

ICAO EUR/MID Radio Navigation Symposium

Mode N - Digital Solution for Sustainable CNS

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Envisaged Take aways

- Aviation (and other industries) needs more resilience against GNSS disturbance, especially jamming & spoofing
- There is a need for a spectrum-efficient A-PNT solution
- Mode N is a digital A-PNT solution with NAV, SUR and IDENT capabilities, supporting iCNSS
- Wide spectrum of applications: civil and military, manned and unmanned aviation



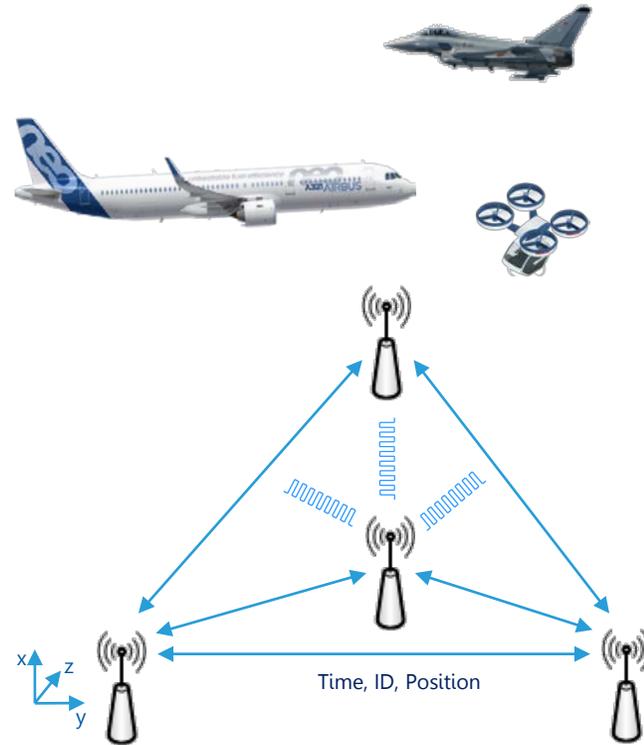
01 **Mode N: Motivation and operating principle**

02 **Fields of application**

03 **Current status**



Mode N – Motivation and operating principle



What is Mode N?

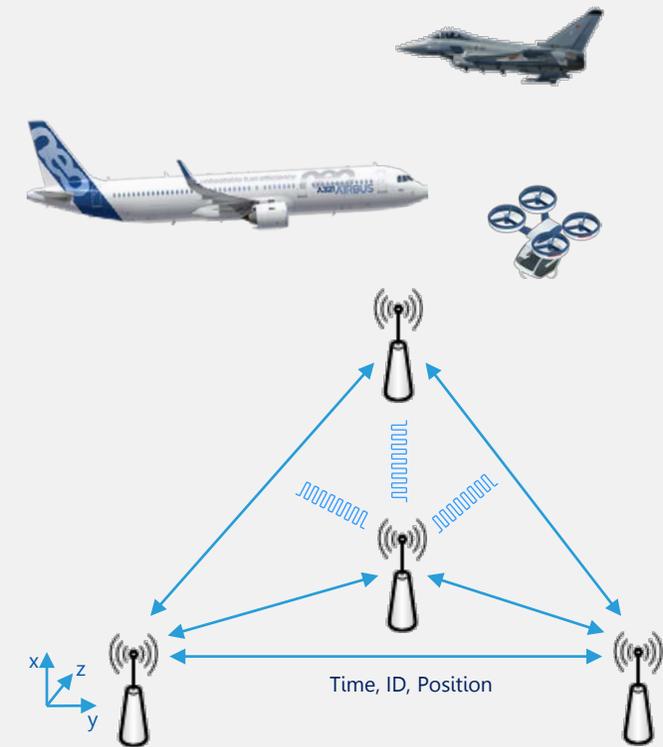
A concept for a terrestrial navigation system (A-PNT)

- A single-frequency solution that requires much less spectrum than DME and TACAN
- Compatible with ICAO PBN, usable for civil, military and unmanned aircraft

Functional principle – "reversed MLAT"

- Timewise synchronized ground stations broadcast a 3D position, time, ID and status
- Aircraft calculates its position by using TDOA and/or slant range measurements to ground stations in radio line of sight

Use of standardized SSR/Mode S signal formats and principles



MLAT	Multilateration
PBN	Performance Based Navigation
TDOA	Time Difference on Arrival
TOA	Time on Arrival

What is Mode N?

Aircraft system – frequency-agile, multi-mode capability across the entire L-band

Passive operations

- Aircraft position is calculated using TDOA measurements

Active operations

- Emulates the DME/TACAN interrogator
- Induces more Mode N squitters from ground stations for additional TDOA measurements
- Verification of the position of the ground station in case of reasonable doubts about the correctness
- Determination of aircraft position by two-way distance measurements in case of lack of Stations for passive operation (e.g. at low altitude)
- Precise synchronization of time of the ground stations and on board for TOA measurements
- Compensation for the loss of time synchronization of the ground station

} Integrity

→ Accuracy

→ Safety



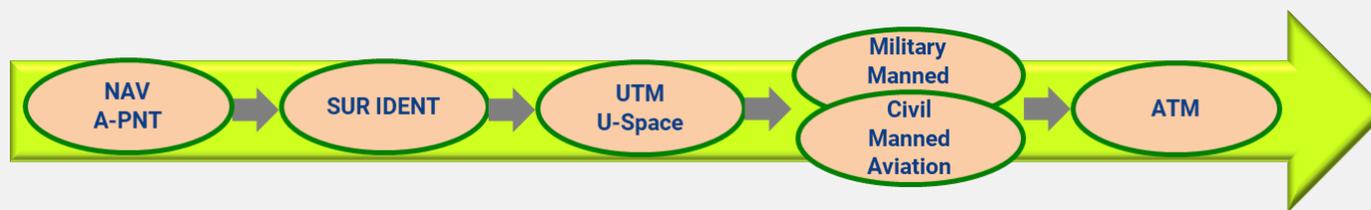
Potentials

Mode N

- ...modernizes, streamlines and digitalizes the CNS infrastructure
- ...strengthens the safety and resilience of the entire aviation system
- ...provides a step towards iCNSS (integrated CNS and Spectrum)

- ...frees spectrum for new broadband services (e. g. LDACS) by replacing DME and TACAN
- ...offers NAV and SUR solutions for UAS operation in U-Space/UTM/ATM and HAO

02 Fields of application



Manned Systems

The system is a **future-oriented solution** and offers:

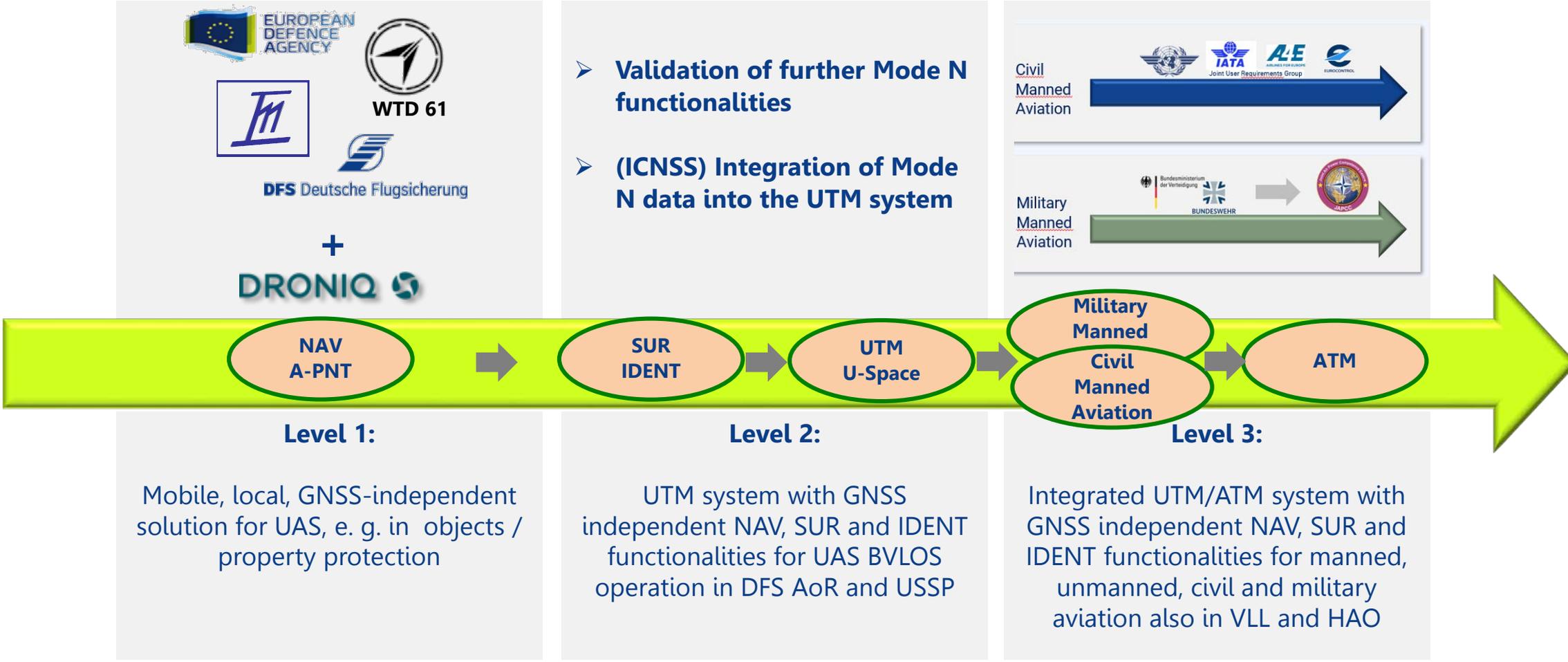
- **A-PNT: Resilience** of the aviation system and KRITIS through
 - **NAV**: Localization (incl. time signal)
 - **SUR**: Position data (GNSS and/or Mode N) via ADS-B and/or Mode N infrastructure
 - **IDENT**: Identification via 24-bit addresses
- Enables the **replacement of DME**
- **Simplified standardization**: Re-use of Mode S standards (ICAO, EUROCAE)
- **Backwards compatibility**: the Mode N on-board unit also uses DME and TACAN ground infrastructure → Parallel operation allows (to a certain extent) a time variable introduction.

Unmanned Systems

Mode N offers an alternative to GNSS for unmanned aviation:

- **Localization + Surveillance + Secure Identification**
- Information source **usable for USSP and CISP**
- Low threshold for adoption: Less regulated market, can be rolled out locally / regionally → Quick win?

Adressing Mode N in three storylines



03 Current Status





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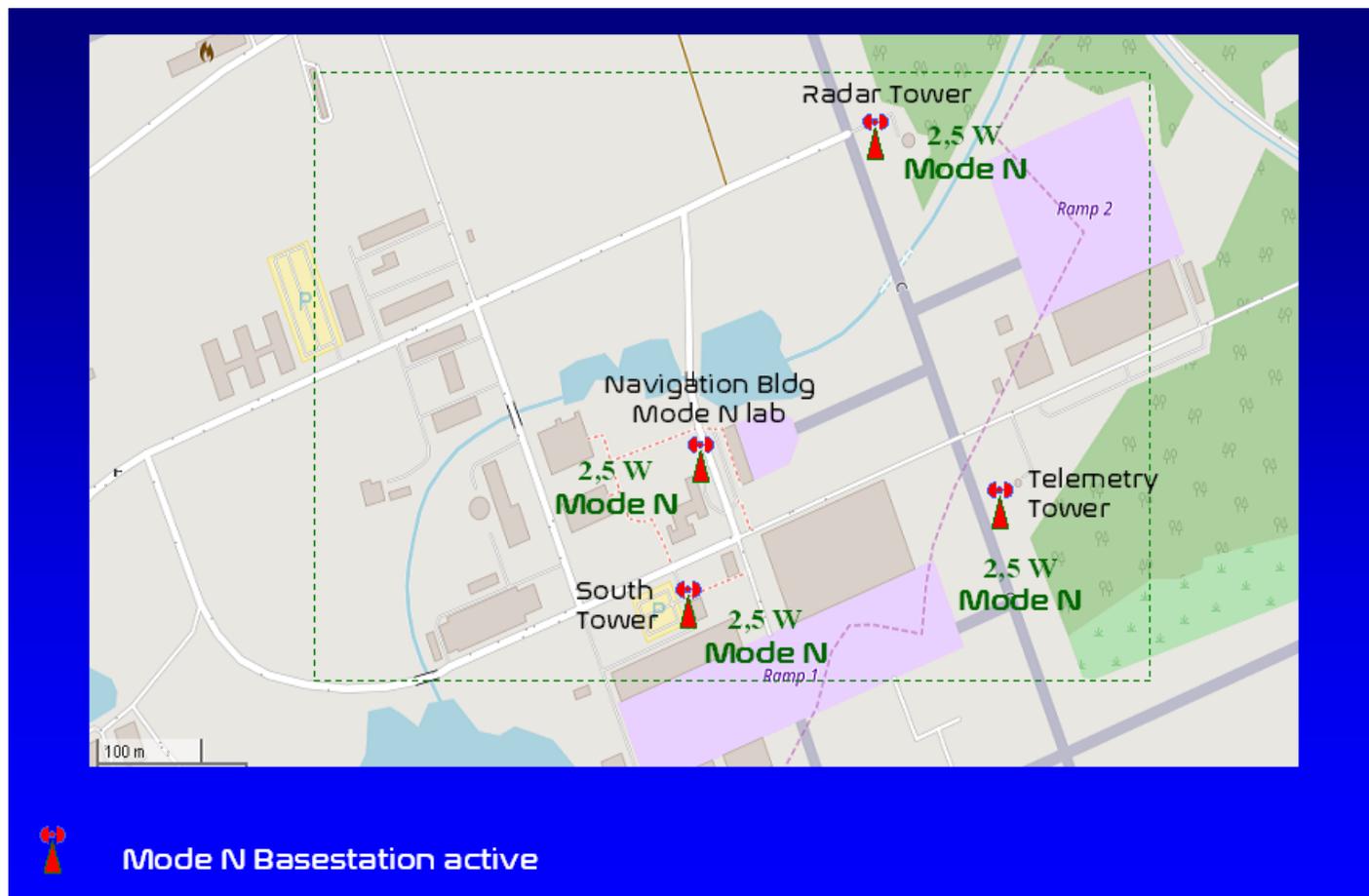


DFS Deutsche Flugsicherung

Ongoing activities

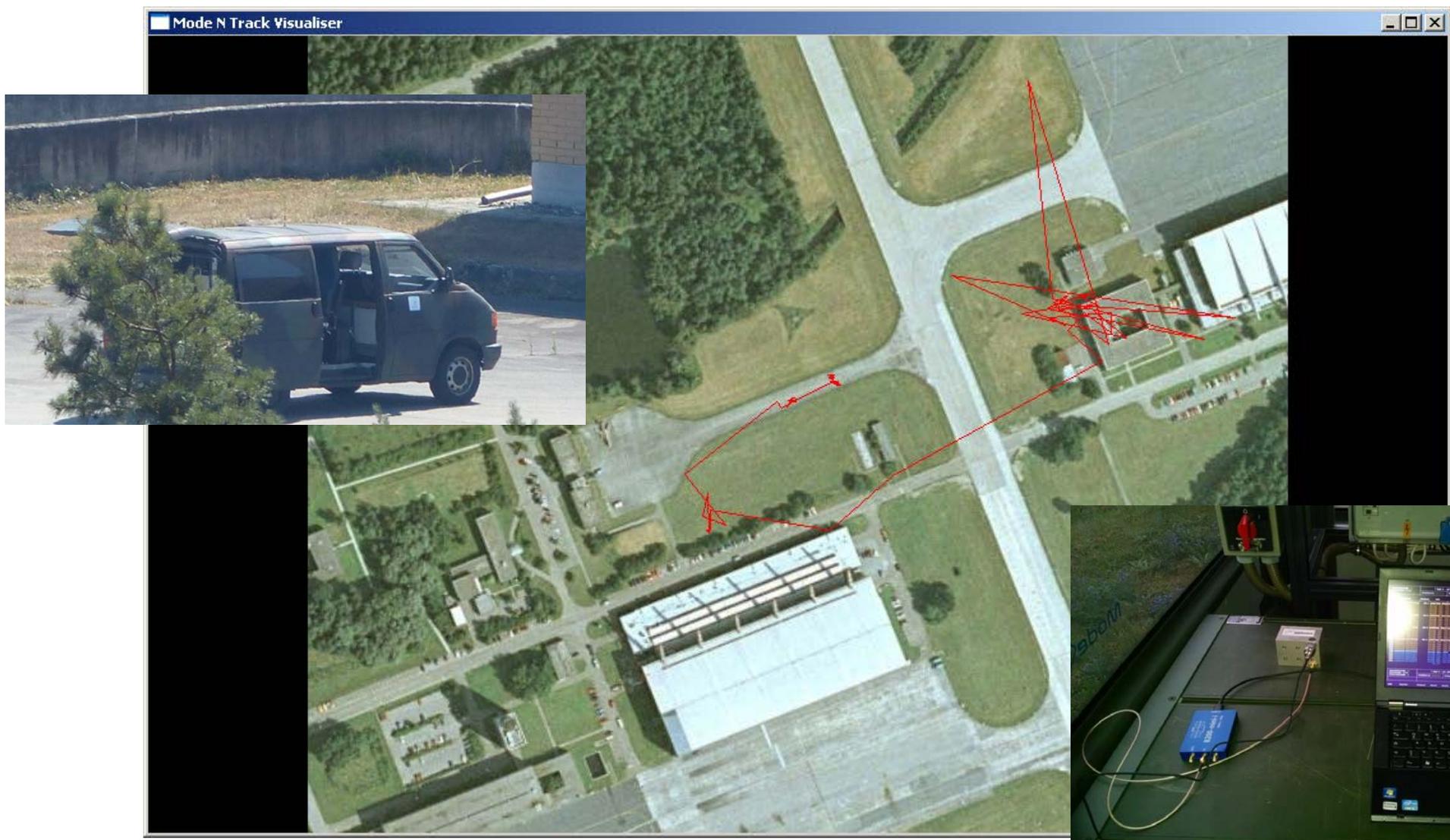
- European Defense Agency - EDA project: DFS cooperation with German Forces and IECM
- 24/7 operation of prototype ground stations at Manching airfield
- Operational range (< 125 km) validated with 2 ground stations
- Expansion of the ground infrastructure in southern Germany
- Possible use of DFS sites

Mode N Test-range with 4 stations at Manching



Mode N Basestation with 500 W amplifier

First Mode N Track on 20th of September 2023



Take aways

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- There is a need for a spectrum-efficient A-PNT solution
- Mode N is a digital A-PNT solution with NAV, SUR and IDENT capabilities, supporting iCNSS
- Wide spectrum of applications: civil and military, manned and unmanned aviation
- First field trials successfully accomplished at Manching airfield



Thank You!