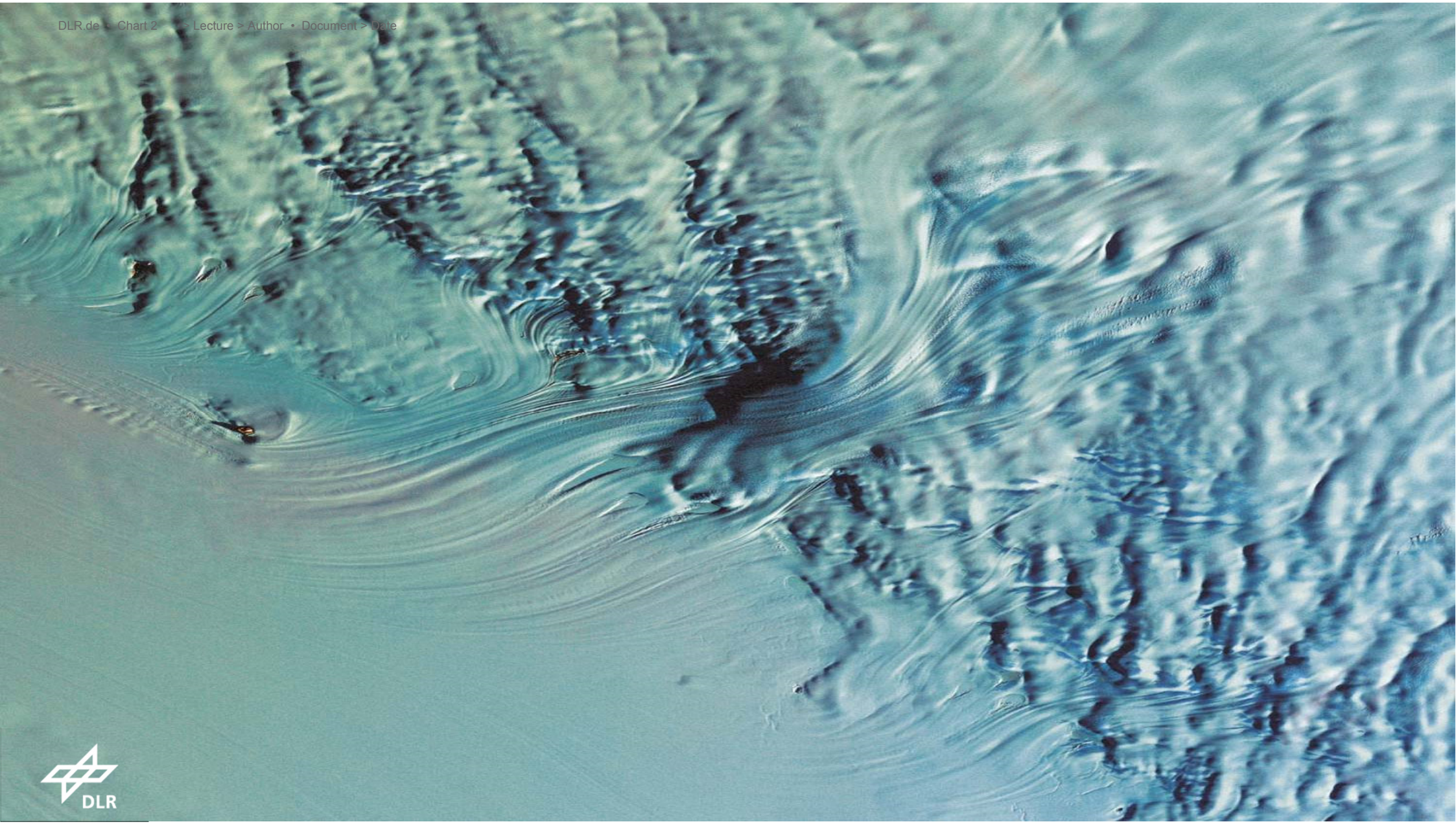
ATM & STM Integration enabler - SWIM in Space

Frank Morlang



DLR

Overview

- **INTRODUCTION**
- **PROVOCATION ☺**
- **MOTIVATION**
- **CHALLENGE**
- **SOLUTION**
- **OUTLOOK**

Introduction

- **Future Commercial Space Traffic assumption**:
  - Will return as a hypersonic glider
  - What does a (Columbia comparable) fatal break up event (ca. 231000 ft. Alt., **speed > Mach 20**) mean ?
    - **Debris** raining down on conventional air traffic will cover a **footprint** of about **300 by 35 nm**
    - No collision of Columbia debris with air traffic was just **luck** (**Casualty propability** for passengers was about **0.3**)

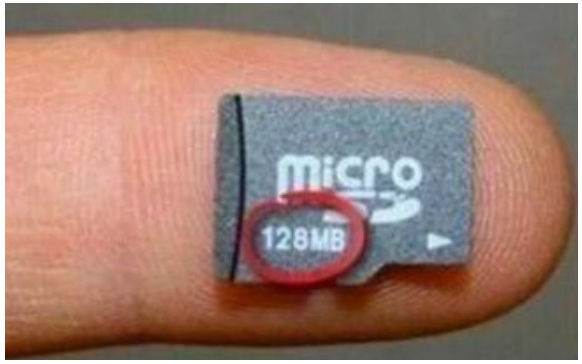
Provocation

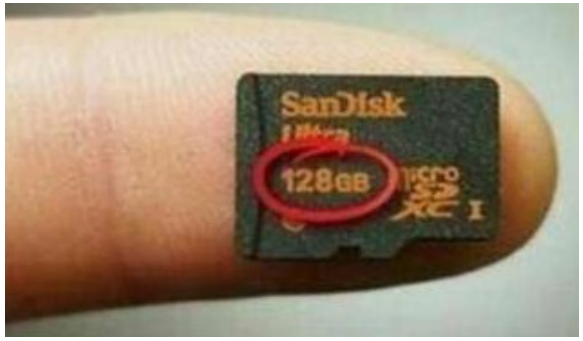
- **Commercial Space Traffic**
  - *Only a few movements per year = research + entertainment for private super millionaires = no air traffic integration considerations needed = If ever relevant, in the very far future !*

  → **Really ?**

Motivation

- 10 years between

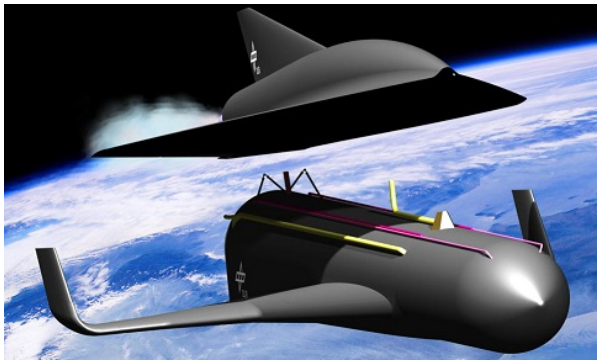




Motivation

- **Now**

- **Future (Who knows when ?)**



Motivation

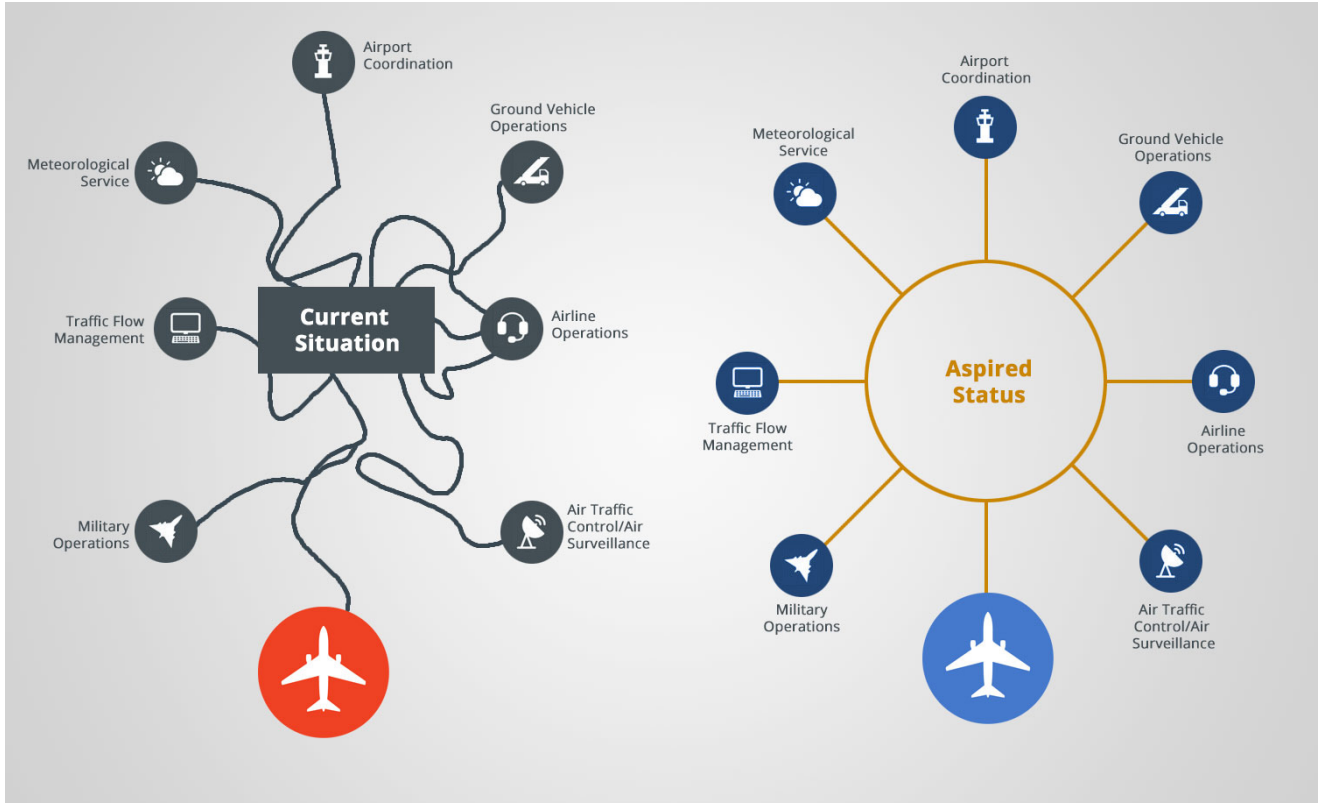
SWIM

= **S**ystem **W**ide **I**nformation **M**anagement

Motivation

SWIM "Intranet for ATM" concept requests **all** the future air traffic participants acting as communicating sub-systems.

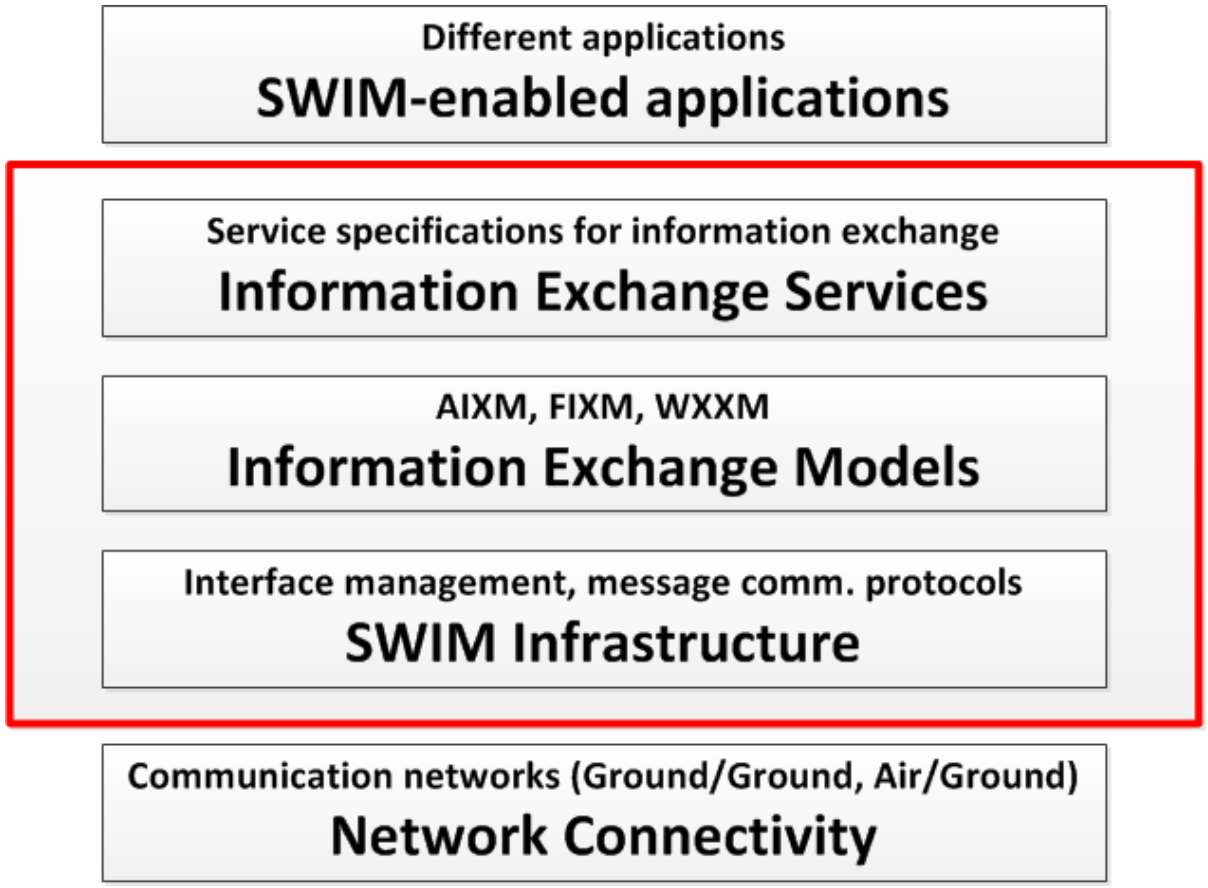
Motivation SWIM → Why ?



Source: https://www.einfochips.com/blog/k2-categories/aerospace/iot-in-aviation-with-system-wide-information-management.html

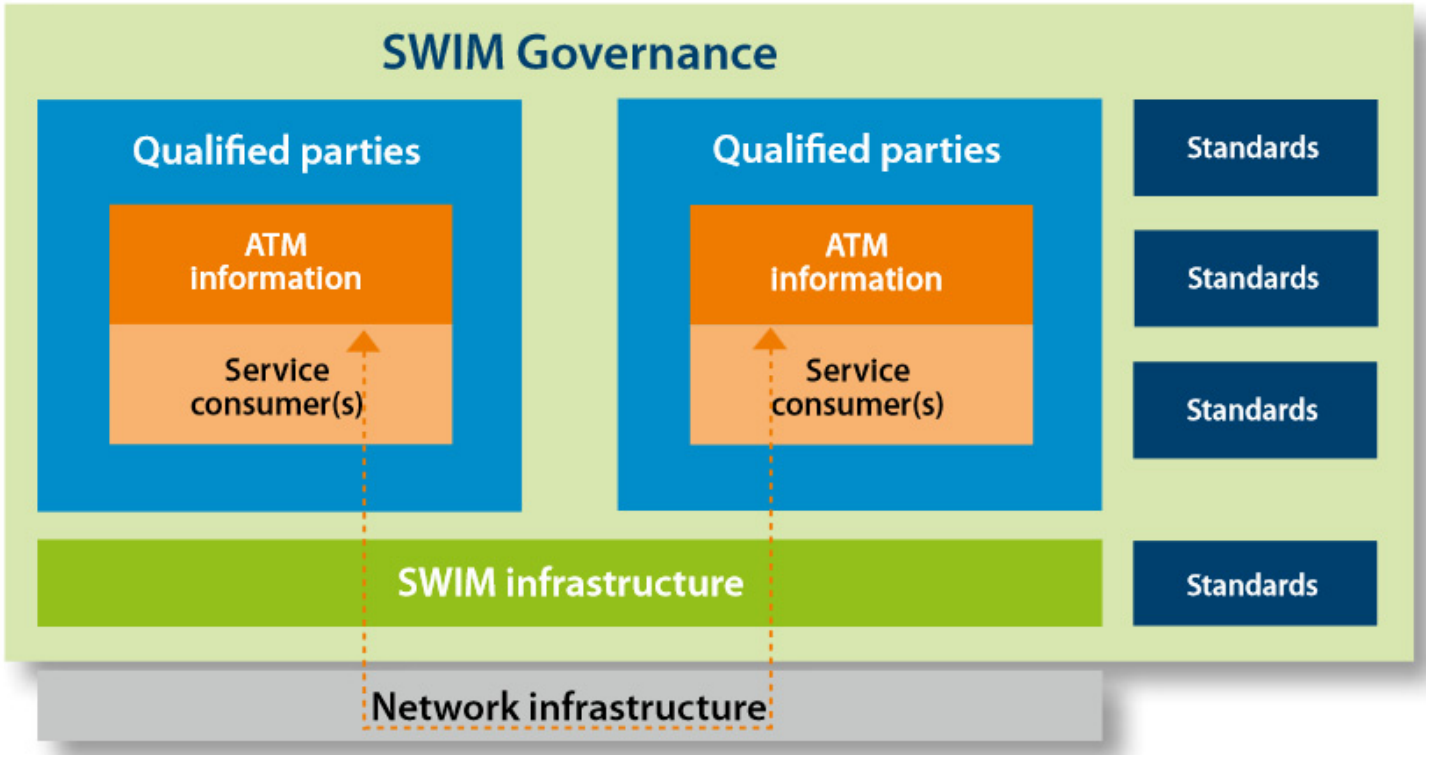
Motivation

SWIM → What ?



SWIM Scope

Motivation SWIM → What ?



Source: http://www.sesarju.eu/sites/default/files/documents/wac/SWIM_Becoming_a_reality_Brochure.pdf

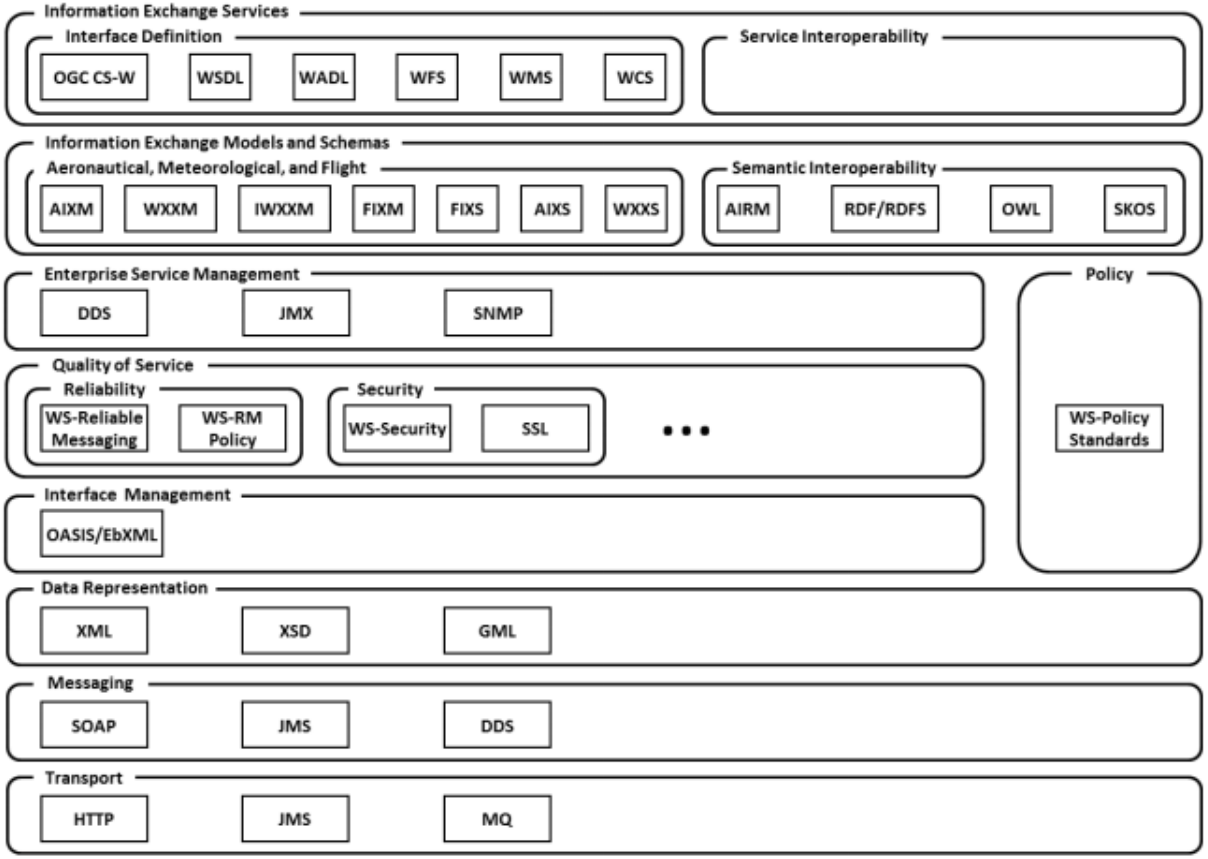
SWIM → What ?

Motivation

- Technical profiles:
  - Yellow → non critical information
  - Blue→ critical information
  - Purple→ Air / Ground info exchanges

Motivation

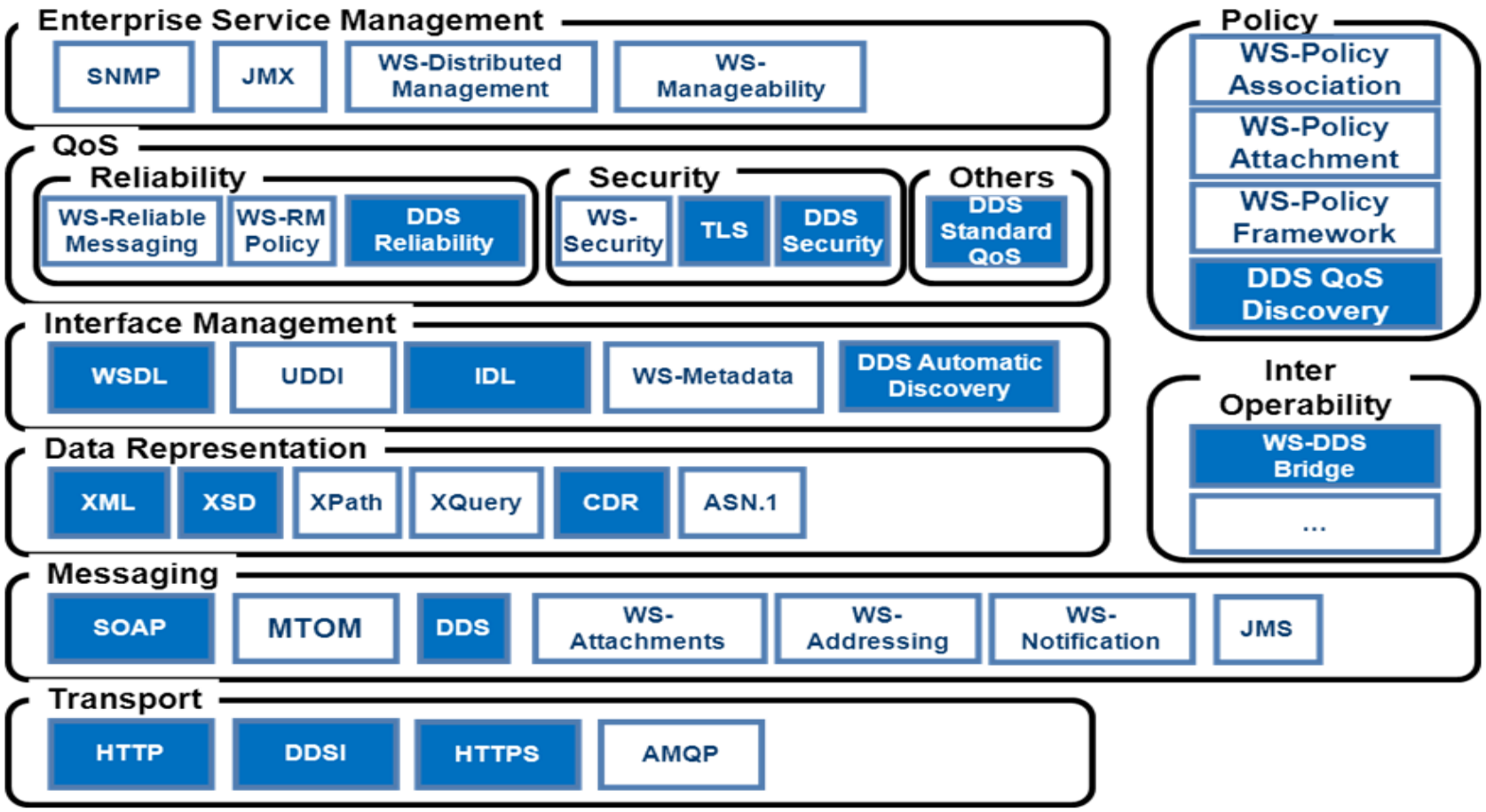
SWIM → What ?



Source: Manual on System Wide Information Management (SWIM) Concept, ICAO Doc 10039 AN/511

Motivation

SWIM → What ?



Motivation

Benefits of acting SWIM compliant

- **Access to real-time, relevant aeronautical, flight, and weather information → faster dedicated response possibilities**

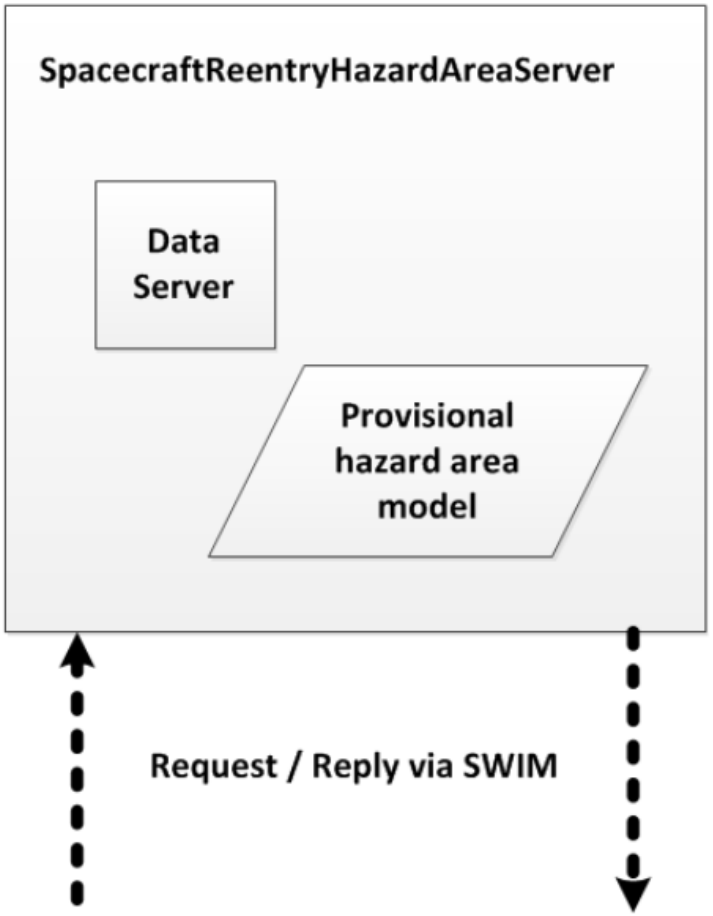
- **Reduced implementation, operating and extension costs because of SWIM's standardized character**

- **SWIM = requested fundament of the future for info based collaboration in ATM (Air Traffic Management) → being prepared for the future**

Challenge

Safe global space traffic integration by taking into account data distribution of its changing debris (= hazard) area during reentry !

Solution



Input:
Hypothetical spacecraft's (returning) runtime data:

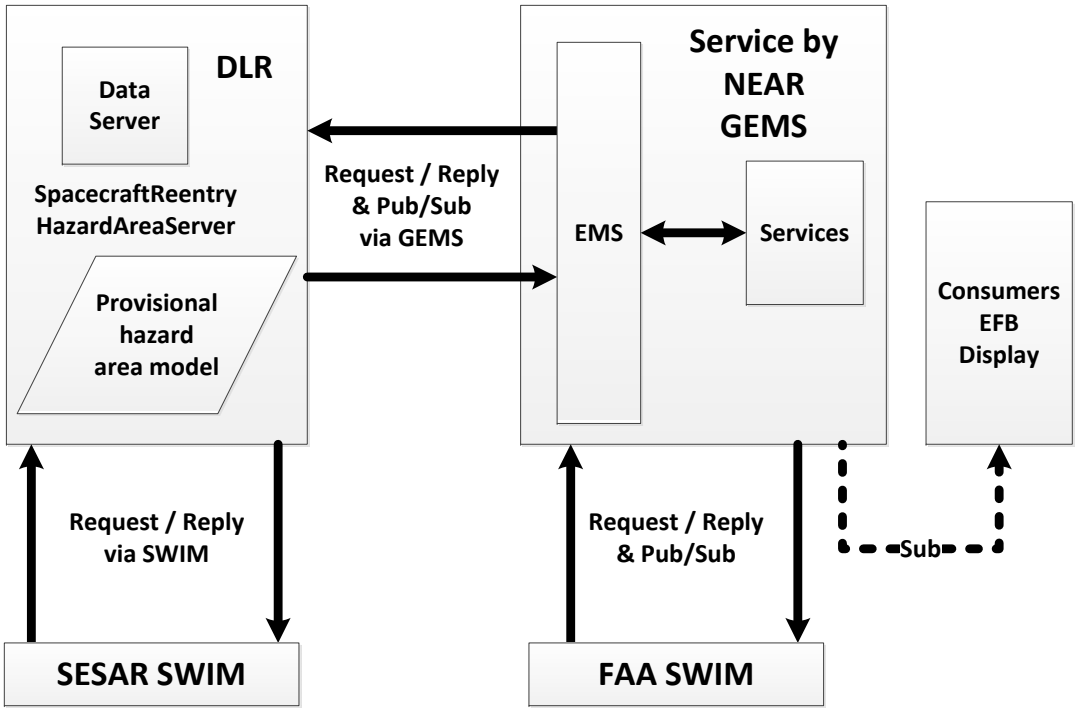
- id
- lat
- lon
- alt
- heading
- path_velocity

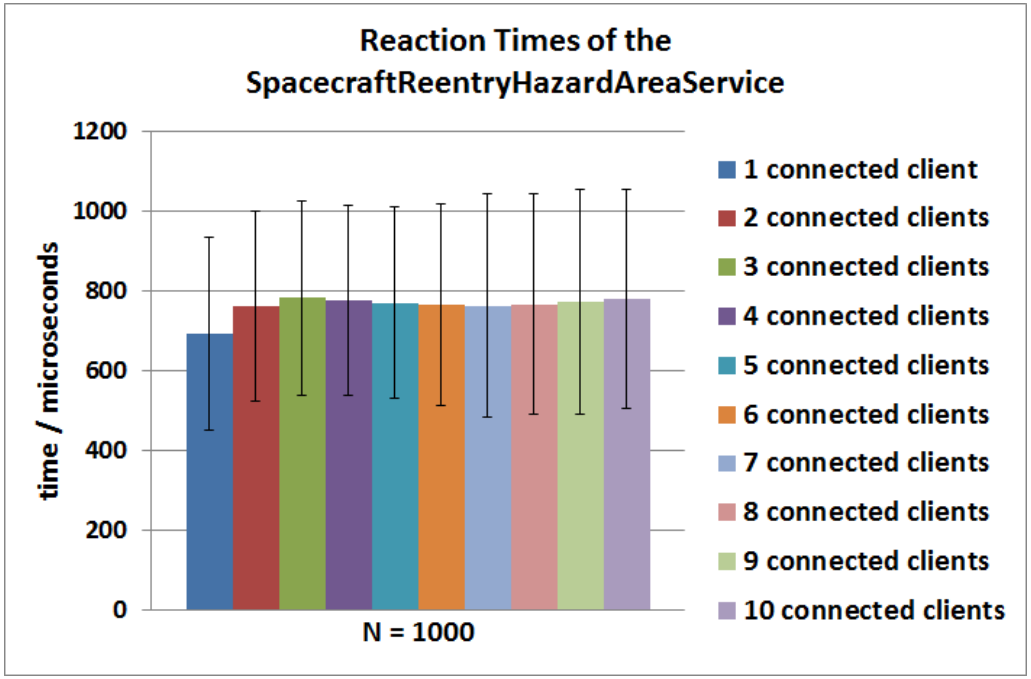
FIXM

Output:
Lat_lon of 4-point-HazardZonePolygon

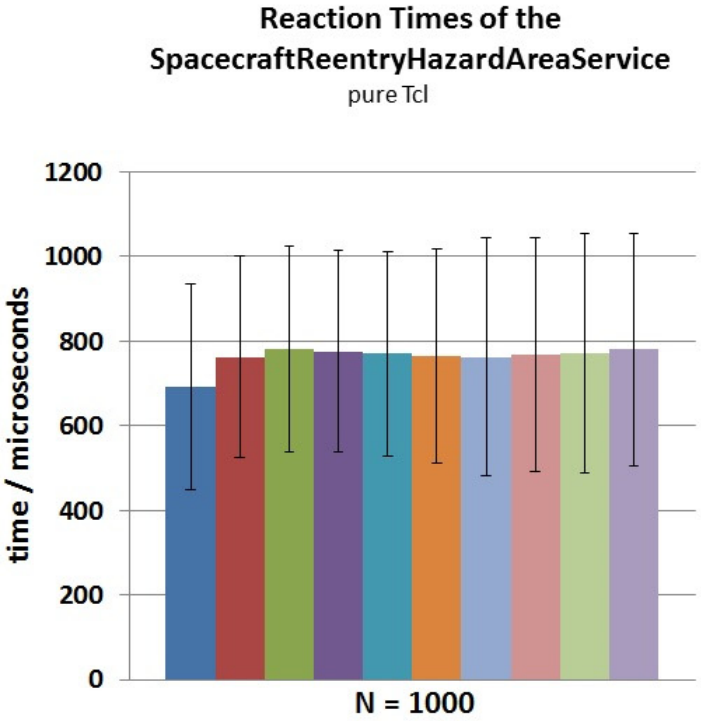
TFR airspace in AIXM

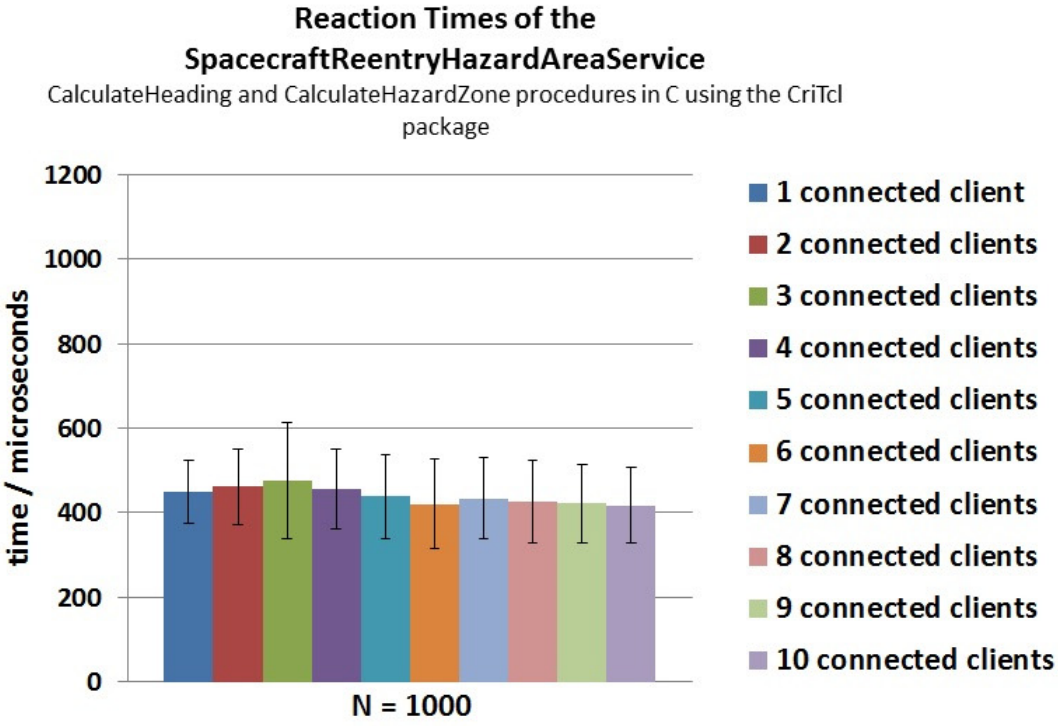
Solution


DLR
Data Server
SpacecraftReentry HazardAreaServer
Provisional hazard area model
Request / Reply & Pub/Sub via GEMS
Service by NEAR GEMS
EMS
Services
Consumers EFB Display
Request / Reply via SWIM
Request / Reply & Pub/Sub
Sub
SESAR SWIM
FAA SWIM


Reaction Times of the SpacecraftReentryHazardAreaService
time / microseconds
1200
1000
800
600
400
200
0
N = 1000
1 connected client
2 connected clients
3 connected clients
4 connected clients
5 connected clients
6 connected clients
7 connected clients
8 connected clients
9 connected clients
10 connected clients

Solution (performance enhancement)

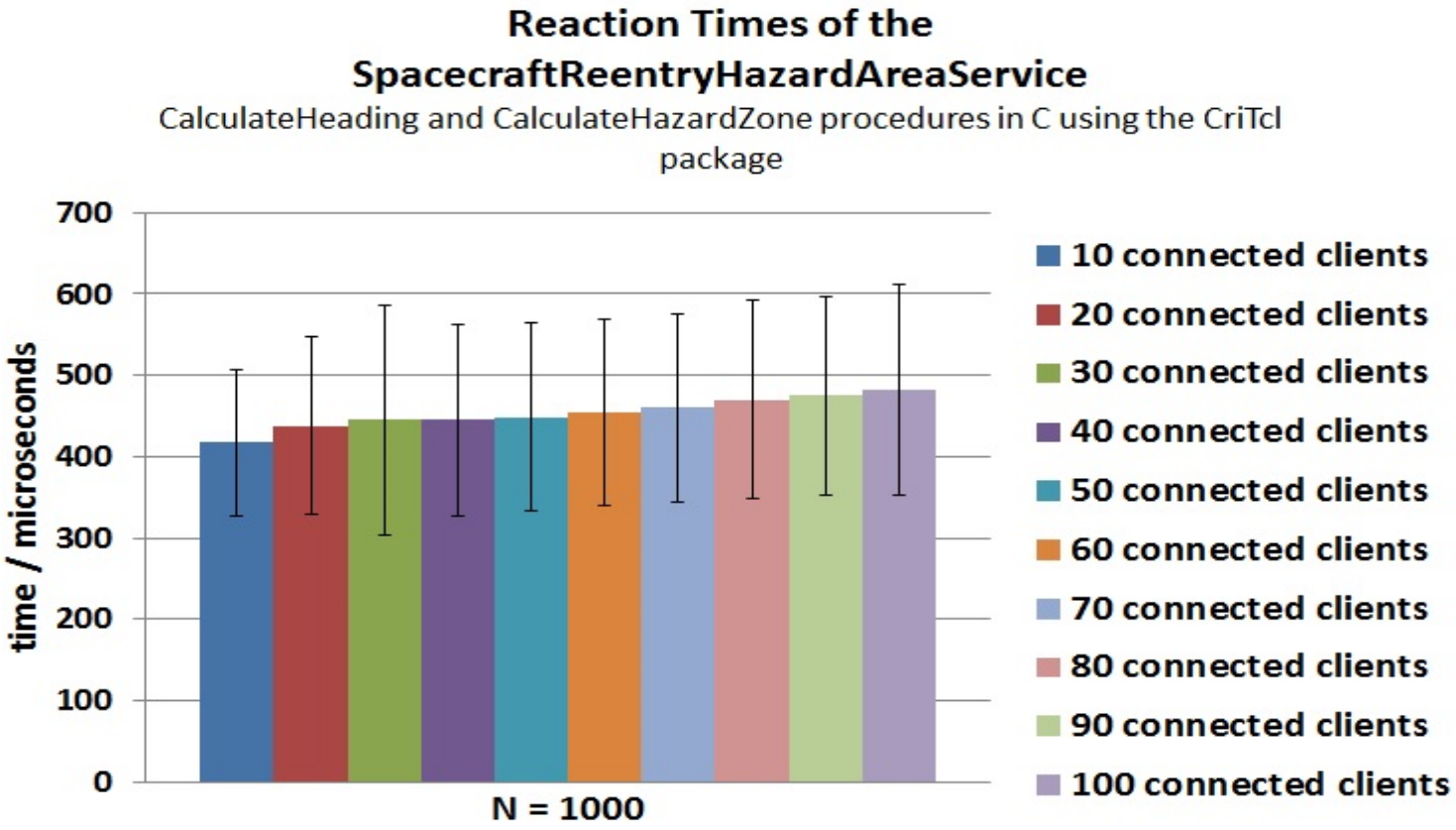




Solution (scalability)

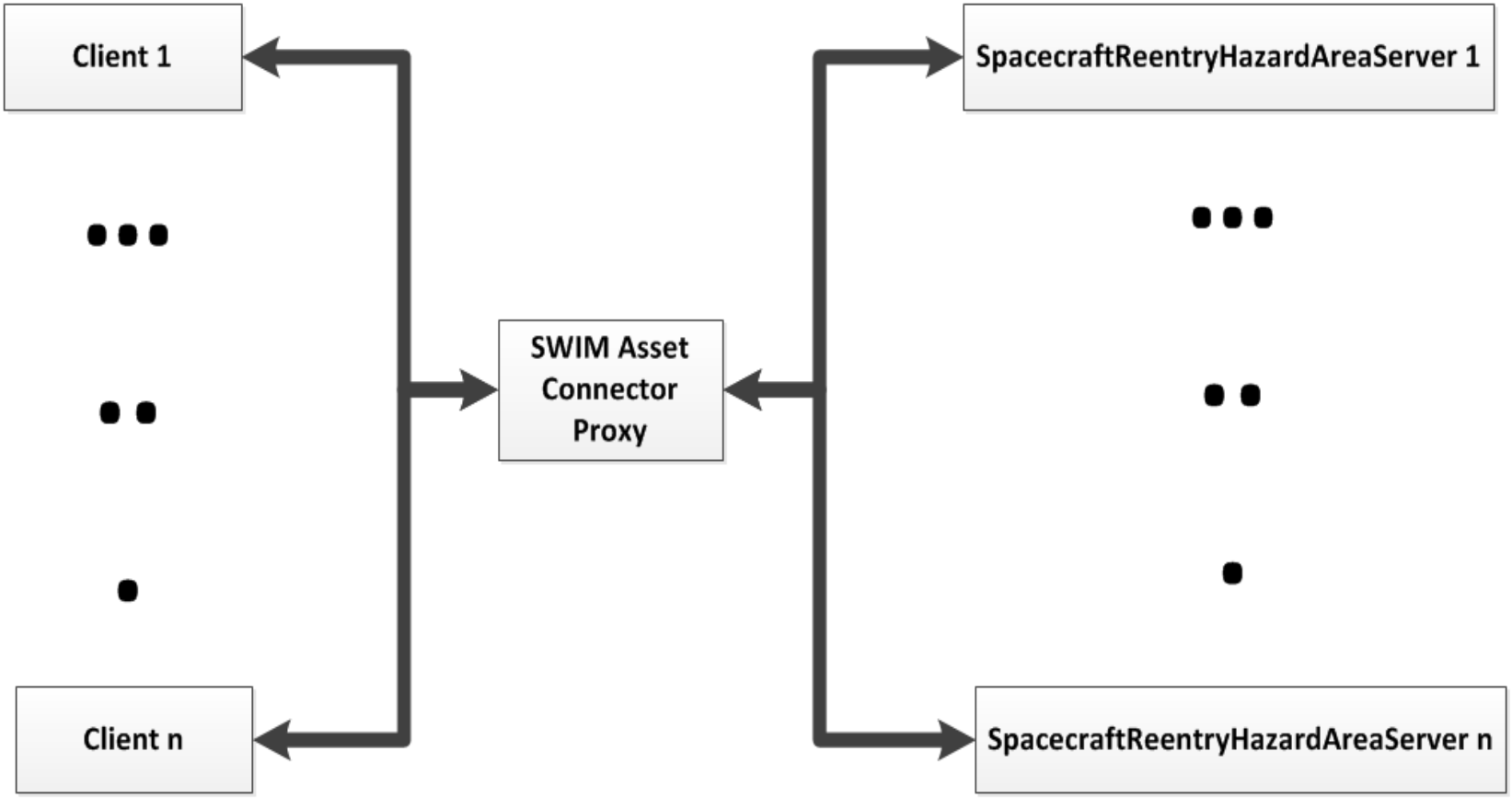
Sufficient for most small and medium sized cases !

Anyhow ….

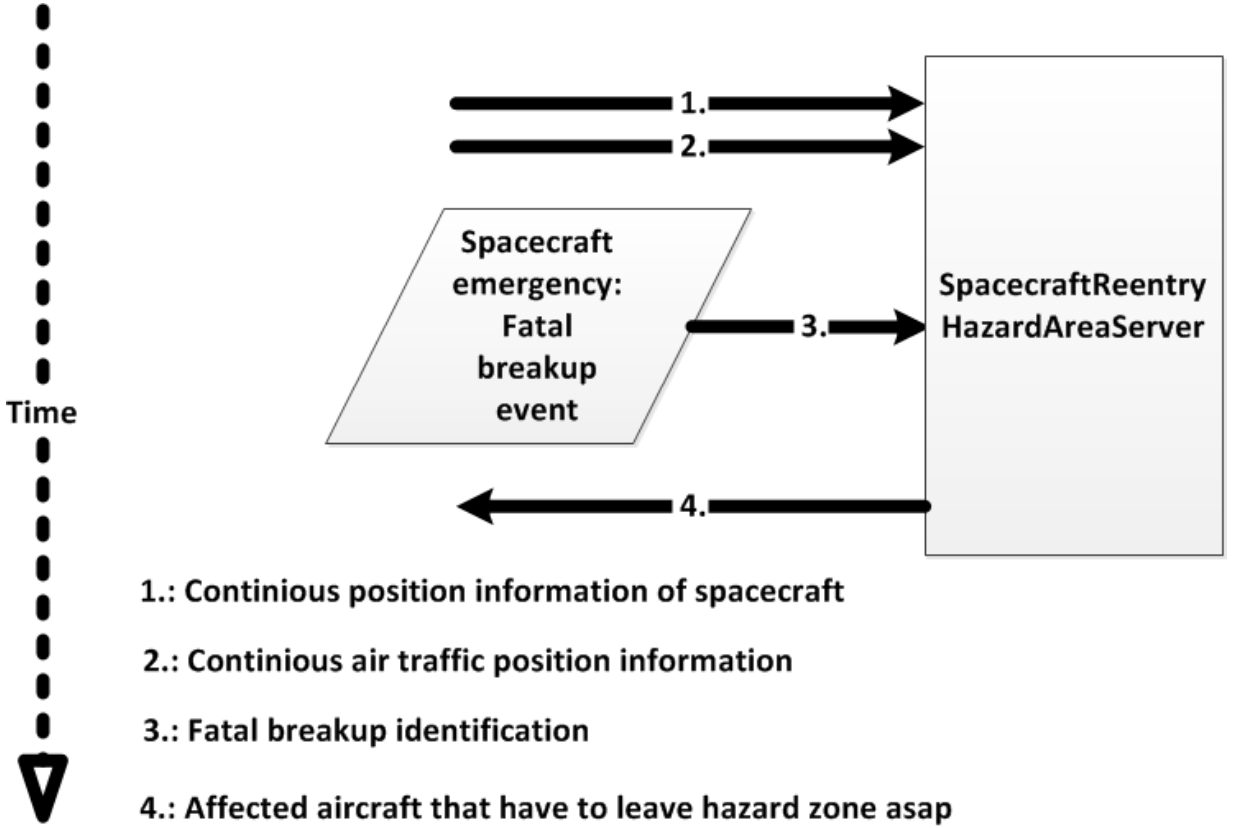


Solution (scalability)

Anyhow ….



Outlook



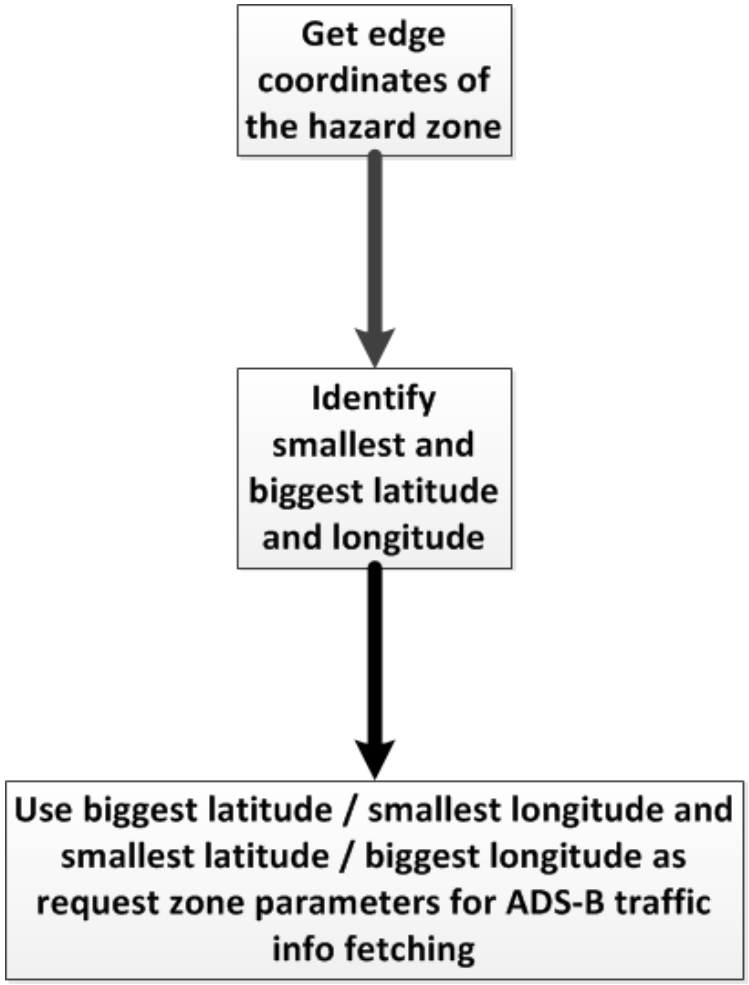
1.: Continious position information of spacecraft

2.: Continious air traffic position information

3.: Fatal breakup identification

4.: Affected aircraft that have to leave hazard zone asap

Outlook


Get edge coordinates of the hazard zone
Identify smallest and biggest latitude and longitude
Use biggest latitude / smallest longitude and smallest latitude / biggest longitude as request zone parameters for ADS-B traffic info fetching

Outlook

- Purple Profile (Air←→Ground Information)