A COOPERATIVE NAVIGATION SIMULATION FRAMEWORK FOR DESIGNING ROBUST NAVIGATION SYSTEMS

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PNT – Positioning, Navigation, Timing

Positioning is the ability to accurately and precisely determine one's location and orientation anywhere in 2D or 3D.

Navigation is the ability to determine current and desired position and apply corrections to course, orientation, and speed to attain the desired position anywhere.

Timing is the ability to acquire accurate and precise time from a standard anywhere. Timing includes time transfer

PNT – Position, Navigation Timing

GNSS

- Space-based navigation system Series of 24 satellites, 6 orbital planes, 4 satellite vehicles (SV) on each plane

- Works anywhere in the world, 24 hours a day, in all weather conditions and provides:

  - Location or positional fix

  - Velocity

  - Direction of travel

  - Accurate time

- Range from each satellite calculated range = time delay X speed of light

INS

- Gives a dynamic output of the full navigation solution (position coordinates, attitude, speed

  and acceleration),

- Initial position and velocity should be known

- Consist of Navigation Computer and Inertial Measurement System (IMU)

- "Gimballed" – "Strapdown" types

- Position error grows with time

GNSS Degraded Environment

"This week, the South Korean government reported that electronic jamming signals from North Korea were affecting communications and GPS signals for passenger aircraft. So far, there has not been a serious threat to safety because the pilots were able to use supplemental navigation devices."
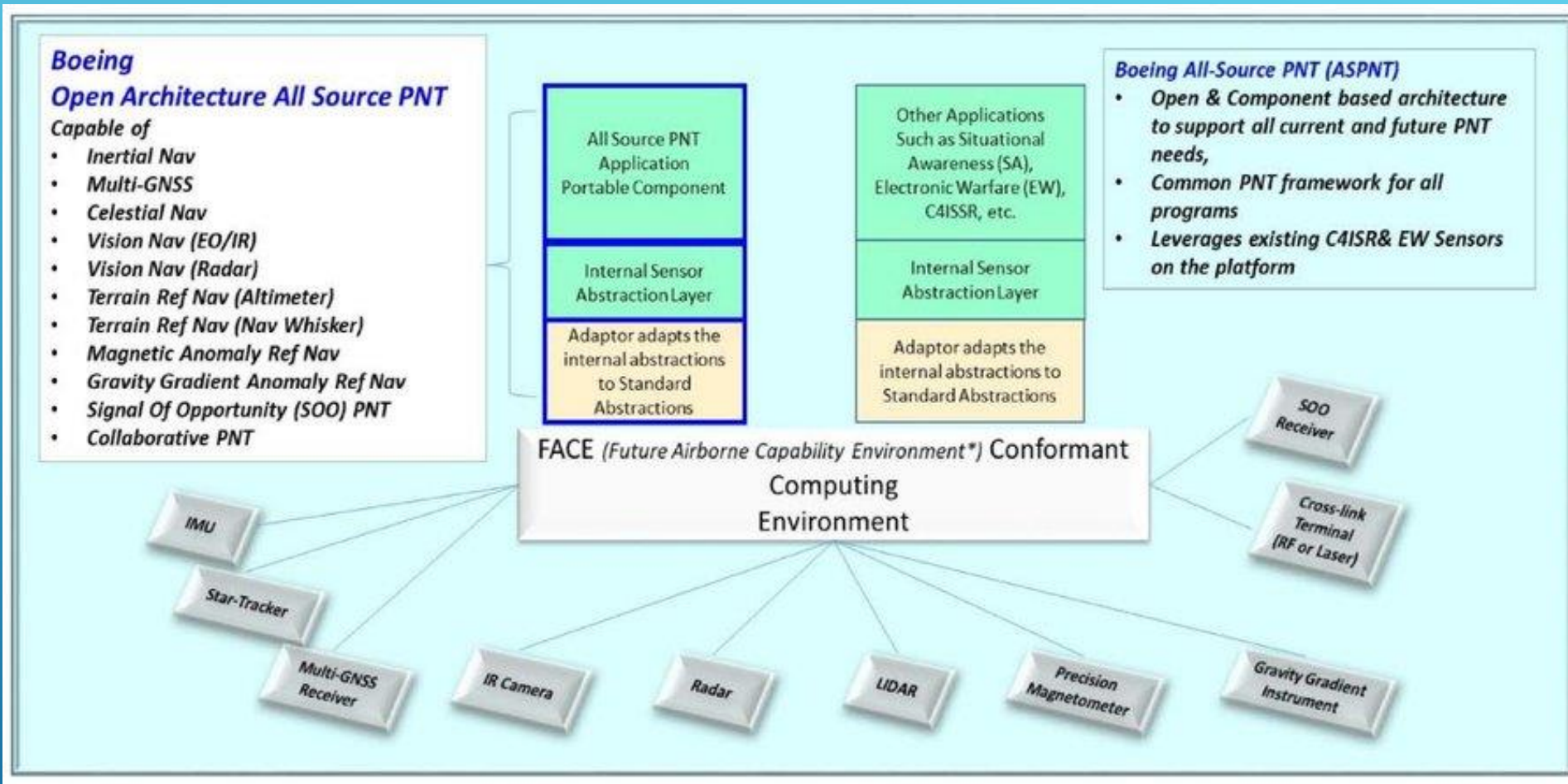*http://news.discovery.com/tech/gps-jamming-120504.htm*

North Korea jamming GPS again

GNSS Degraded Environment

- *"Iran hacked U.S. drone and tricked aircraft into landing on its soil"* (Washington Post, 5 December 2011)
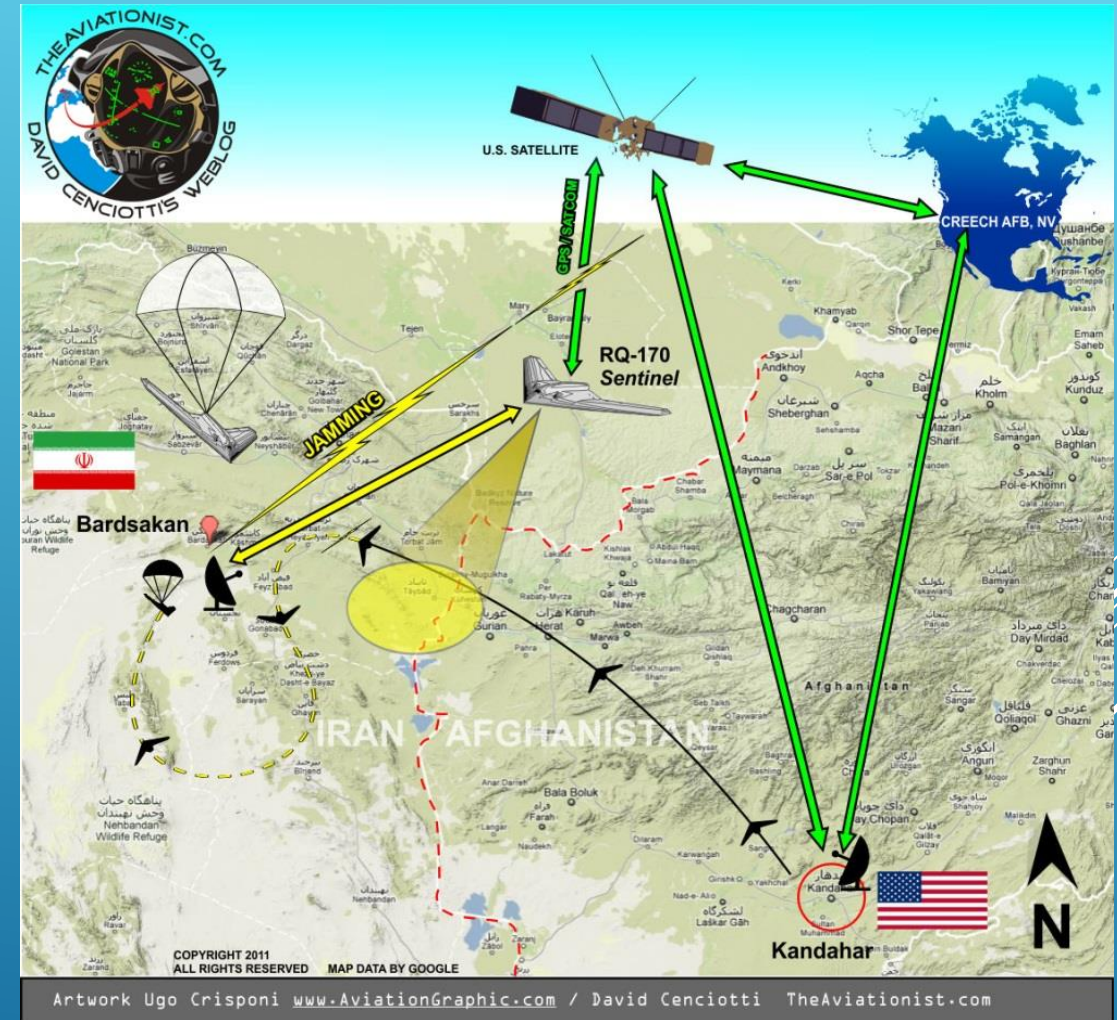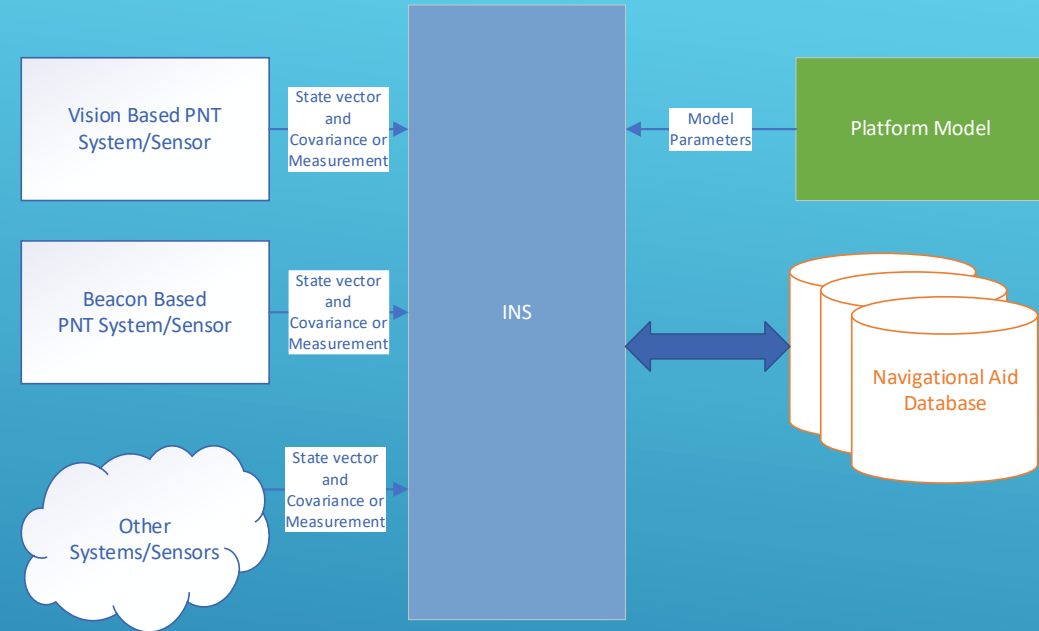
All Source PNT

All-source position, navigation, and timing (all-source PNT) by
Paul Haug, Rongsheng Li, Chang J. Yoo, Tung-Ching Tsao, Andrey Tolstov, Cody L. Gruebele, Kevin O. Davis in
SPIE Proceedings Volume 11424, Situation Awareness in Degraded Environments 2020
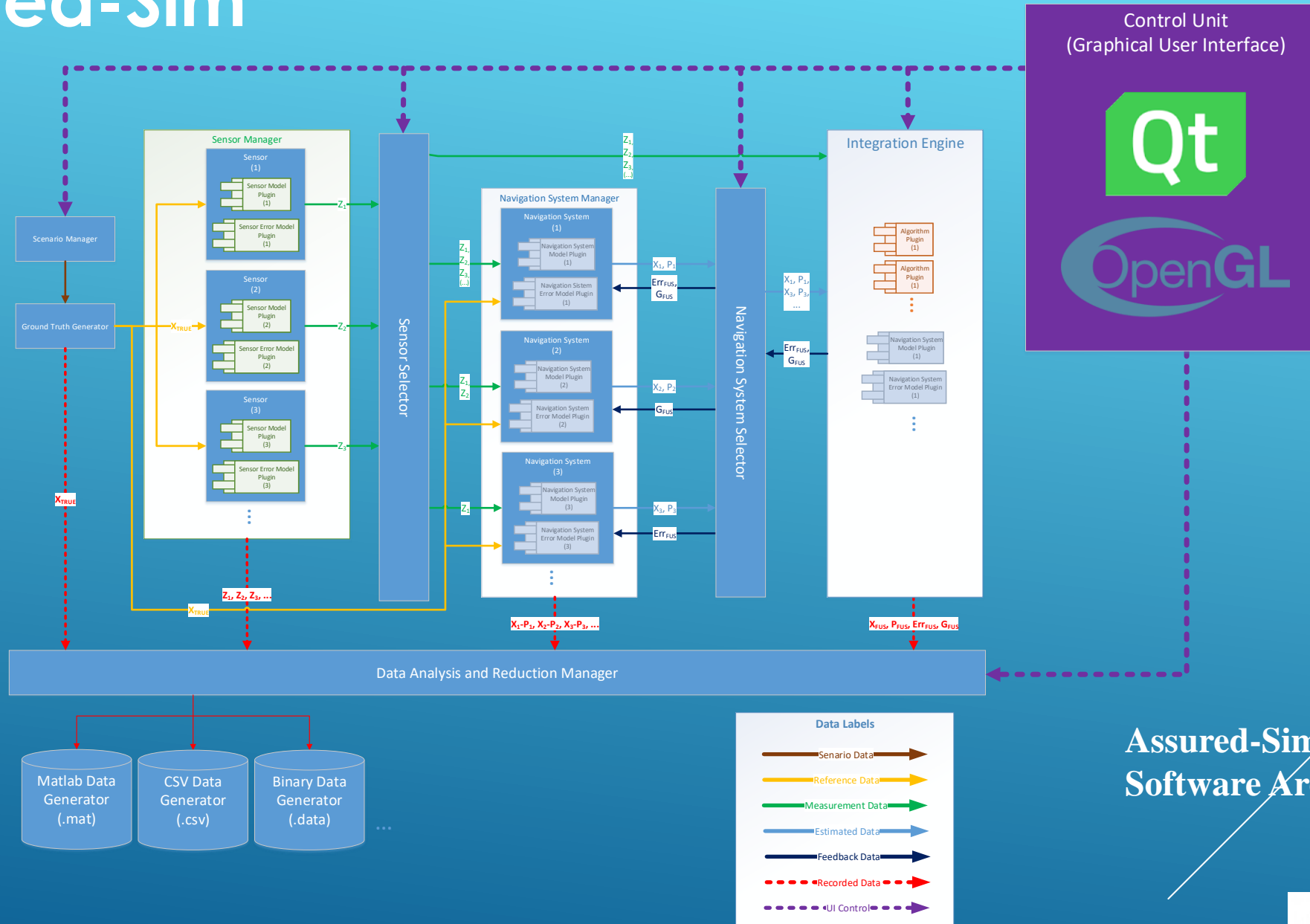
Assured-Sim
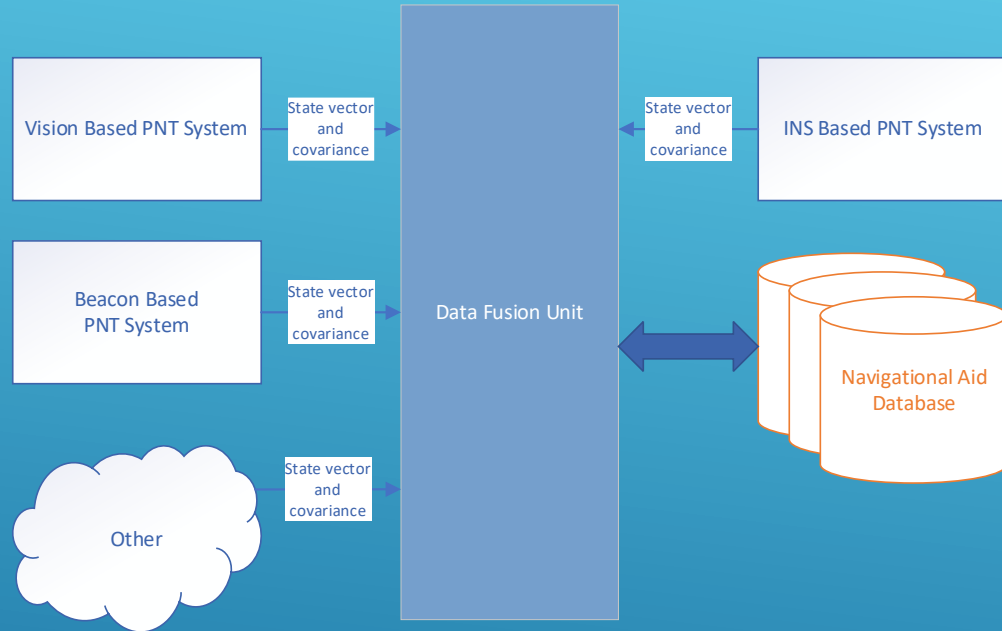
Distributed Integration Architecture

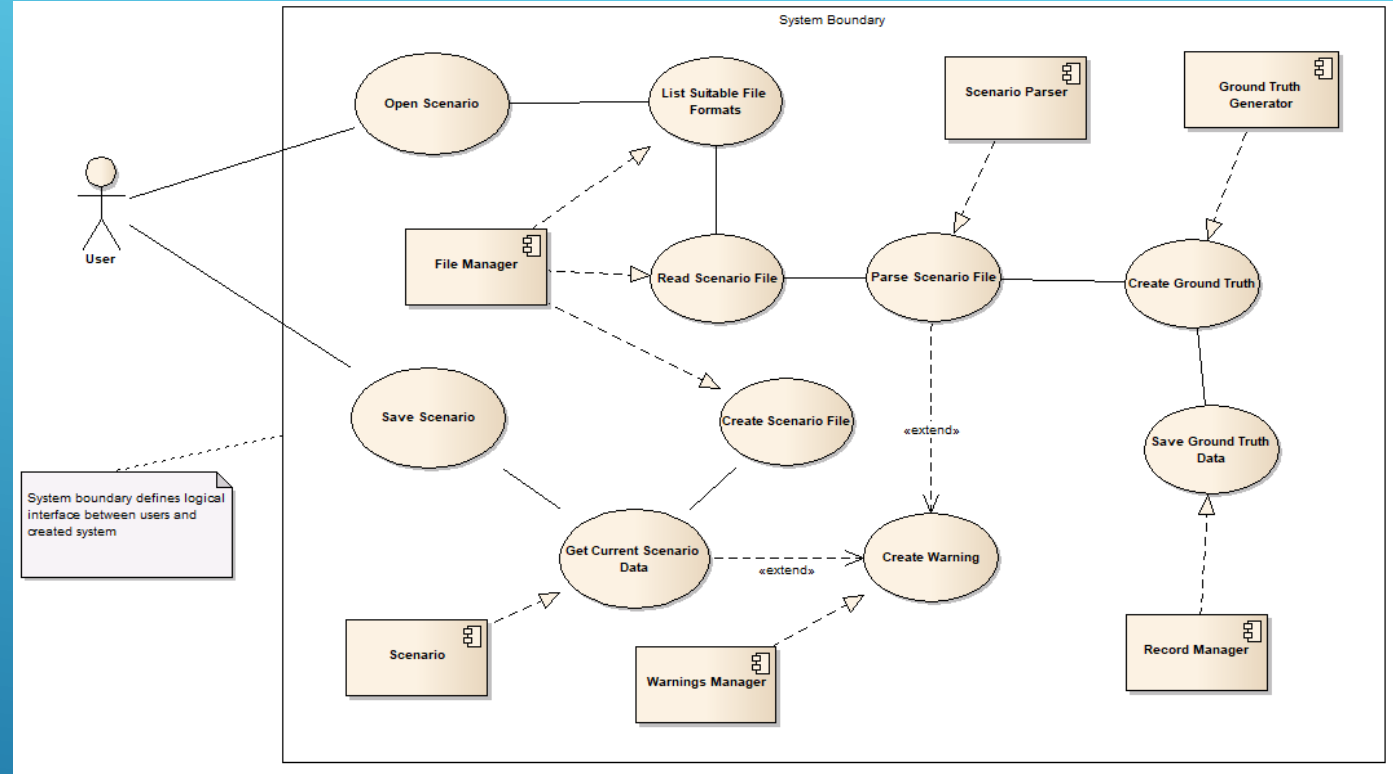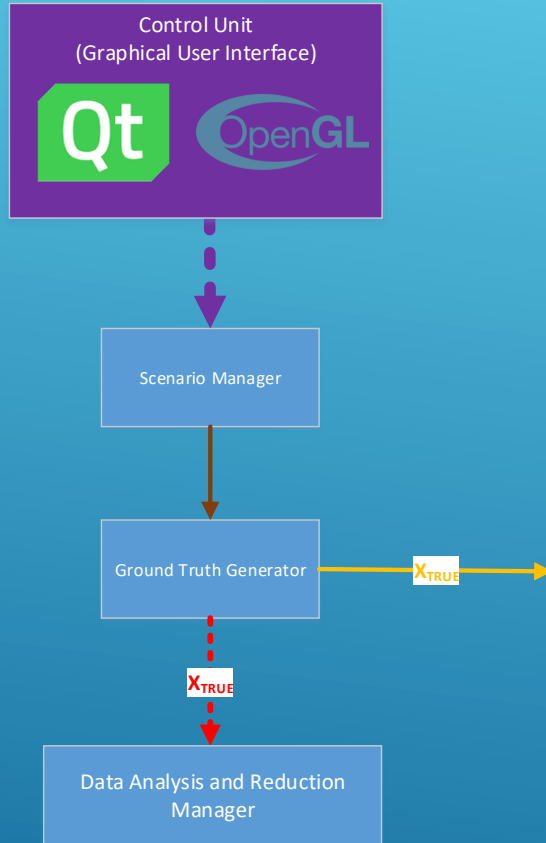INS Centric Integration Architecture

Assured-Sim
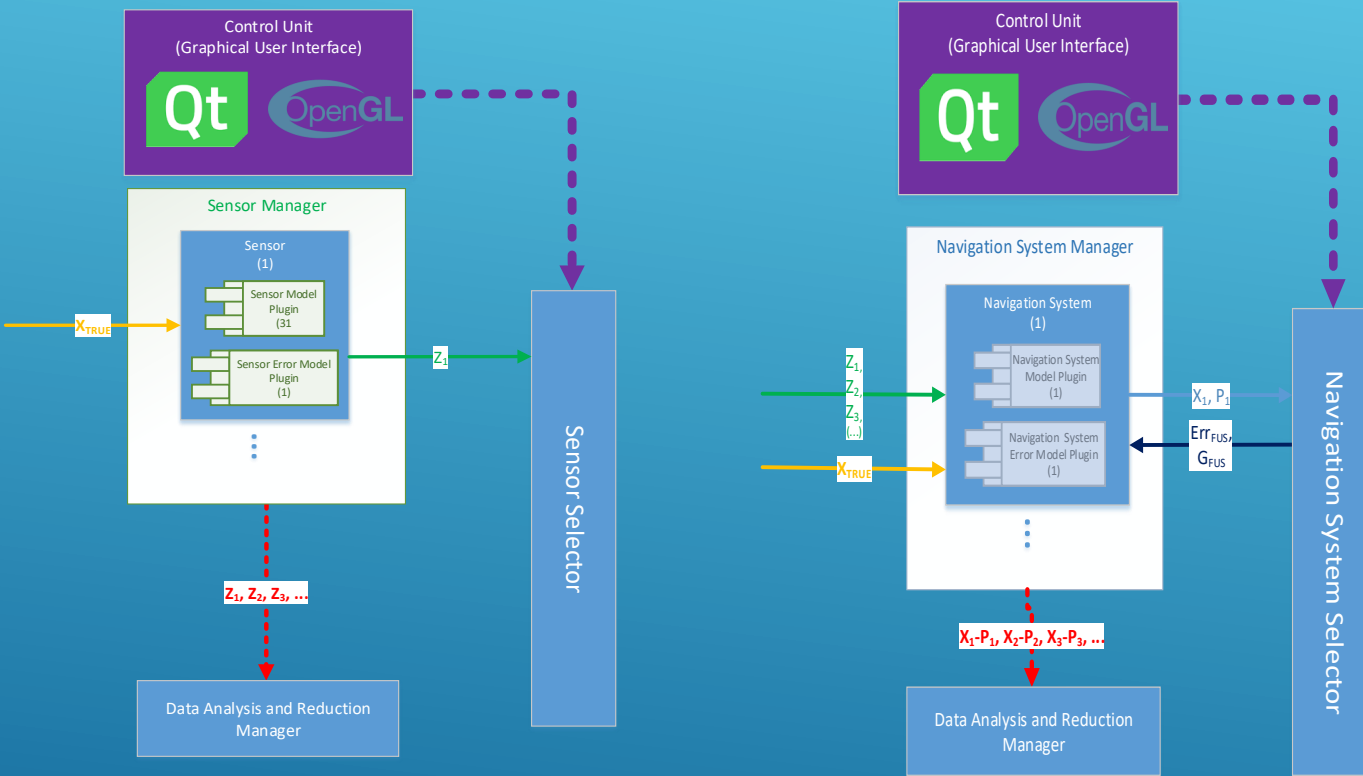

Assured-Sim High-Level Software Architecture

Assured-Sim

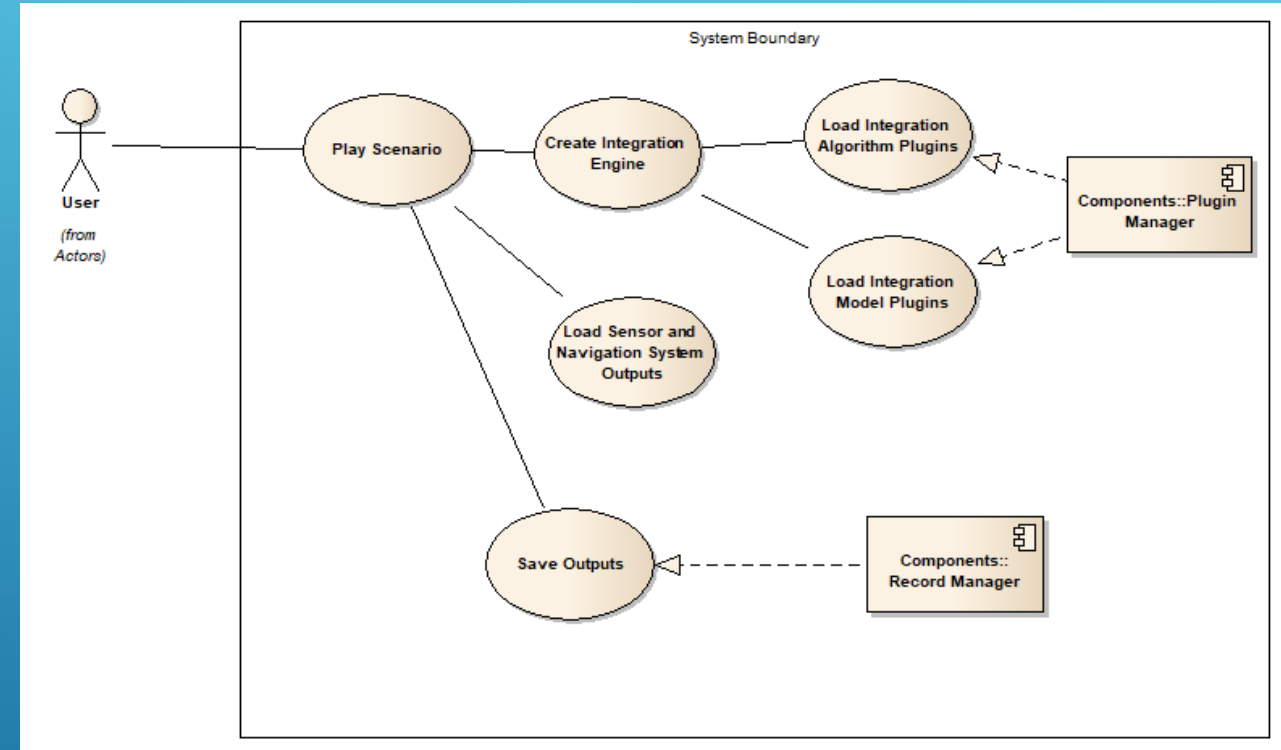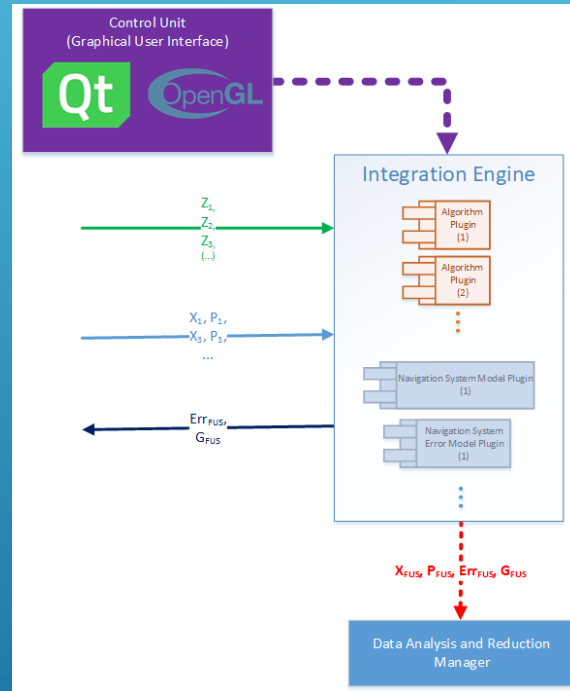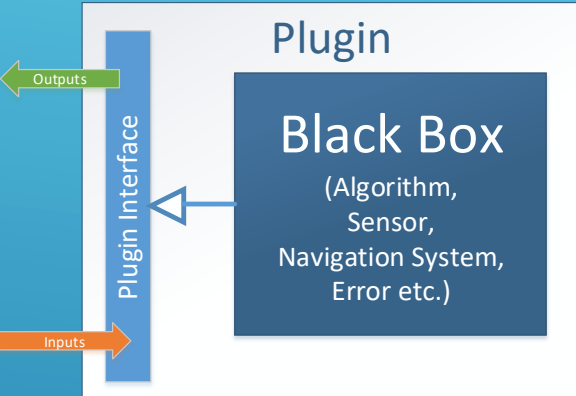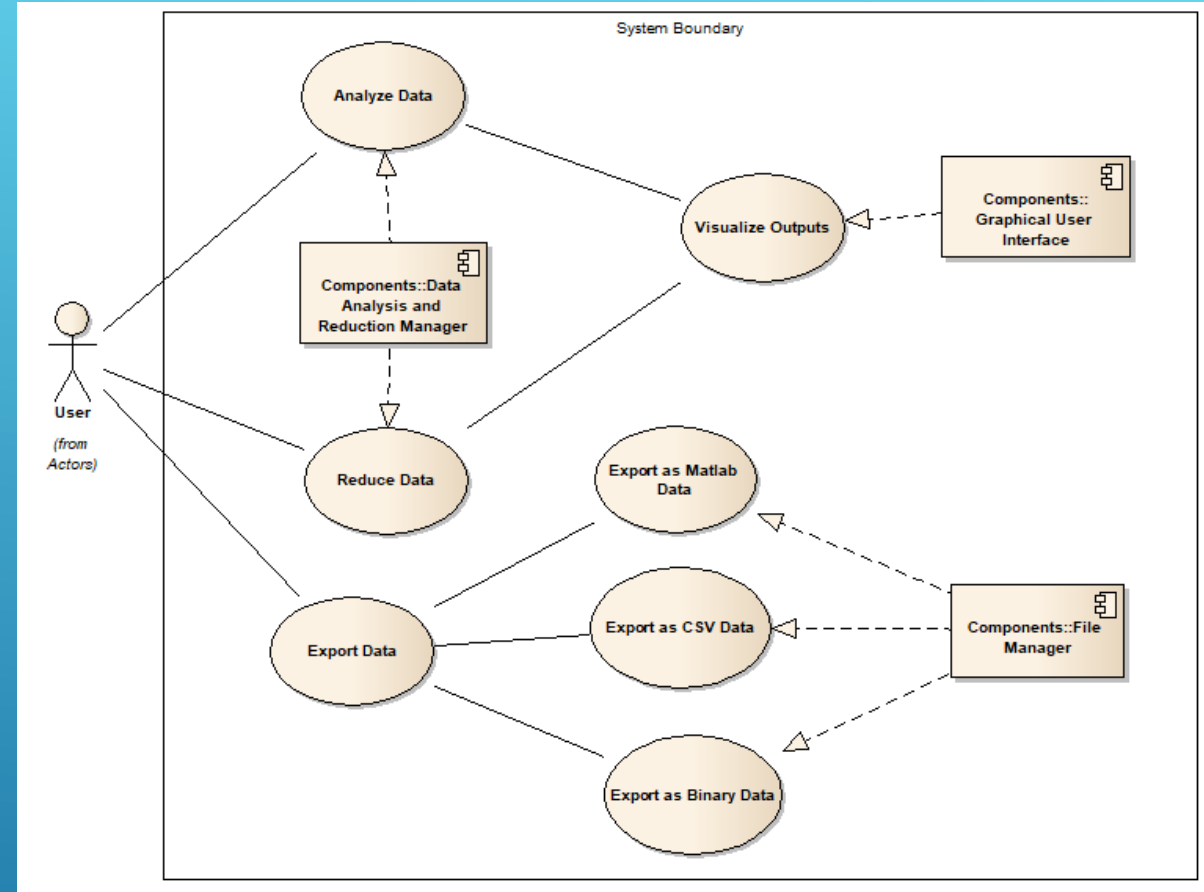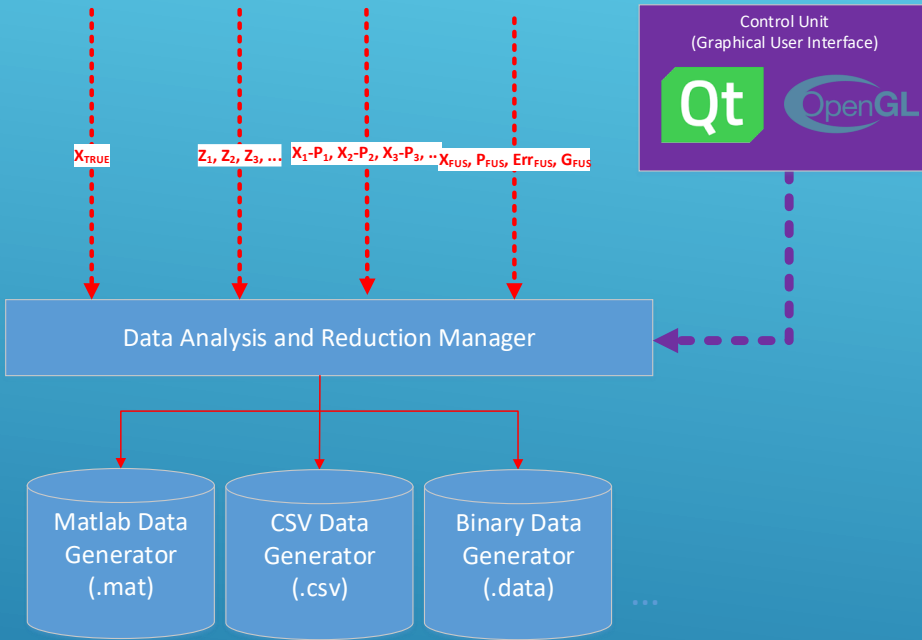Scenario management and ground truth generation

Assured-Sim
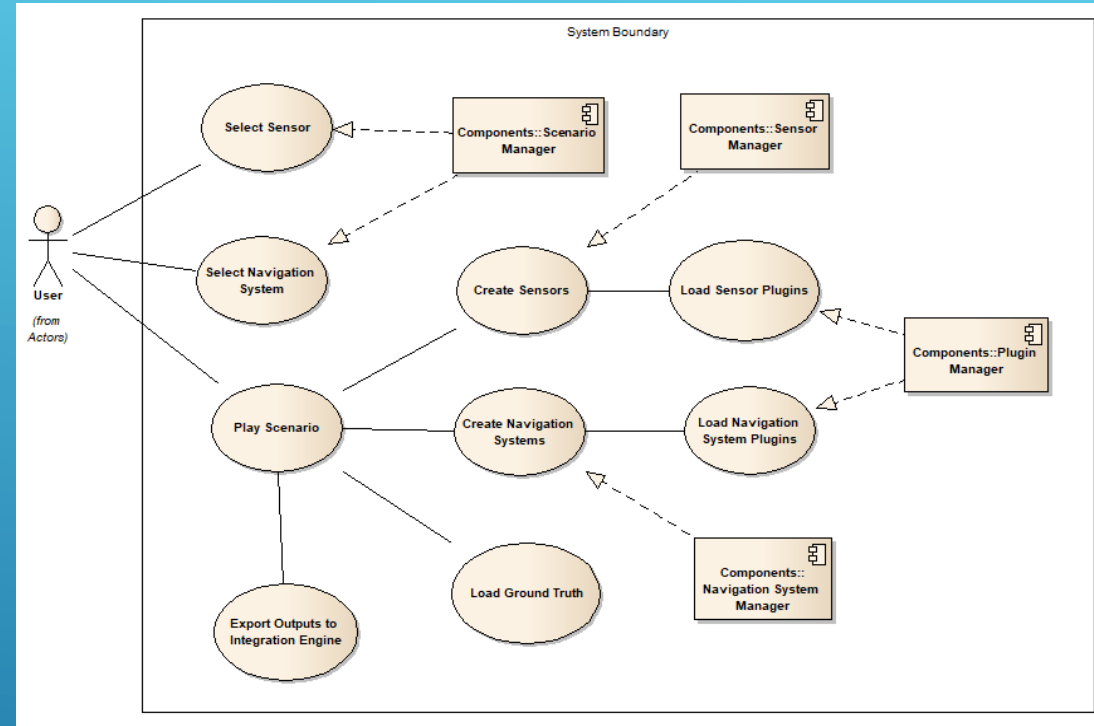
Generation of sensor/system outputs

Assured-Sim

Integration process

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Data analysis and recording

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GNSS Denied environment due to jamming / spoofing etc.

Drone/UAV

EM and/or Optic observation / measurement regarding the drone/UAV

EM and/or Optic observation / measurement regarding the drone/UAV

EM and/or Optic observation / measurement regarding the drone/UAV

Accompanying Platform 1

Accompanying Platform 2

Accompanying Platform *N*

Information Sharing Network for Distributed Decision Making

Distributed Decision Making Sample Scemario

Thank You!

Questions?