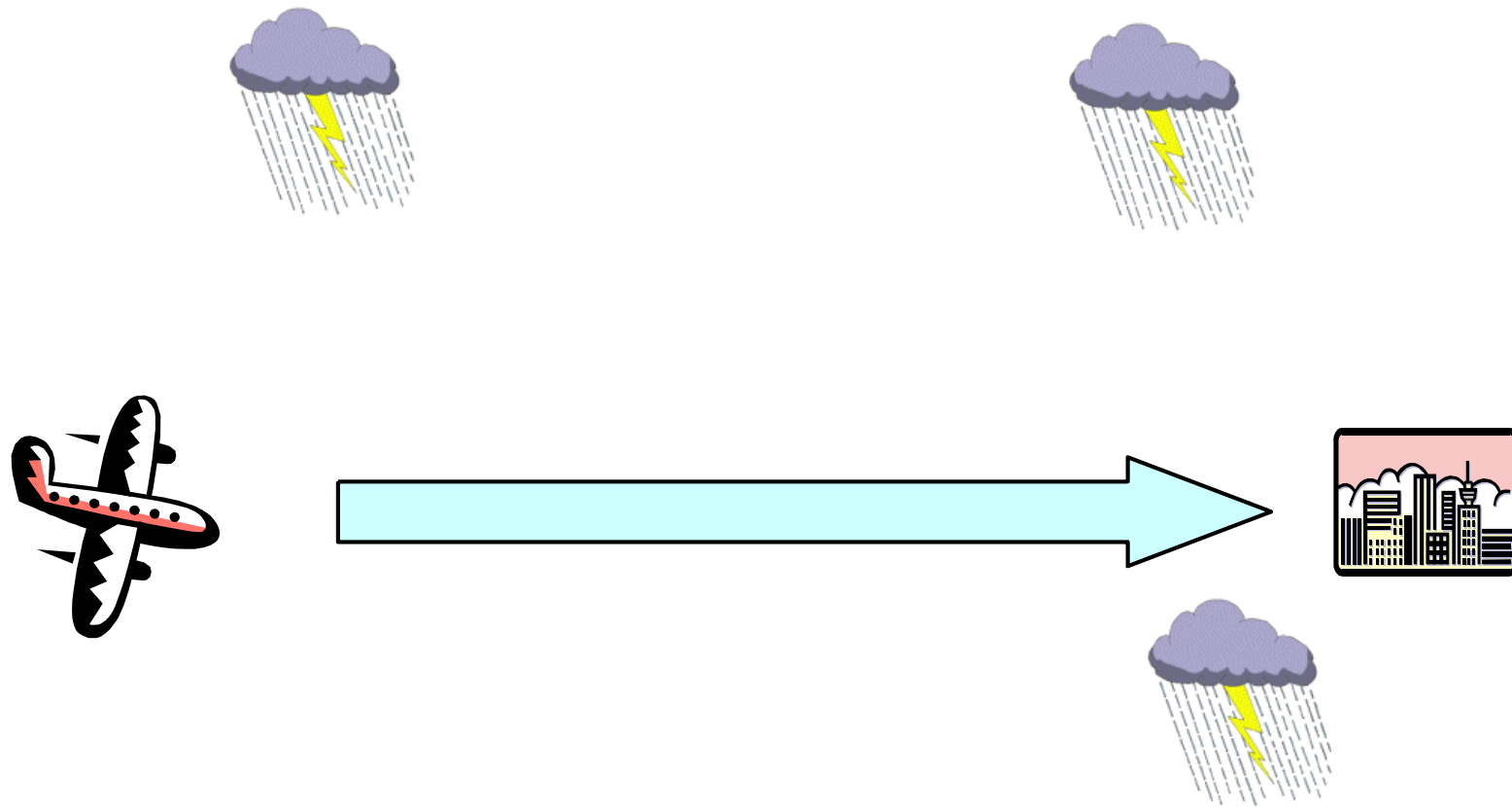
# Experience

- Evolvability: modular agent approach with flexible data allows quick and easy implementation of new nodes and services.
  - Volcanic Ash alerts - 2 days
  - TITAN storm alerts - 1 week
- Flexibility: use of publish-subscribe pattern allows any agent to connect to any other.
- Self-healing: leasing of service for 5 minute period, then re-lease. Thus broken links are repaired.

# Issues

- Subscriptions are hard wired (static)
- Avoiding “alert pollution”
- Subscriptions are simple (all-or-none)

# Time-dependant queries



# Research Questions

- Self-describing Data
- Service Description
  - Complex selection expressions
- Service Location

# Future Work

We intend to increase the range of alertable phenomena.

We intend to investigate better notations for subscriptions

Pilot study with forecasters

# Conclusion

- Agent approach provides flexibility, robustness and extensibility.
  - The system has evolved from simple pressure forecast vs. observation discrepancy alerter, to one which alerts on temperature, wind speed, volcanic ash and thunderstorms.
  - Subscription/leasing links between agents provides robustness.
- To trial the system, go to:

<http://servb.ho.bom.gov.au/ia/docs/>