CEMTEx
Army Centre for Operational Experimentation and Technological Modernization

Developing a (C-)UxS ecosystem for the Portuguese Army:

"EXE02 – Remote and Autonomous Systems"

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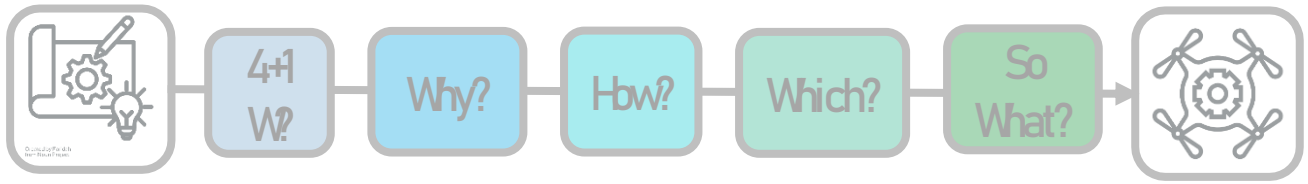
Ao serviço dos Portugueses

Disclaimer: *the images shown throughout the presentation should be understood as merely illustrative of desired UxS concepts, and not as endorsements of specific UxS systems.*

Agenda



1	Overview	What? Who? Where? When? + What for?
2	Filling Capability Gaps *vs.* Implementing Disruptive Tech	Why?
2.1	The Impact of UxS on Land Tactics	Why are UxS disruptive tech?
2.2	Implementing an Evolving UxS Ecosystem	Why should UxS be viewed as part of an evolving ecosystem?
3	From CONOPS to Capability	How?
3.1	From Use Cases to Specs	How are desirable and feasible UxS concepts identified?
3.2	From Prototype to Low-Rate Initial Production	How are the UxS concepts being developed into capabilities?
3.3	The role of Operational Experimentation	How are UxS concepts tested and evaluated?
4	The EXE02 – RAS UxS Concepts	Which?
5	The EXE02 – RAS End State	So what?

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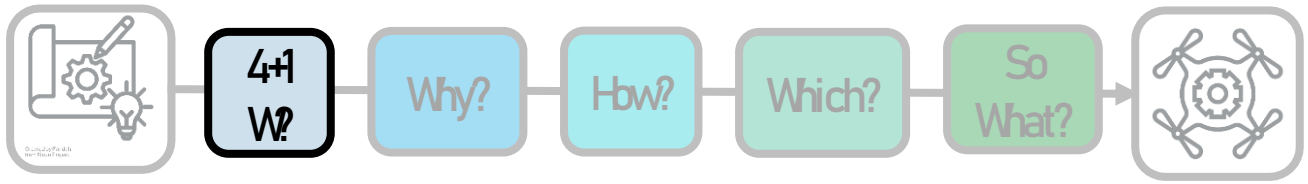
1. Overview



Who?

Portuguese Army through **CEMTEx** funded by the Military Programming Law (**LPM**)

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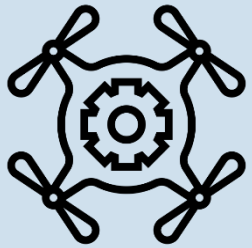
What?

Acquires, Develops, and Tests prototypes and demonstrators (**TRL 4-8**) of UxS (**UAS + UGS**)



Where?

From **Industry** and **Academia**

When?

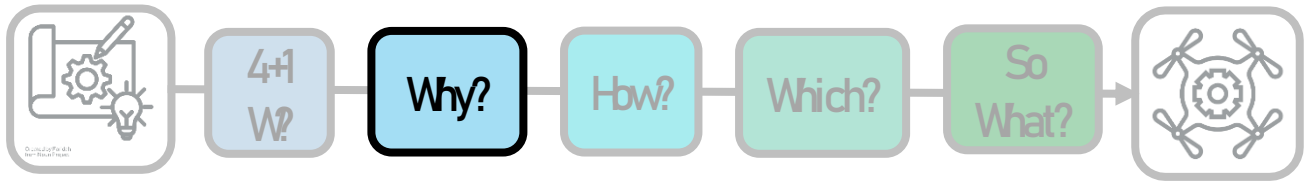
Along three phases between **2024** and **2034**:

1. *COTS Acquisition (2024-2026)*
2. *Public Purchase of Innovation (2026-2030)*
3. *Low-Rate Initial Production (2030-2034)*

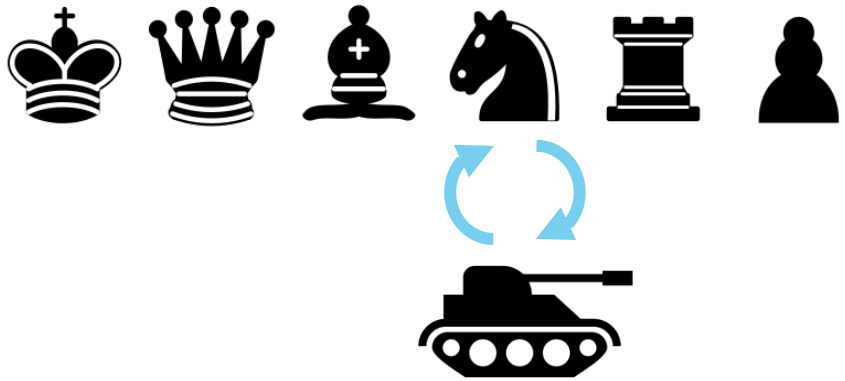
What For?

- To implement on a limited scale **innovative** and **disruptive concepts of operation** through the use of **UxS**
- To stimulate the **Portuguese National Scientific and Technological System**

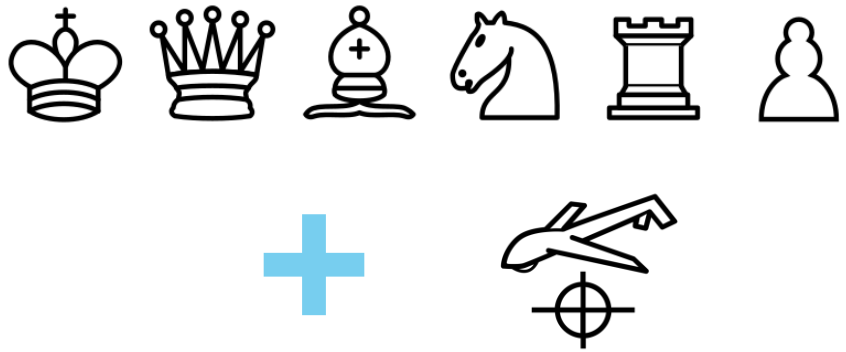
2. Filling Capability Gaps *vs.* Implementing Disruptive Tech



You have a 10M€ budget. Do you…



…upgrade a legacy capability which might lose relevance in the short-term?



…bet on adding an experimental, but potentially disruptive capability whose development cycle might never conclude?

…Or do you do both?!

Why is the Portuguese Army investing in devoping an experimental (C-)UxS ecosystem?

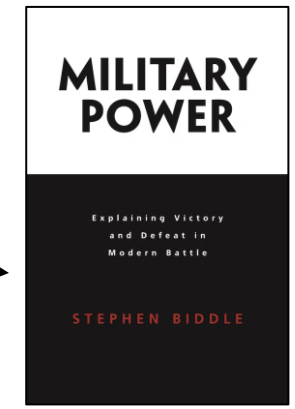
Why does the Portuguese Army consider UxS as disruptive technologies?

Why should UxS be viewed as part of an evolving ecosystem?

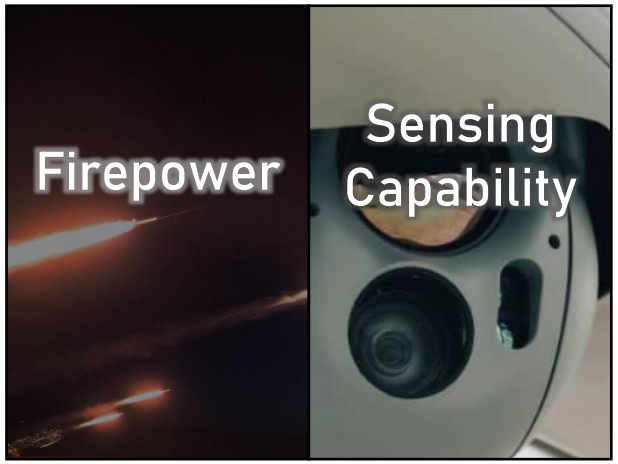
2.1 The Impact of UxS on Land Tactics

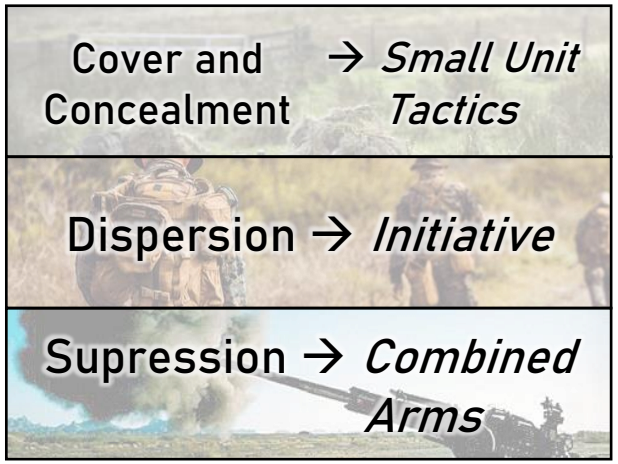
Baseline: the Modern System

Analysis of level of parity in military technology of belligerents between 1815 and 1992



Statistical analysis of 660 land battles and major engagements between 1600 and 1982



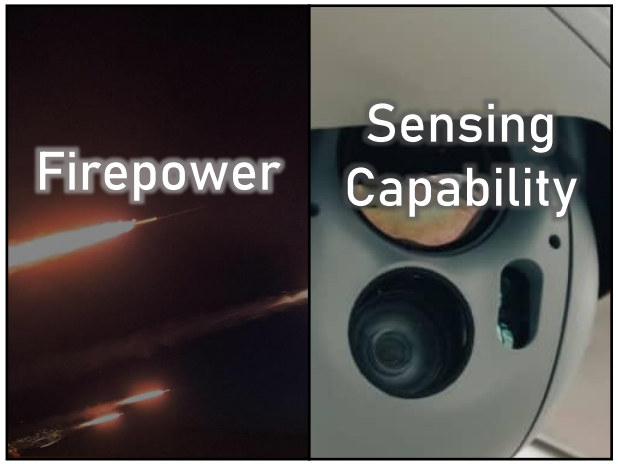


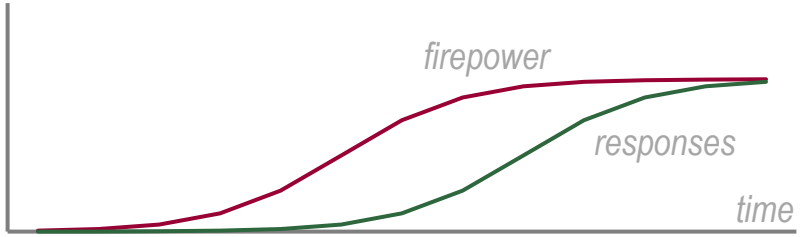
- In 2004, Stephen Biddle proposed the "**Modern System**" model, which explains the base principles of **modern land tactics as a function of the increase in firepower afforded by technological advances** (indirect fire, automatic firearms, radio, …)
- According to the model, further increases in firepower and sensing capability will bring about **further reliance on the tactical responses**: increased **dispersion** of forces, use of **cover and concealment**, and use of **suppression**
- Given that **technology evolves stepwise** (i.e., non-linear, with bursts of innovation and periods of incremental change), **for a given generation, the system** (firepower vs. tactical responses) **will tend to equilibrium**

2. [Why?]
2.1 The Impact of UxS on Land Tactics
Disruptive technologies, incremental tactics

Persistent Surveillance

Low-cost Mass Precision Strike





Recce for Small Units

Unmanned Logistics & Relays

Precision for Small Units

Cover and Concealment	→ *Small Unit Tactics*
Dispersion	→ *Initiative*
Supression	→ *Combined Arms*

- At present, **UxS can both increase** firepower and sensing capabilities, **and improve** concealment, dispersion, and suppression of **existing force structures** – think of how an infantry platoon can diminish its exposure by having unmanned Observation Posts ahead of their position

2.1 The Impact of UxS on Land Tactics

Disruptive technologies, disruptive tactics

Directed Energy Weapons?

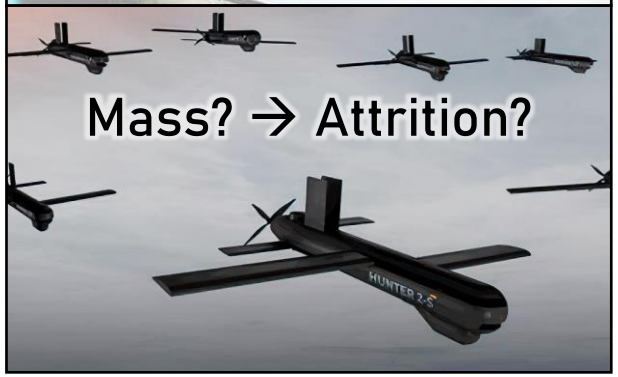
Counter-Swarms?

?

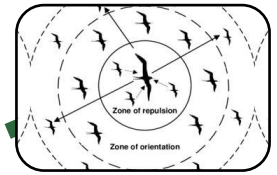
Cover and Concealment → *Small Unit Tactics*

Dispersion → *Initiative*

Supression → *Combined Arms*

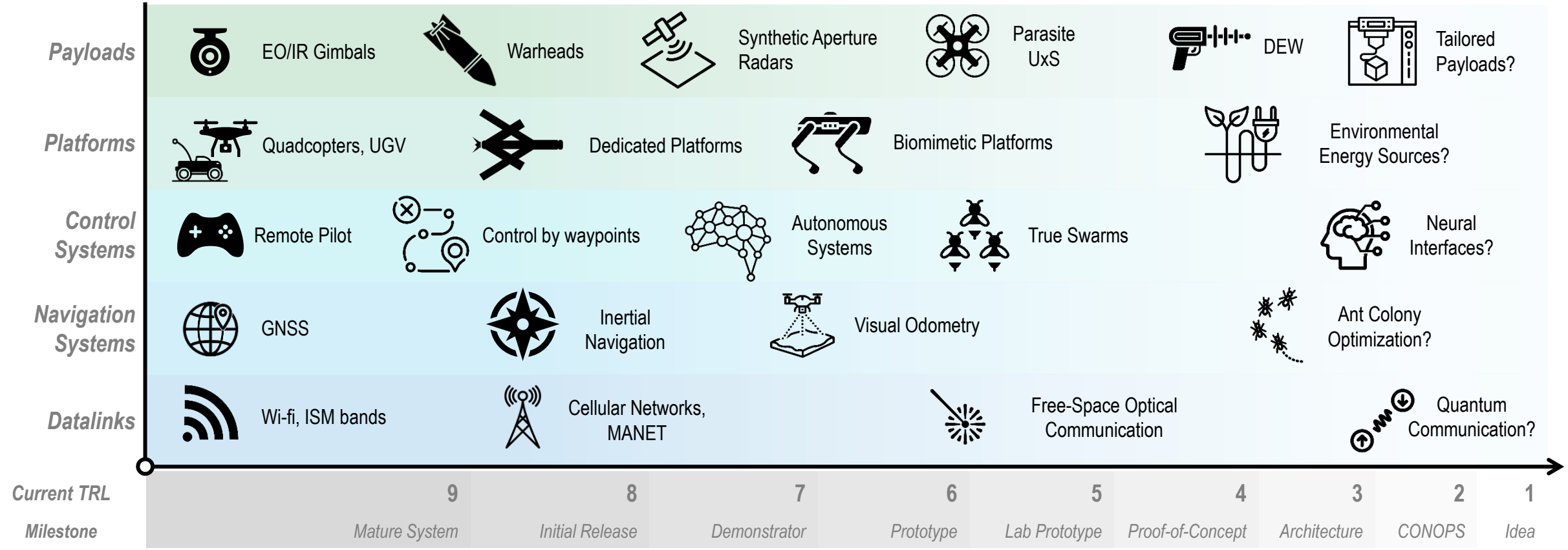


Swarms



- UxS may also allow for truly **disruptive tactics**: large numbers of attritable UxS might overwhelm adversary sensors and fires, creating another tactical response for firepower out of unmanned mass – which will, in turn, lead to its own counter-tactics...

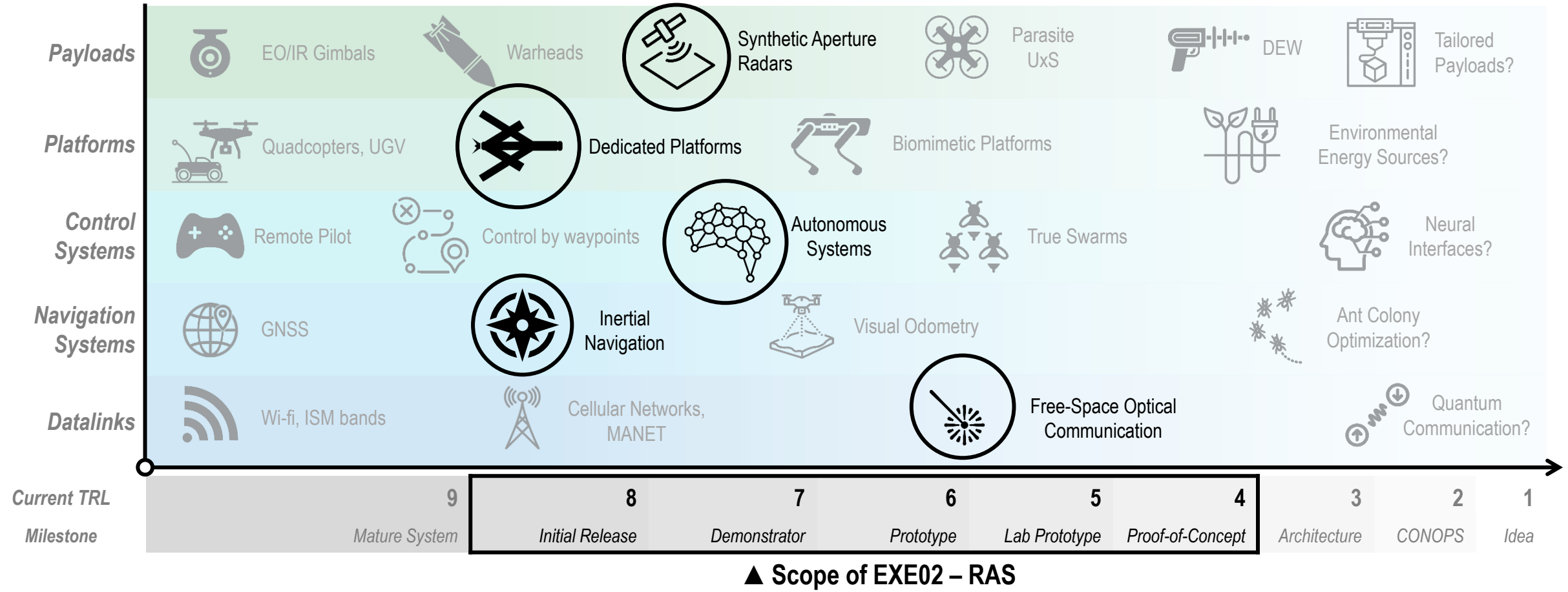
2.2 Implementing an Evolving UxS Ecosystem



- Rather than standalone platforms coordinated by techniques, tactics, and procedures, **UxS** must be considered as part of an **ecosystem of mutually compatible software, datalinks, control stations, and payloads** to truly leverage their disruptive potential
- Furthermore, the use of **modular architectures** and **open formats** leads to a **DevOps environment**, where UxS can be adapted to perform specific roles, or counter evolving threats

2.2 Implementing an Evolving UxS Ecosystem

Example: an "instance" of the UxS "class"



▲ **Scope of EXE02 – RAS**

- With a modular system architecture and open formats, components with various degrees of technological maturity (TRL) and with diverse provenance (i.e., manufacturer) can be integrated to form a **concrete UxS configuration (pictured above)** for a given operational experiment – for example, to test a new concept of operations

3. From CONOPS to Capability

ROGUE

We are not in any way affiliated with the US Defence consultant "**UseRogue.com**", but we kindly requested permission to use their memes in this presentation, as we think they illustrate perfectly what should *not* be done.

How will the Portuguese Army *actually* implement its vision of the desired UxS ecosystem?

- How are desirable and feasible UxS concepts identified?
- How are the UxS concepts being developed into capabilities?
- How are UxS concepts tested and evaluated?

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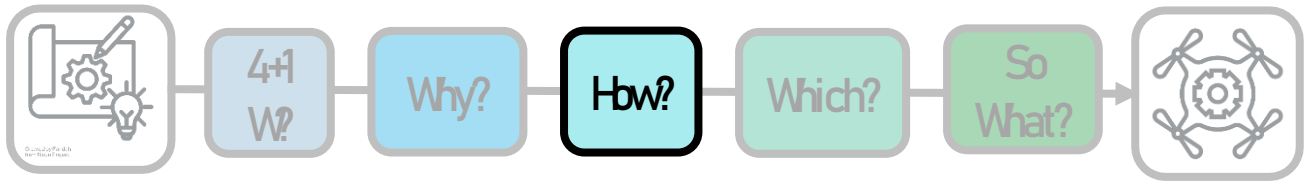
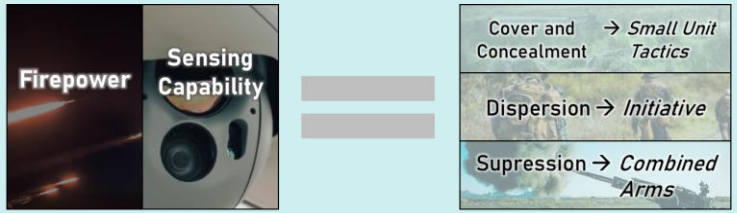
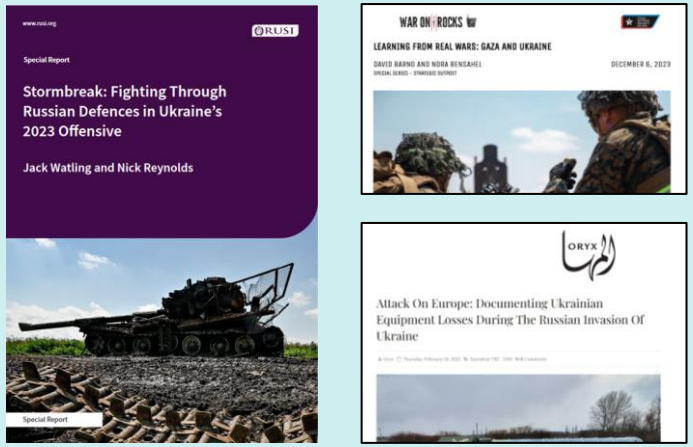
3. [How?]
3.1 From Use Cases to Specs





Models of Land Warfare



Lessons from Recent Conflicts

frames

Analysis of Tactical Impact

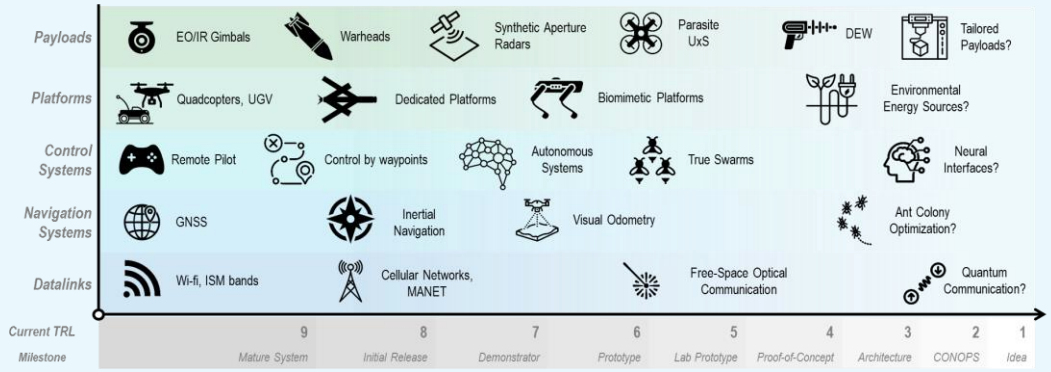
corrects

Desirable *UxS concepts*

Analysis of Technological Trends and State-of-the-Art

informs

Desirable *and* ***Feasible*** *UxS concepts*



Technology Trends and State-of-the-Art

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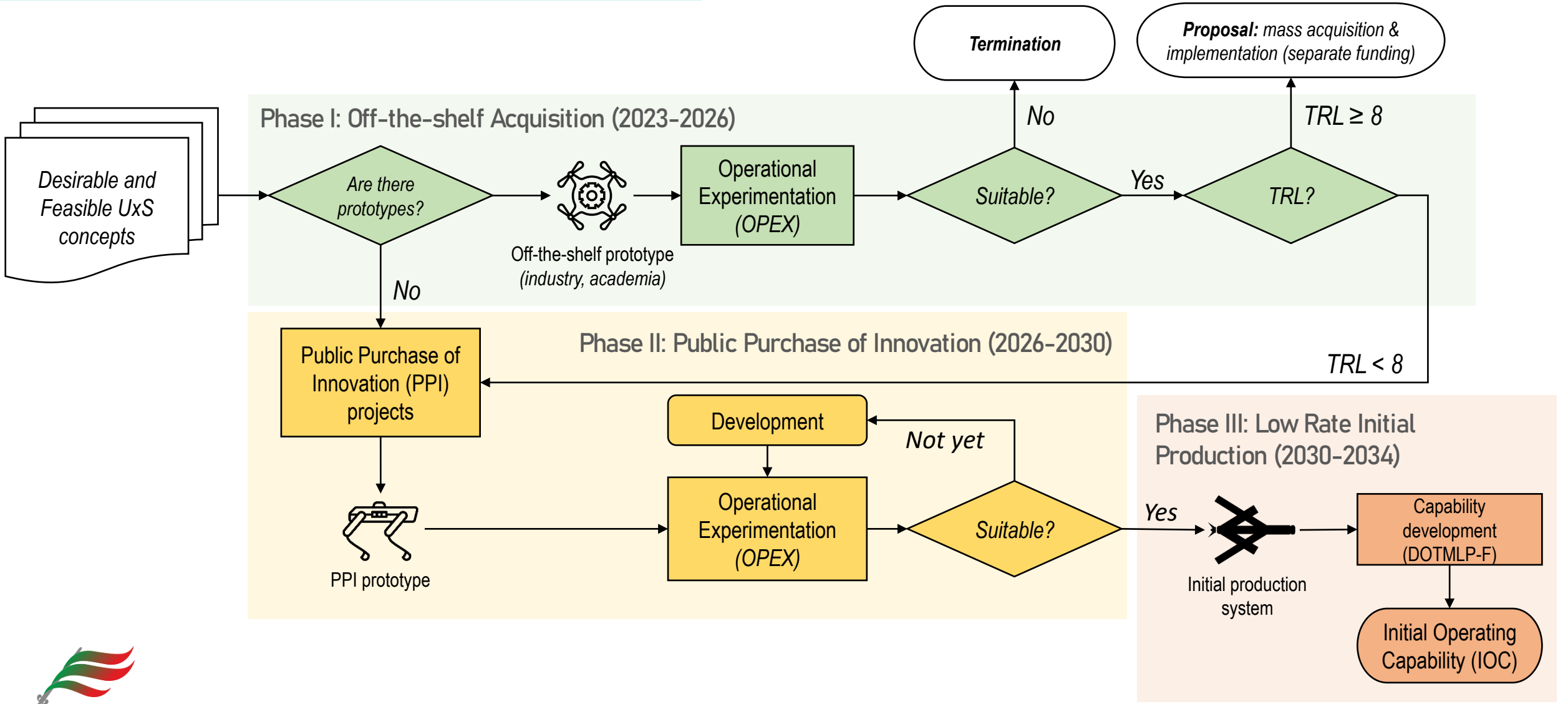
Desirable UxS Concepts

Scope of EXE02 – RAS ▼

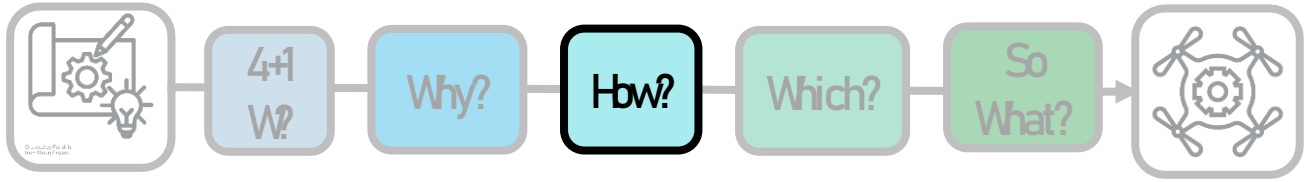
*Desirable and Feasible **UxS concepts***

Time for TRL=8	2024-2029	2029-2034	>2034
Increase Firepower	UAS I mini FPV Loitering Munition	Autonomous Crew-Served Weapon C-UAS Kinetic Interceptor	Autonomous Artillery Smart hand-grenade
Improve Sensing	UAS I mini, >2h, EO/IR	UAS II SAR/GMTI UAS I Tethered Sensor	True UAS Swarms
Increase Dispersion	UAS I mini, >2h, relay	UAS II relay	UGS Swarms
Diminish Exposure	UGS <30 kg Robotic APC	Micro UAS	Quadruped UGS

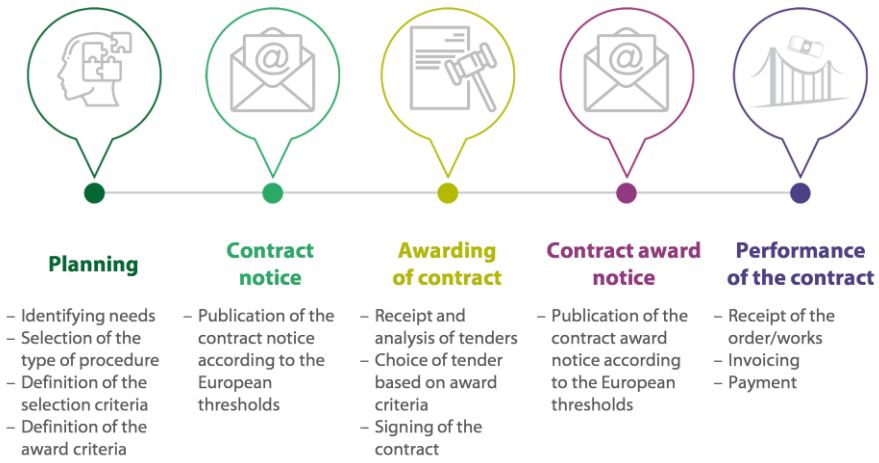
3.2 From Prototype to Low-Rate Initial Production



Methods of Public Procurement

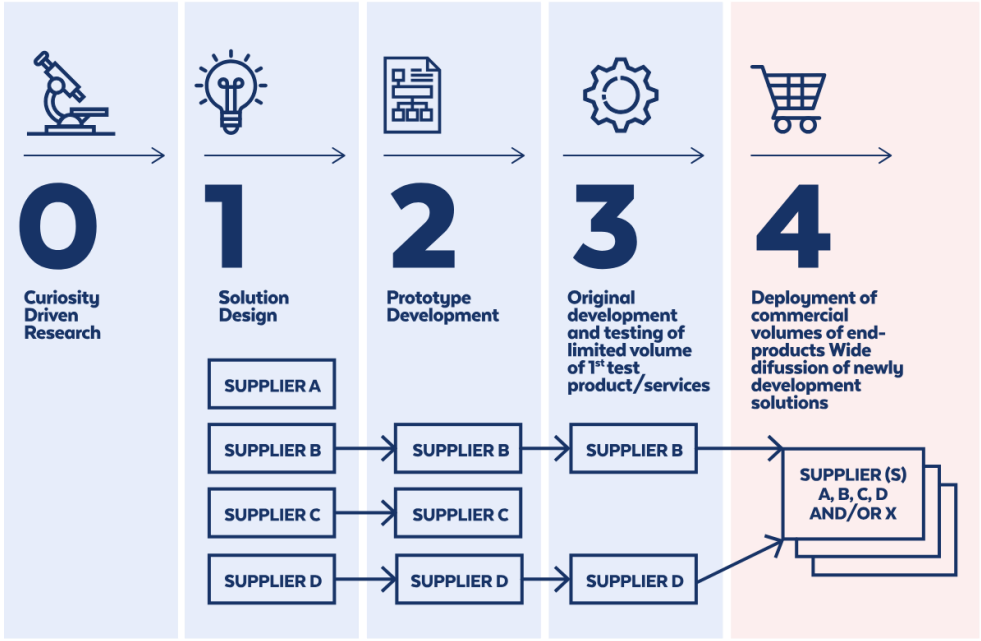


Phase I: Off-the-shelf Acquisition



Phase II: Public Purchase of Innovation

Phase III: Low Rate Initial Production



PROCURE2 INNOVATE

CPI COMPRAS PÚBLICAS DE INOVAÇÃO

PROCURE+i CENTRO DE COMPETÊNCIAS COMPRAS PÚBLICAS DE INOVAÇÃO Portugal

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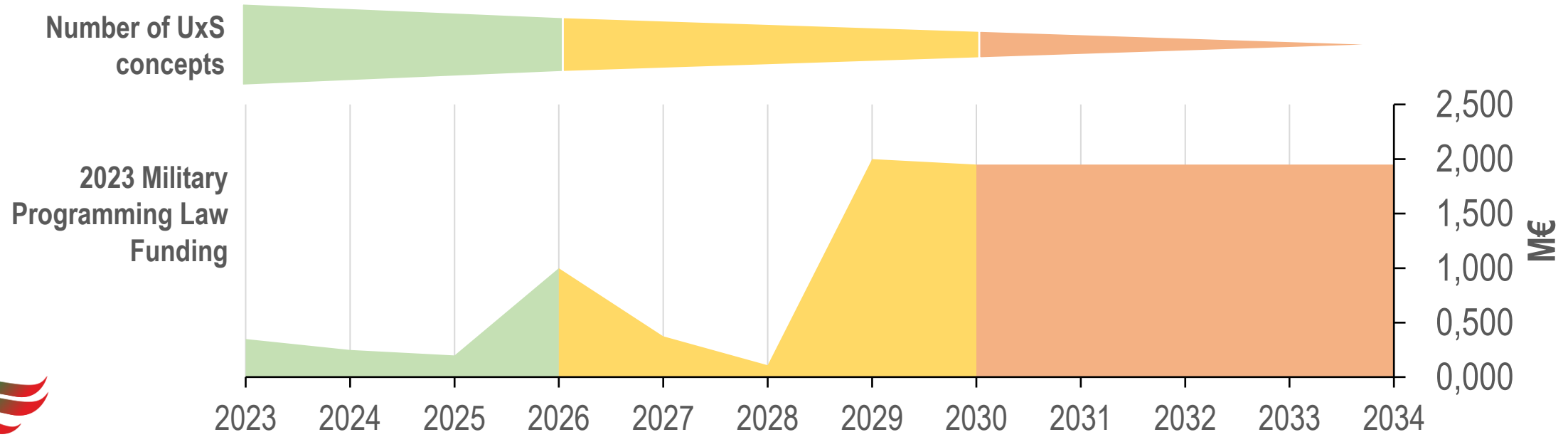
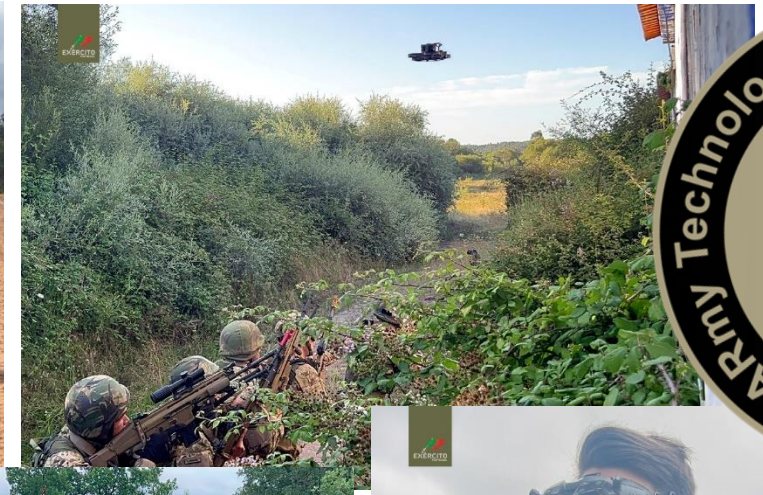
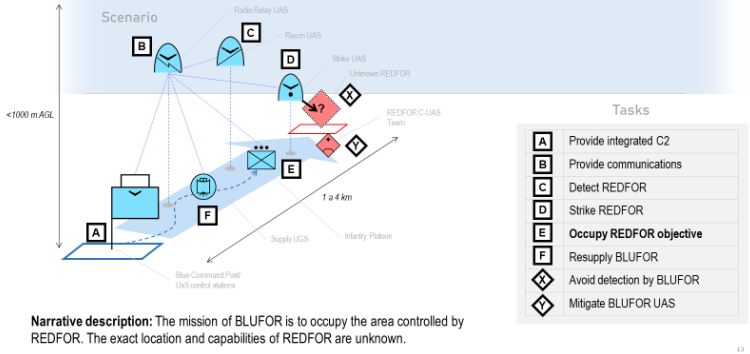
Details and Available Funding

Phase	**Phase I:** Off-the-shelf Acquisition	**Phase II:** Public Purchase of Innovation	**Phase III:** Low Rate Initial Production (LRIP)
Concept	*Off-the-shelf UxS demonstrators and prototypes are tested by CEMTEx & the units*	*Tailored UxS are developed according to PRT Army specs and tested by CEMTEX & the units*	*Desired UxS capabilities are implemented on a small scale (DOTMLP-F)*
Output	Proven UxS systems ready for mass acquisition and capability development	Tailored UxS ready for LRIP	IOC of desired capabilities Tailored UxS ready for mass acquisition



3. [How?]
3.3 The role of Operational Experimentation
ARTEX

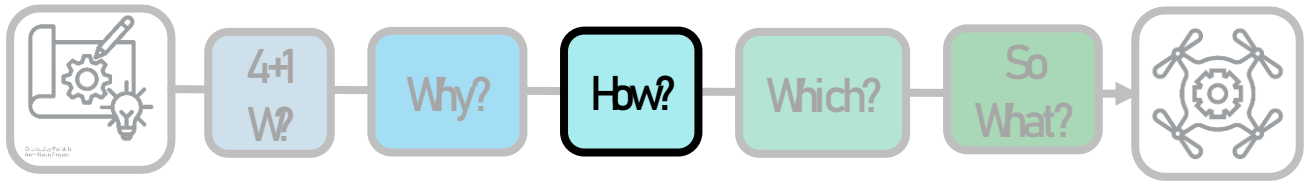


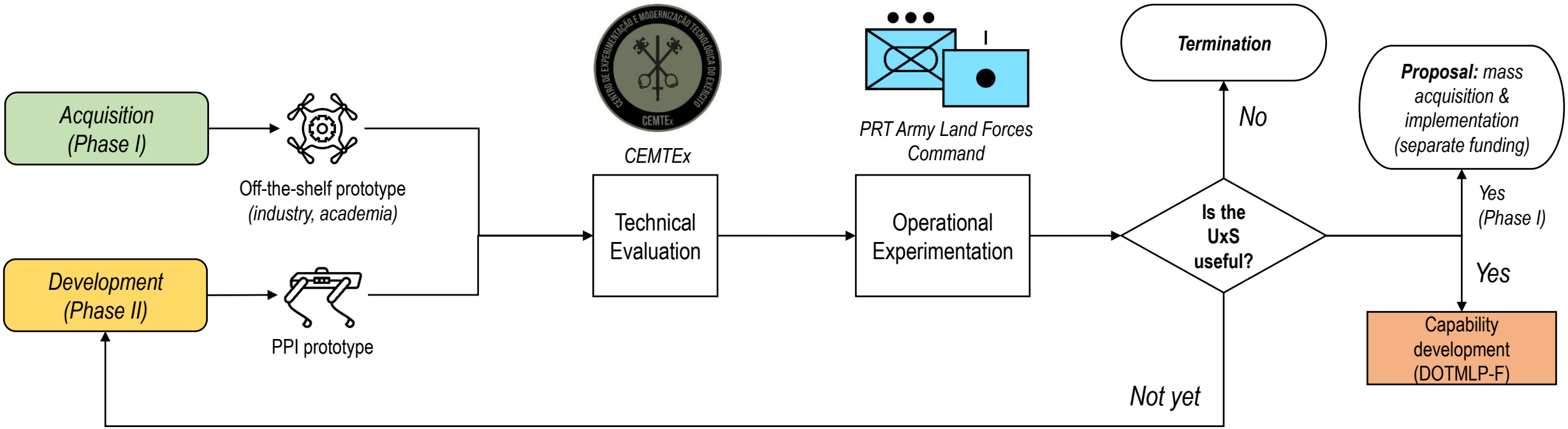


Narrative description: The mission of BLUFOR is to occupy the area controlled by REDFOR. The exact location and capabilities of REDFOR are unknown.

- The ARmy Technological EXperimentation is an annual operational experiment whose main goal is to test emerging technological solutions – whether proposed by the industry/academia, or directed by the PRT Army, such as EXE02 – RAS prototypes
- ARTEX comprises both standalone tests, and integrated Field Training Exercises and Live Fire Exercises

3. [How?]
3.3 The role of Operational Experimentation
Unit-level OPEX





1. CEMTEx tests the prototype (**technical evaluation**) and prepares evaluations tools and metrics for the unit-level OPEX
2. Target unit is trained on the prototype and uses it during a set period (training cycle/deployment) (**operational experimentation**)
3. CEMTEx analyses evaluation data and OPEX results, and **proposes** one of the following to the **Army General Staff**:
   A. If the prototype UxS is considered **useful**: mass acquisition (for off-the-shelf prototypes), capability development (for PPI prototypes)
   B. If the prototype UxS is considered **not useful**: further development or termination

4. The EXE02 – RAS UxS Concepts

Phase I: Off-the-shelf Acquisiton

2023-2026

Phase II: Public Purchase of Innovation

2026-2030

Phase III: Low Rate Initial Production

2030-2034

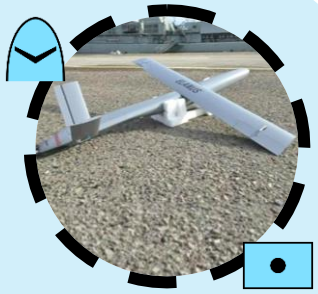
Method
Standard Public Procurement (PRT law)

Subproject **EXE03 – UAS**

Quadcopter FPV

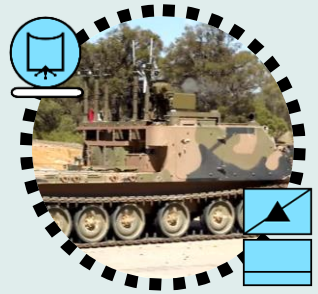
Long-endurance Orbiter

Multicopter Multirole



Loitering Munition (Phase II, PPI?)

Subproject **EXE03 – UGS**



Unmanned M113

Mini-UGV

"Enablers"

"Drone carrier" vehicle

GCS vehicle

Portable jammer + RFDF equipment

FPV simulation & training systems

Form: *tracked* *wheeled* *quadcopter* *winged* *tethered* *baloon*

Function: *attack* *ISTAR* *relay* *cargo*

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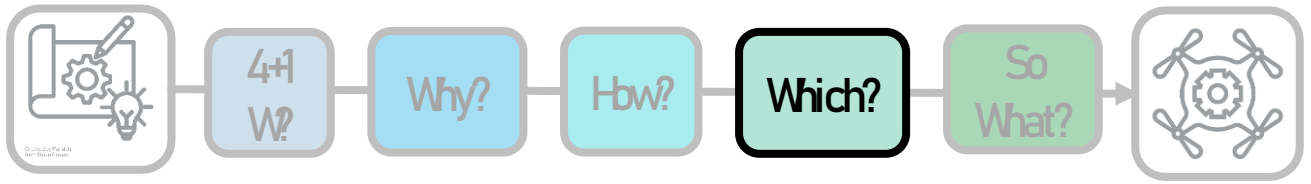
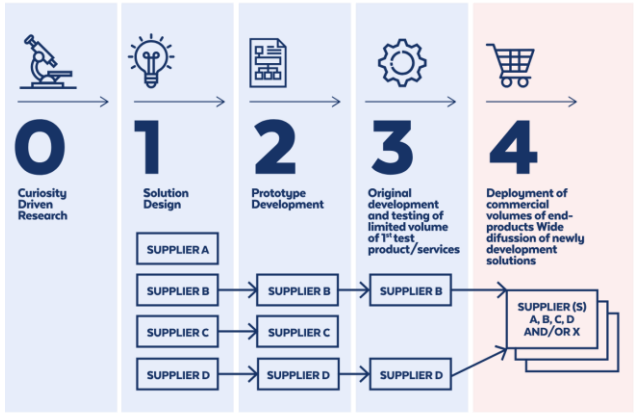
4. The EXE02 – RAS UxS Concepts



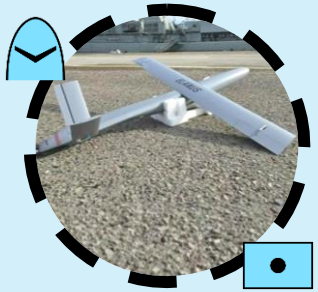
Phase I: Off-the-shelf Acquisiton	**Phase II:** Public Purchase of Innovation	**Phase III:** Low Rate Initial Production
2023-2026	**2026-2030**	**2030-2034**

Method

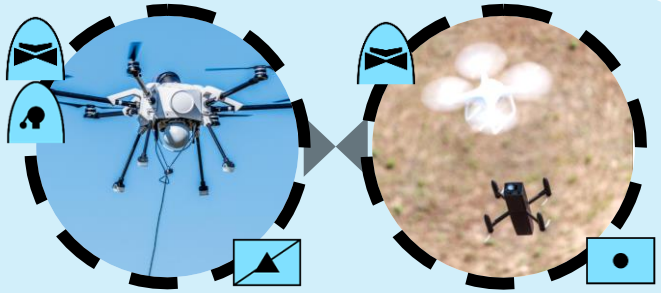
Public Purchase of Innovative Solutions (PRT based on EU law)



Subproject **EXE03 – UAS**



Loitering Munition

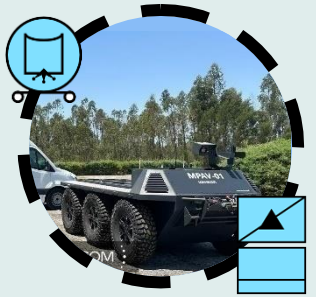


Tethered C-UAS sensor + kinetic interceptor

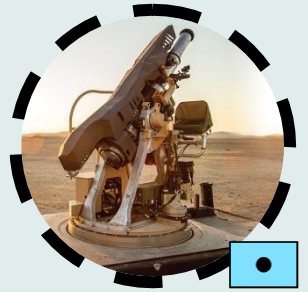
Urban micro-UAS

Large orbiter

Subproject **EXE03 – UGS**



Squad UGV



Autonomous crew-served weapon

Form: tracked · wheeled · quadcopter · winged · tethered · baloon

Function: attack · ISTAR · relay · cargo

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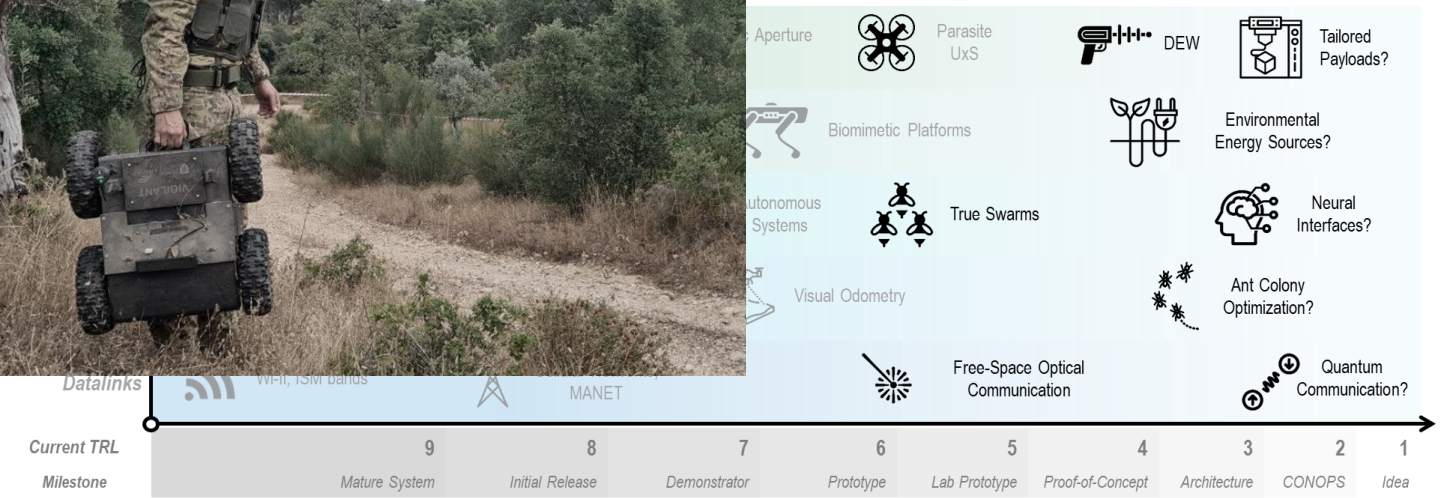
5. The EXE02 – RAS End State



At the end of the EXE02 – RAS program:

- The PRT Army will **have implemented disruptive and innovative concepts of operation** made possible by an ecosystem of UxS
- The **resulting UxS ecosystem** – system architecture, components, formats, software, procedures, training – will be **ready for further evolution**

Army Centre for Operational Experimentation and Technological Modernization

“EXE02 – Remote and Autonomous Systems”

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