



# 'PX4 State Estimation'

## PX4 Developer Summit

### Zurich 2019

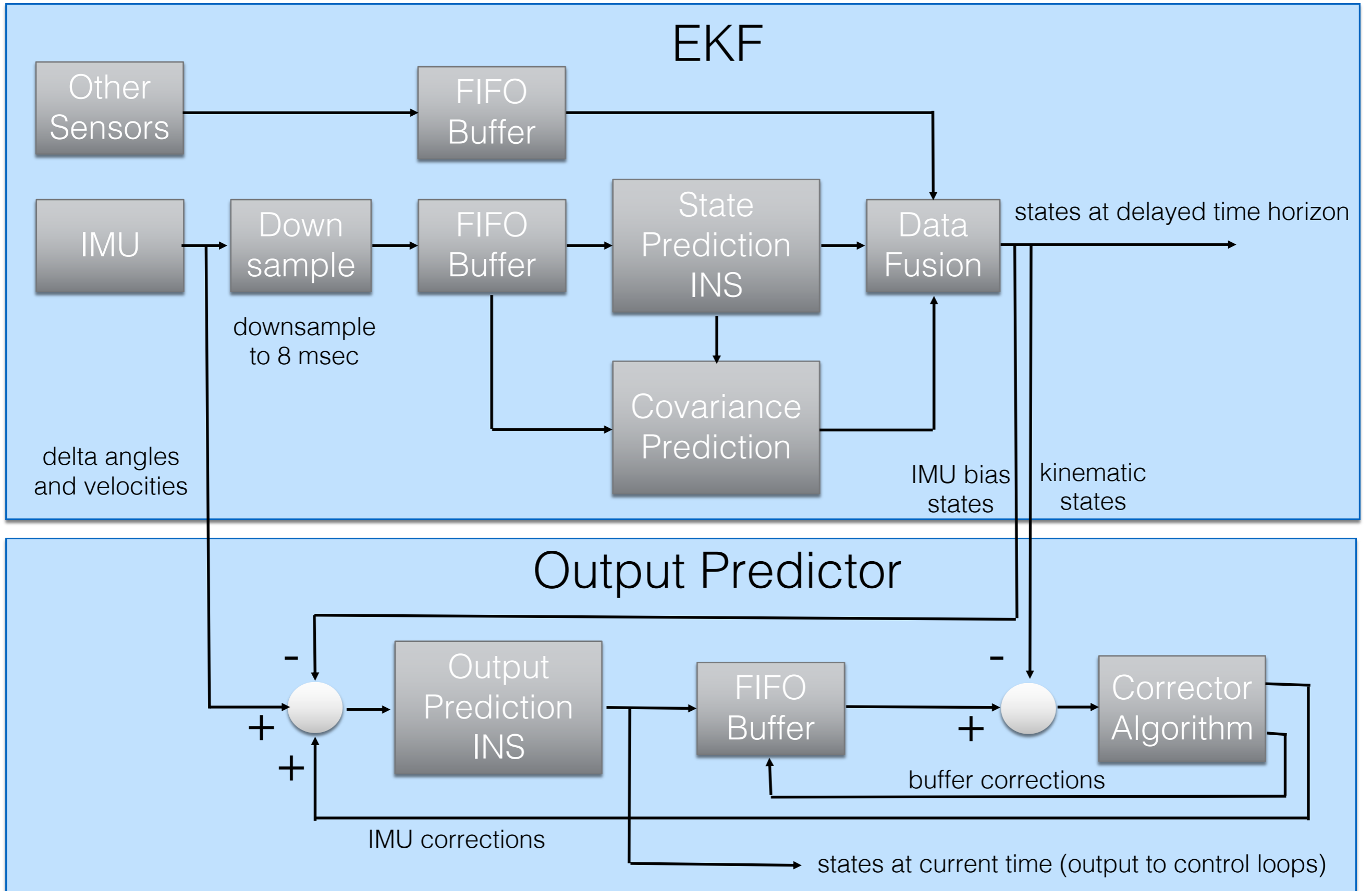
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# Overview



- Vehicle state estimation is performed by the PX4 [ekf2](#) module. It uses an Extended Kalman Filter (EKF) algorithm from the [PX4/ecl EKF](#) library
  - 24 States
    - Angular Orientation (4 quaternion states)
    - Velocity (3 states)
    - Position (3 states)
    - IMU and Magnetometer Bias (9 states)
    - Earth Magnetic Field (3 states)
    - Wind Velocity (2 states)
  - 6808 SLOC (Executable)
  - 41 contributors

# Architecture



# Status



We have:

- Merged 54 pull requests in the past 12 months
  - 20 enhancements
  - 24 bug fixes
  - 10 non-functional ‘house keeping’
- 2 Open pull requests
  - 2 enhancements
- 13 Open issues
  - 6 enhancement requests
  - 4 potential bugs
  - 2 bugs
  - 1 documentation request

# Enhancements



- Latency from receipt of IMU to output of vehicle attitude was reduced by an order of magnitude from ~ 1000 to < 100uSec, [#471](#)
- Terrain height estimation using optical flow sensing was added, [#597](#)
  - Tested on FW and RW using PMW3901 flow sensor
- Use of RTK GPS heading for magnetometer free operation was added, [#497](#)
  - Tested with Trimble MB-Two GPS

# Open EKF Bug Reports



- [#474](#) Use of optical flow data from wide fov sensors can degrade height estimation when vehicle is tilting.
  - Awaiting further testing to quantify the issue
- [#602](#) Operation in higher wind conditions with FW/VTOL platform types results in degraded wind velocity initial state estimates.
  - Fix in progress – see pull request [#615](#).

# Open EKF Pull Requests



1. [#505](#) Miscellaneous optical flow changes.
  - In testing and review
2. [#613](#) Allow use of double precision floating point if available.
  - In draft

# Future Estimation Work



- Improve tolerance to sensor faults
  - Use multiple EKF instances to enable isolation of ‘soft’ IMU sensor faults. Current sensor selection code limited to failover for ‘hard’ faults (if an alternative sensor is available).
  - Use of earth magnetic field a-priori information to improve handling of in-flight magnetometer errors during up and away flight.
  - User adjustable correction for electromagnetic offsets using measured current.
  - Fusion of dual airspeed sensors for improved fault isolation. Will enhance airspeed fault tolerance introduced by PR [#11846](#).
- Support for range to beacon measurements (eg UWB RF tags)
- Increase reversion test coverage and increase level of test evidence required for future change requests.