The Future of Undersea Warfare

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Phases of undersea warfare (ASW and offensive submarine ops)

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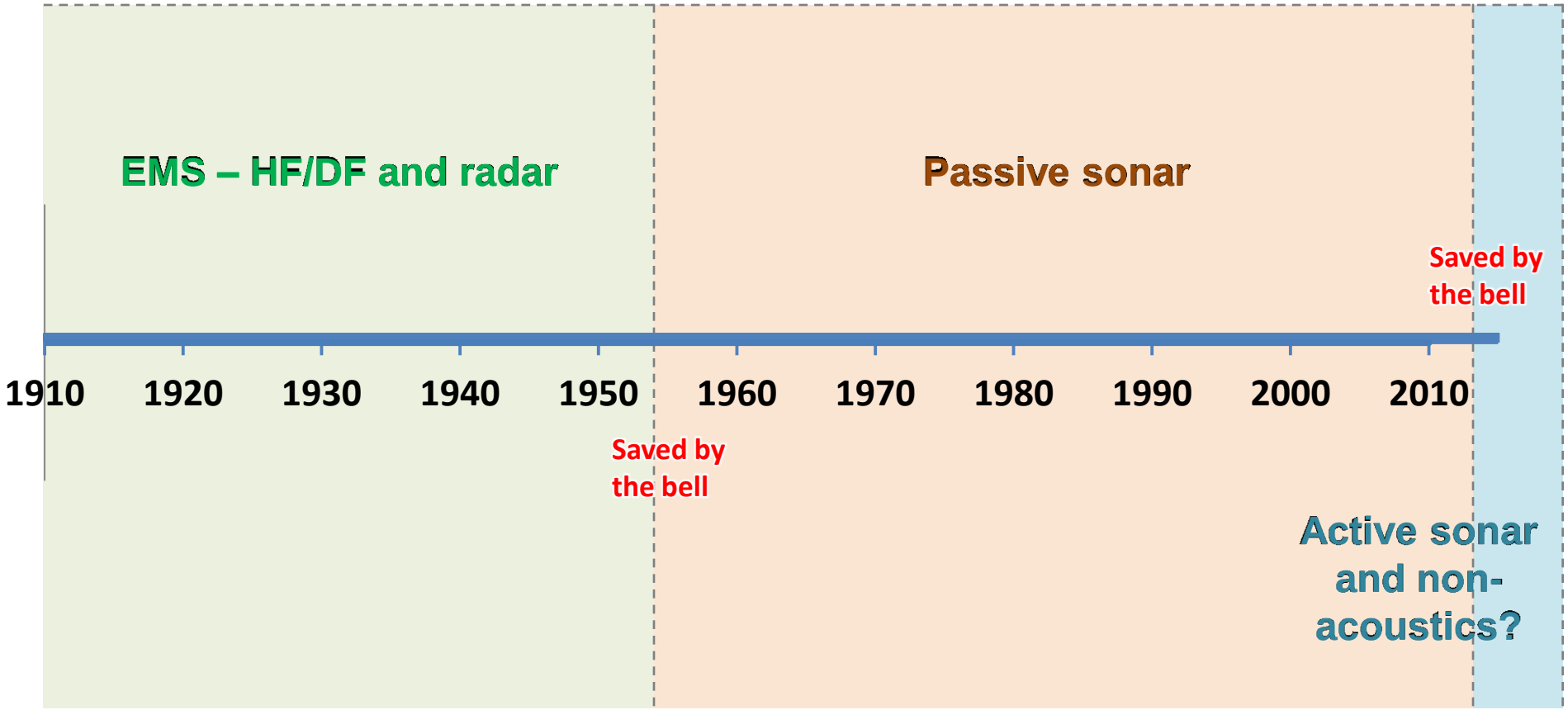

Advent of nuclear submarines led to passive sonar phase; quiet Soviet submarines led to development of low frequency active sonar and non-acoustics

Battle of the Atlantic longest and most extensive undersea competition

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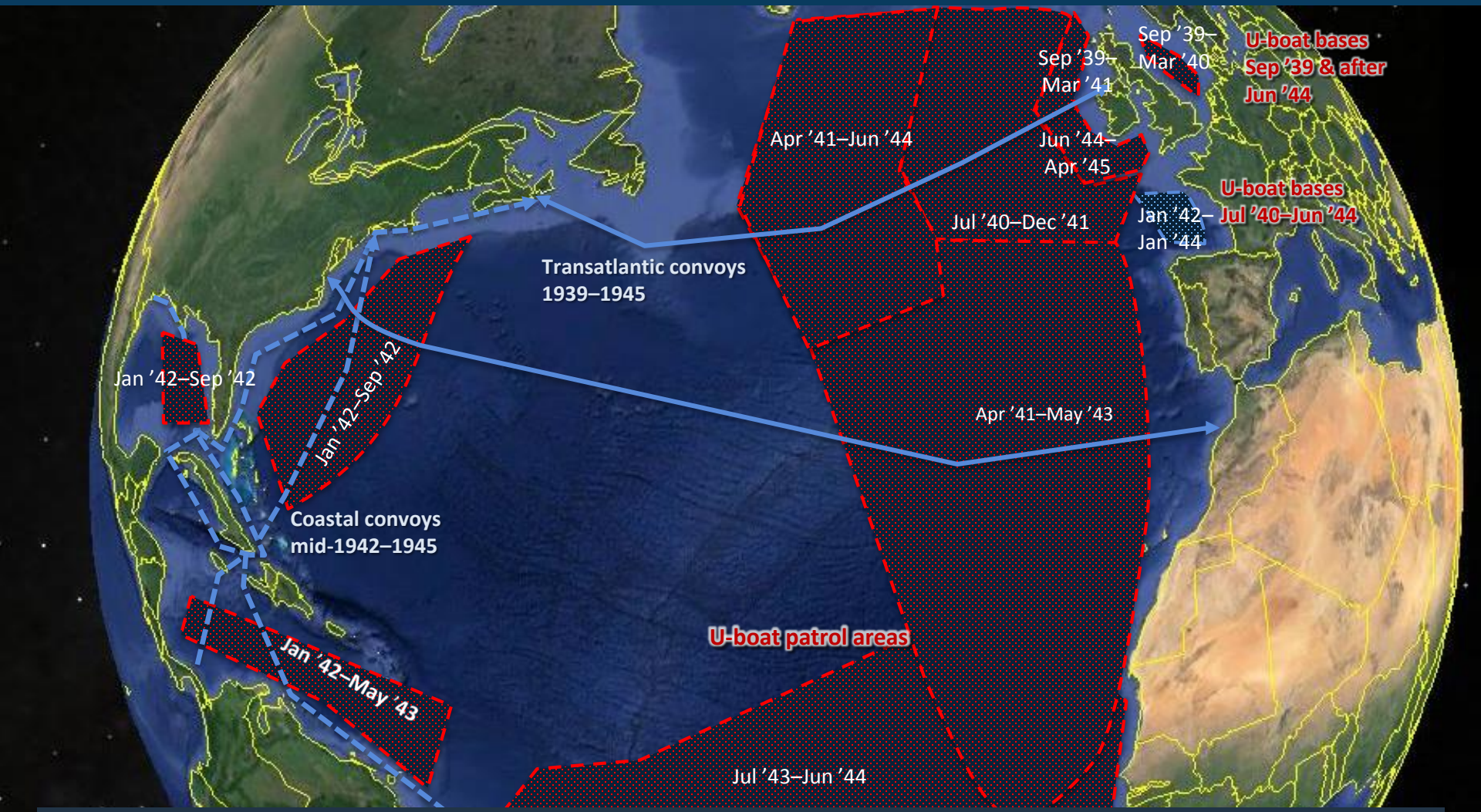

Diesel (rather than nuclear) submarines, long ranges, and slow-moving competition made radio direction finding and radar the dominant sensors

Battle of the Atlantic showed subs could be suppressed

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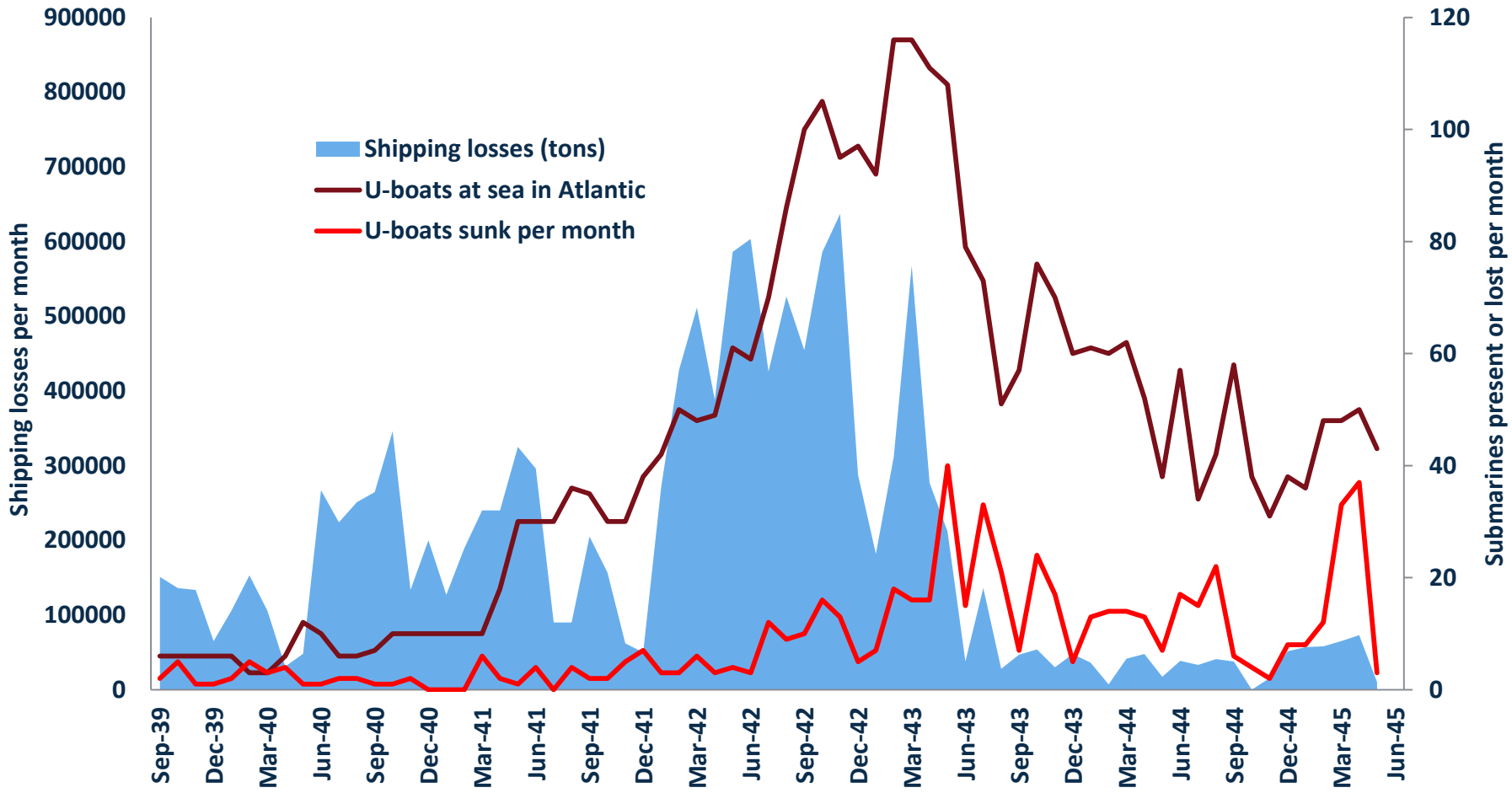

Exploits 3 major limitations of submarines: they are slow, have short-range sensors, and carry minimal self-defense

EM spectrum competition in WWII ASW accelerated throughout war

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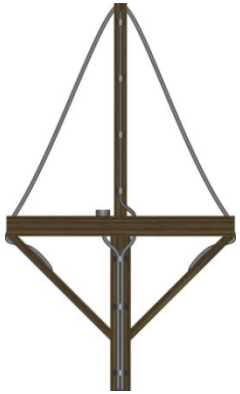
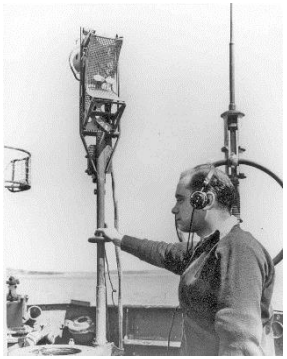


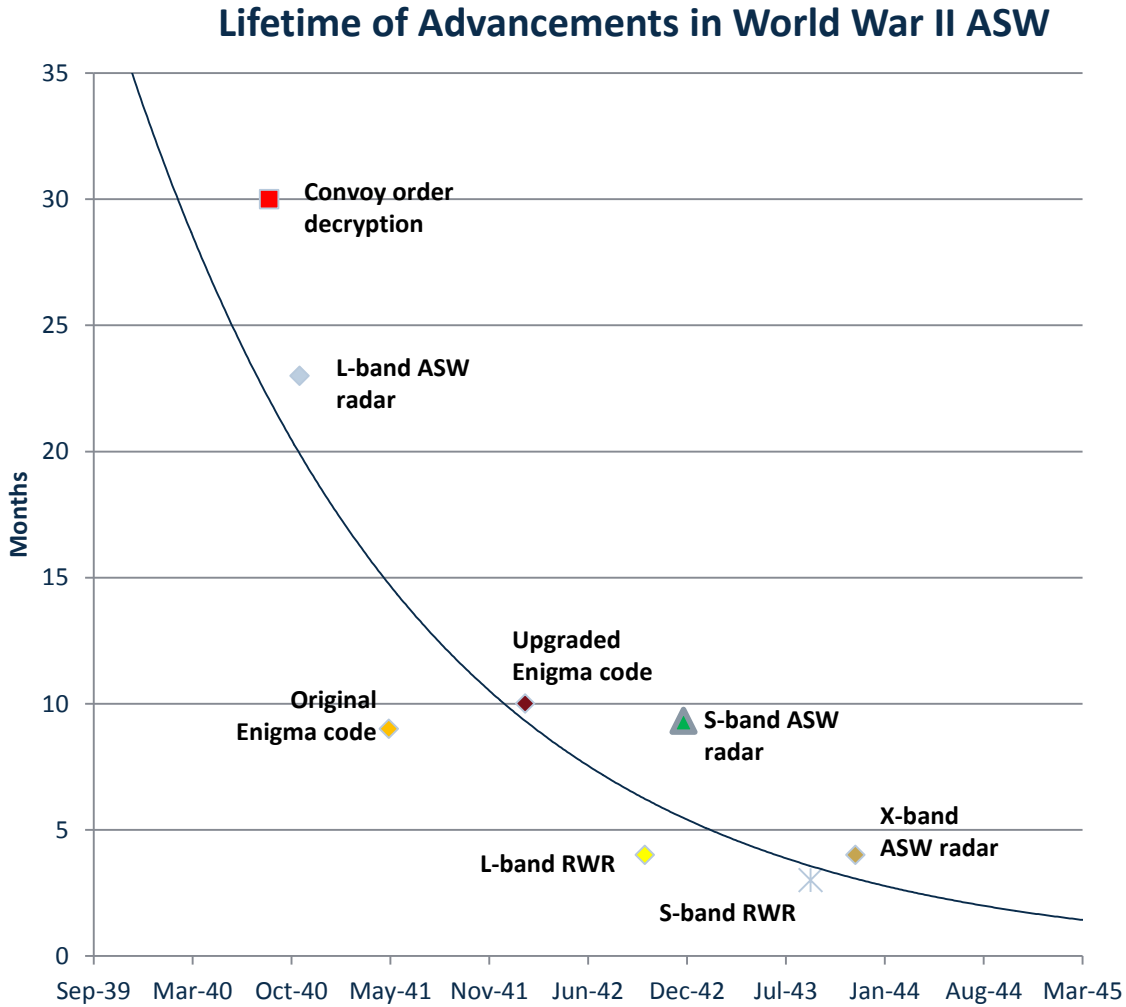
Metox L-band GSR

H2S S-band radar

Naxos S-band RWR



Tunis X-band RWR



Competition and innovation accelerates until the competition "jumps" to a new band –in this case passive sonar

U.S. exploited lead in passive sonar against the new nuclear subs

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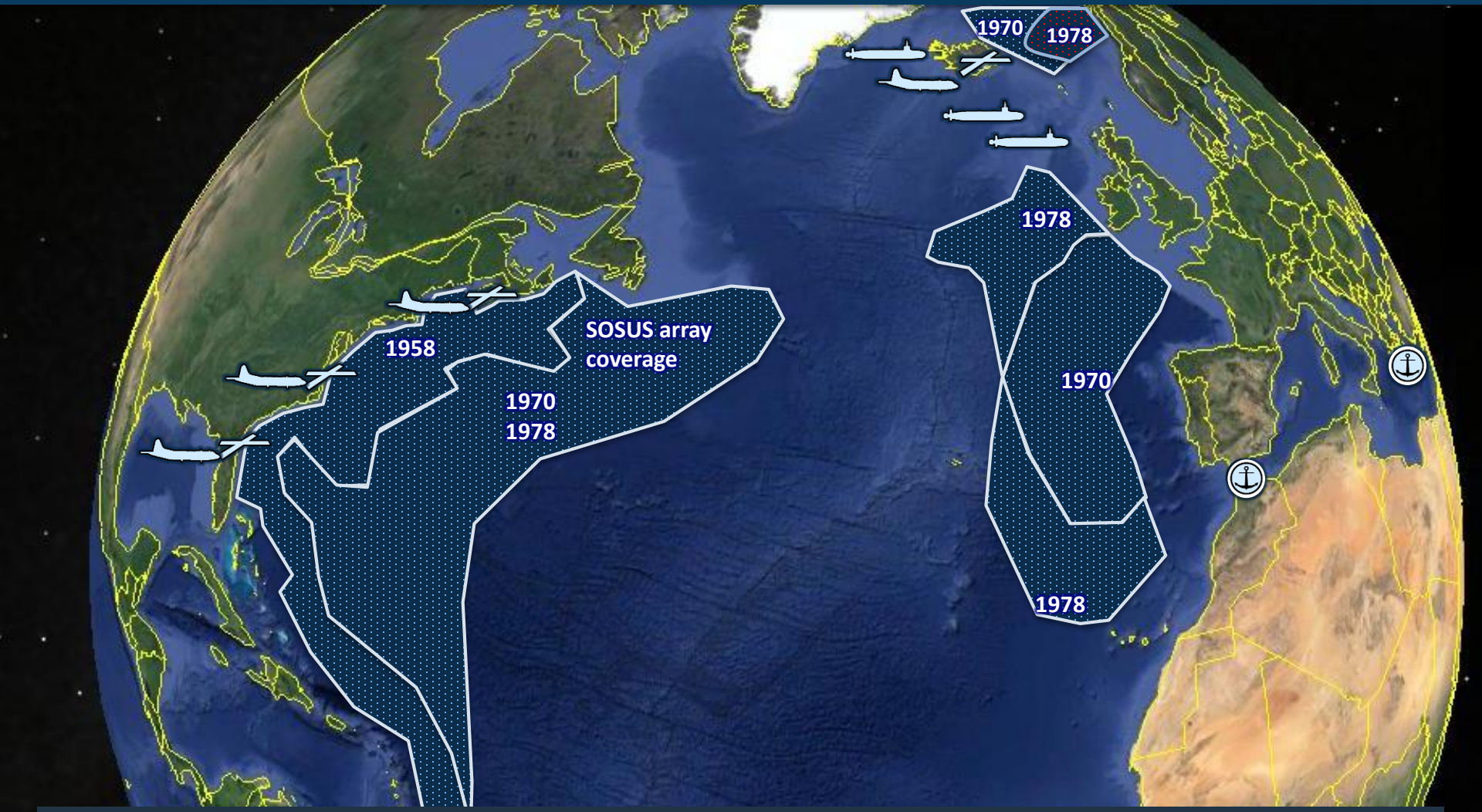

Although they remained submerged and away from radar, nuclear subs generated continuous machinery noise and were vulnerable to passive sonar

U.S. lead shrank as Soviet SSNs incorporated sound silencing

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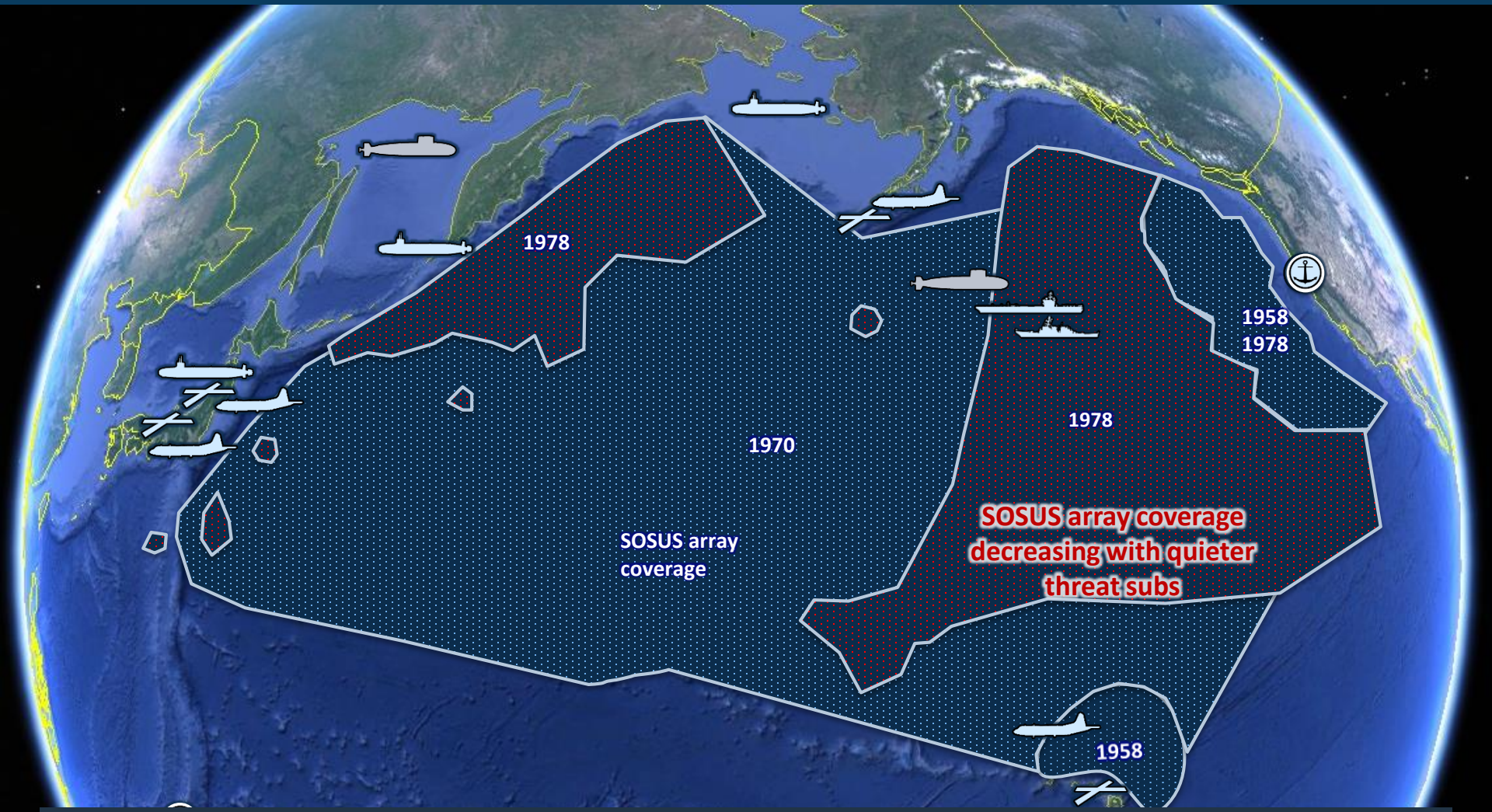

SOSUS and submarine arrays enabled near-continuous track against early generations of Soviet nuclear submarines; this era ended in late Cold War

Next phase of undersea warfare will incorporate unmanned systems

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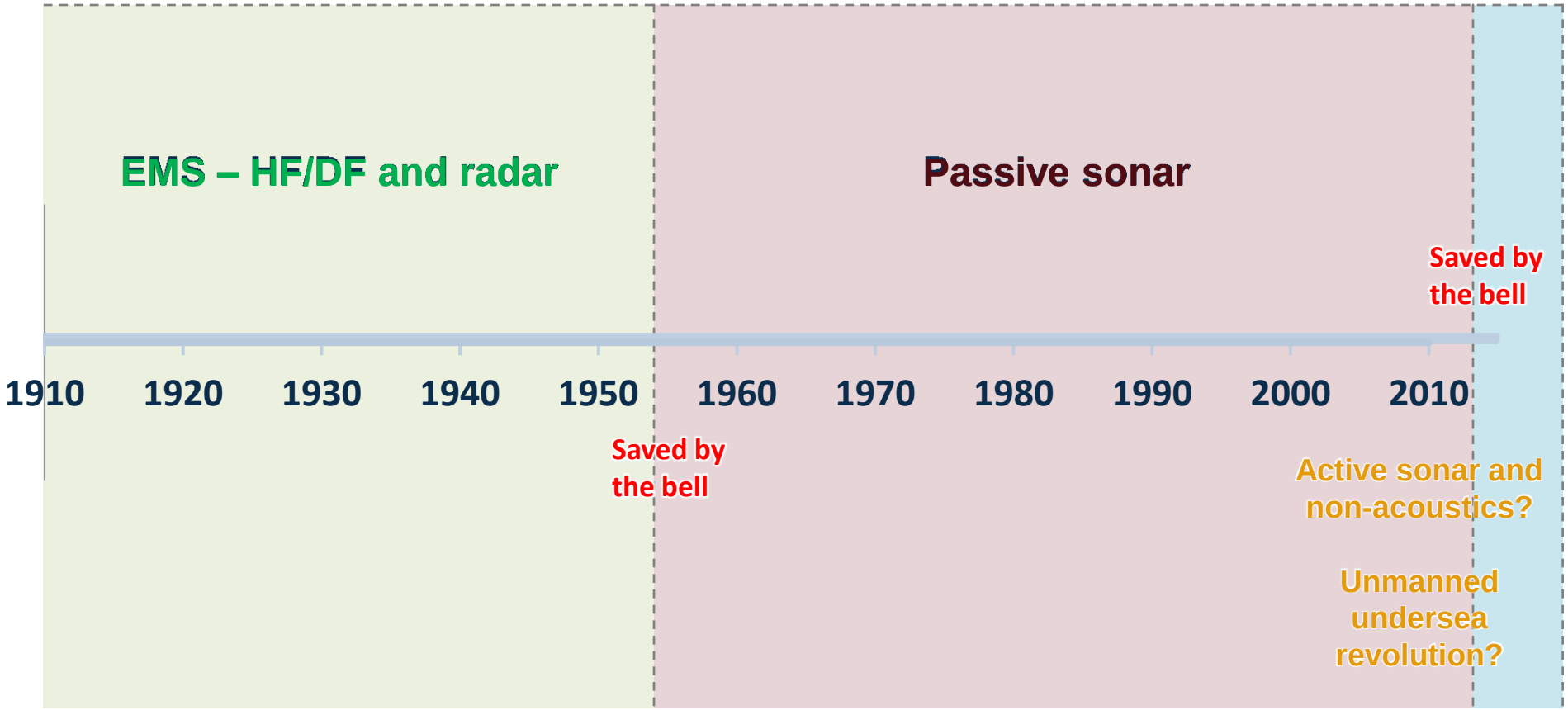

Unmanned undersea vehicles and stationary systems won't need to evade if detected or attacked and are less likely to be successfully engaged

Great power competition returning, placing new emphasis on undersea

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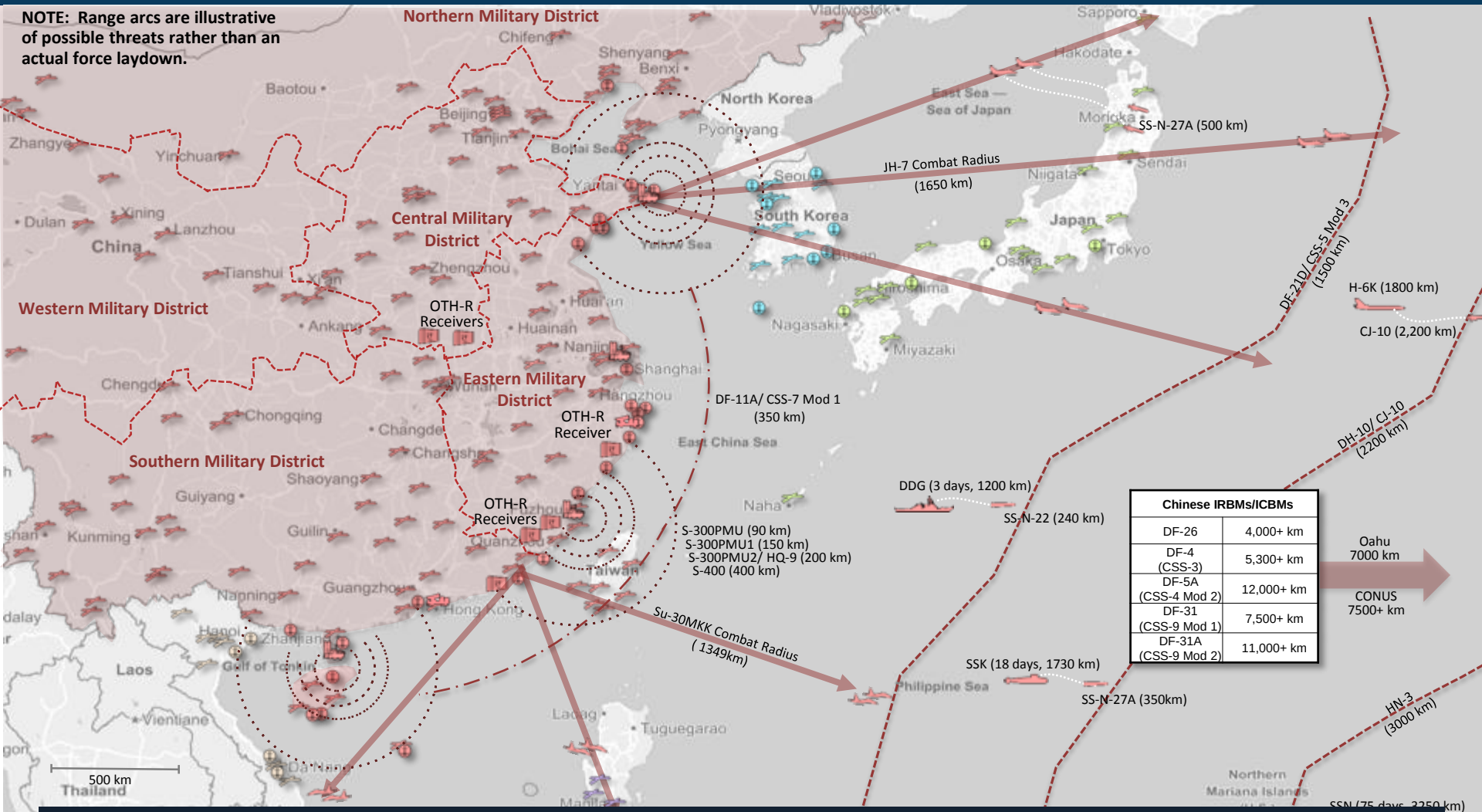

Chinese IRBMs/ICBMs	
DF-26	4,000+ km
DF-4 (CSS-3)	5,300+ km
DF-5A (CSS-4 Mod 2)	12,000+ km
DF-31 (CSS-9 Mod 1)	7,500+ km
DF-31A (CSS-9 Mod 2)	11,000+ km

China's ability to threaten airspace and surface around their territory increases importance of undersea capabilities to U.S. deterrence and warfighting

Sensor networks extending undersea; increasing threat to SSNs

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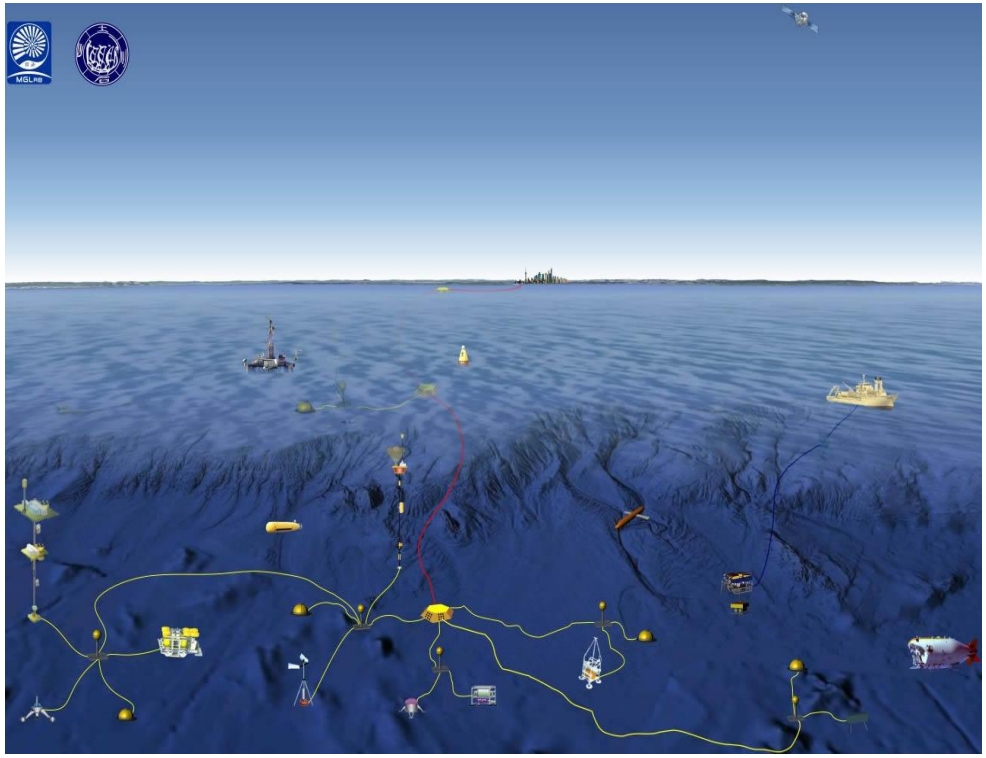

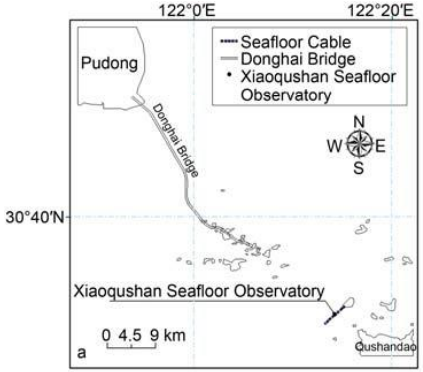

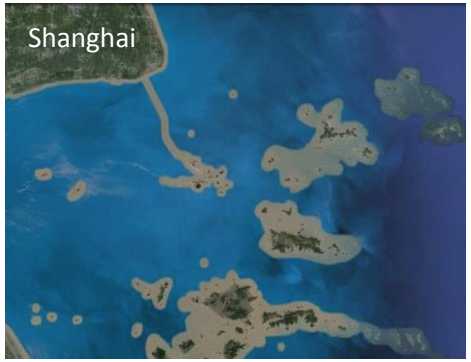

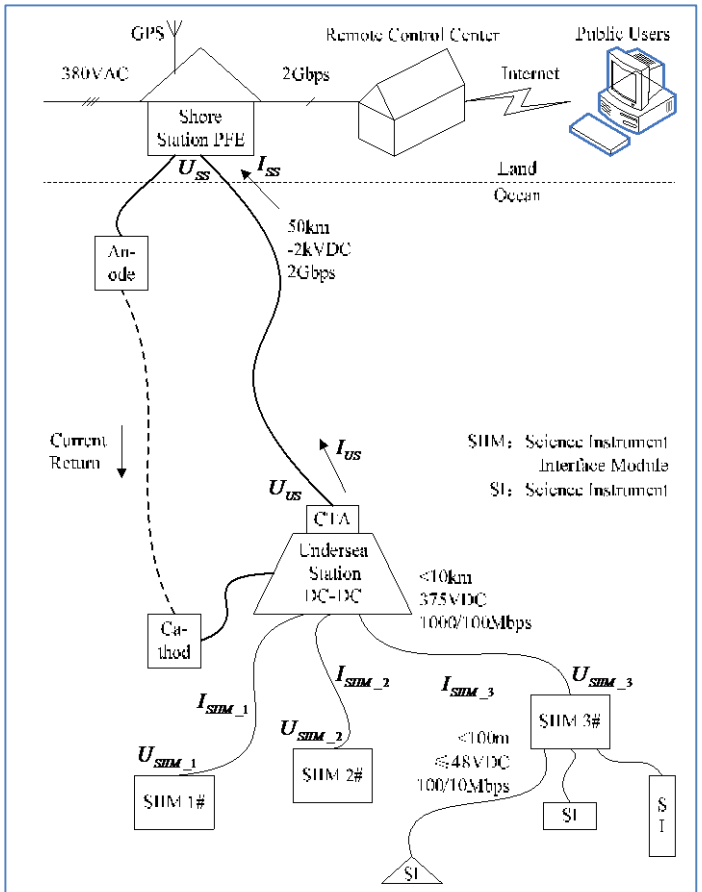

Fig. 2. The schematic diagram of the ECS expeirmental cabled seafloor observatory.

Design of an Undersea Power System for the East China Sea Experimental Cabled Seafloor Observatory
Feng Lu1, Huaiyang Zhou2, Jiguang Yue1, Xiaotong Peng2, Bin He1, Zhengwei Wu2
1College of Electronics and Information Engineering 2School of Ocean and Earth Science
Tongji University, Shanghai 200092, China univ.feng.lu@gmail.com, {zhouhy, yuejiguang}@tongji.edu.cn

Seabed not necessarily a sanctuary for unmanned undersea systems

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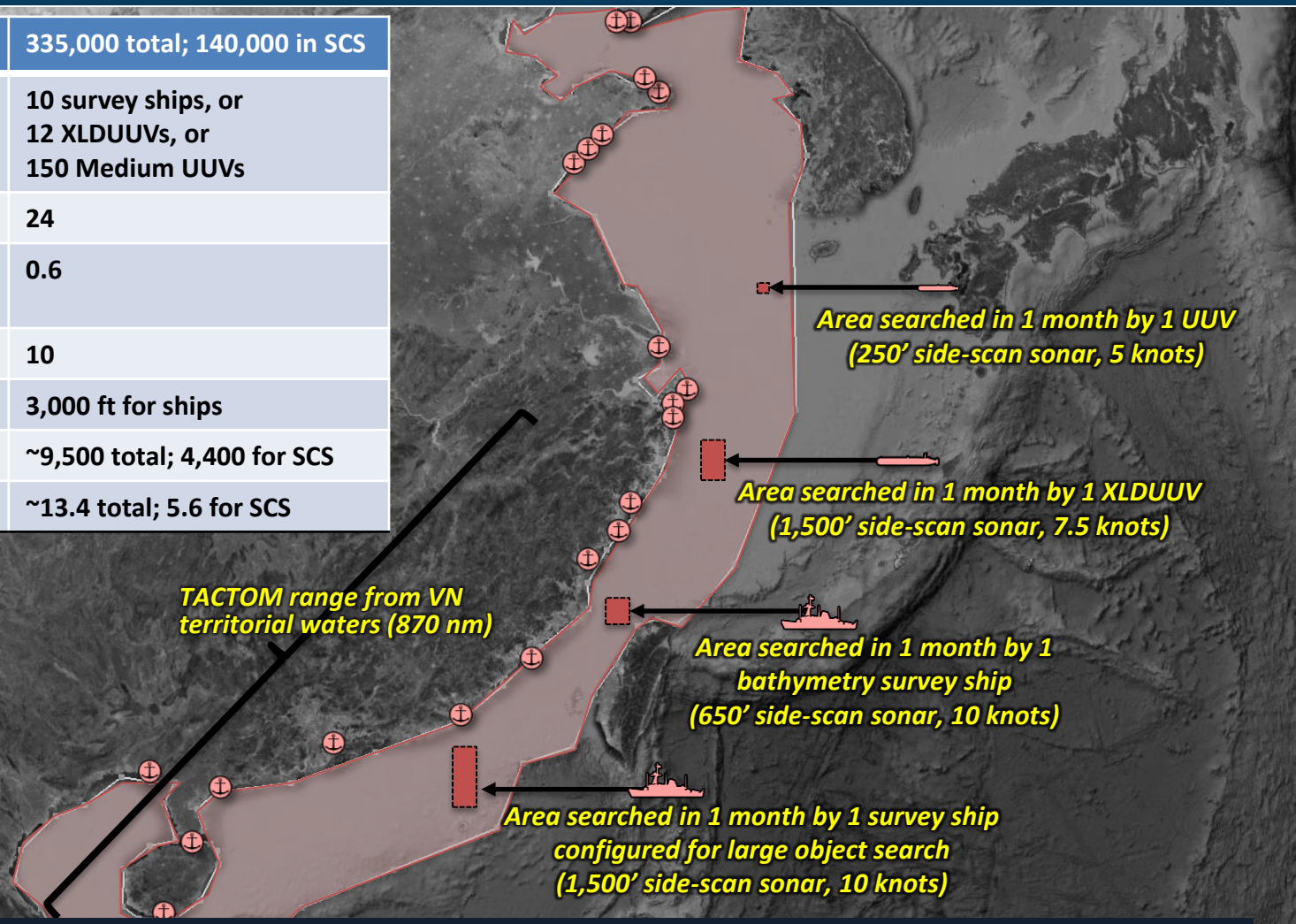
Seabed to Cover (sq. nm)	335,000 total; 140,000 in SCS
Survey fleet	10 survey ships, or 12 XLDUUVs, or 150 Medium UUVs
Hours surveyed per day	24
Operational availability (due to sea state, maintenance)	0.6
Vessel speed (knots)	10
Bathymetry sensor swath	3,000 ft for ships
Hours required	~9,500 total; 4,400 for SCS
Time to survey (months)	~13.4 total; 5.6 for SCS



Seabed payload modules could be found by surveys, but payloads carried by USVs and UUVs could have a lower risk of counter-detection

Large & small UUVs the most useful parts of today's portfolio

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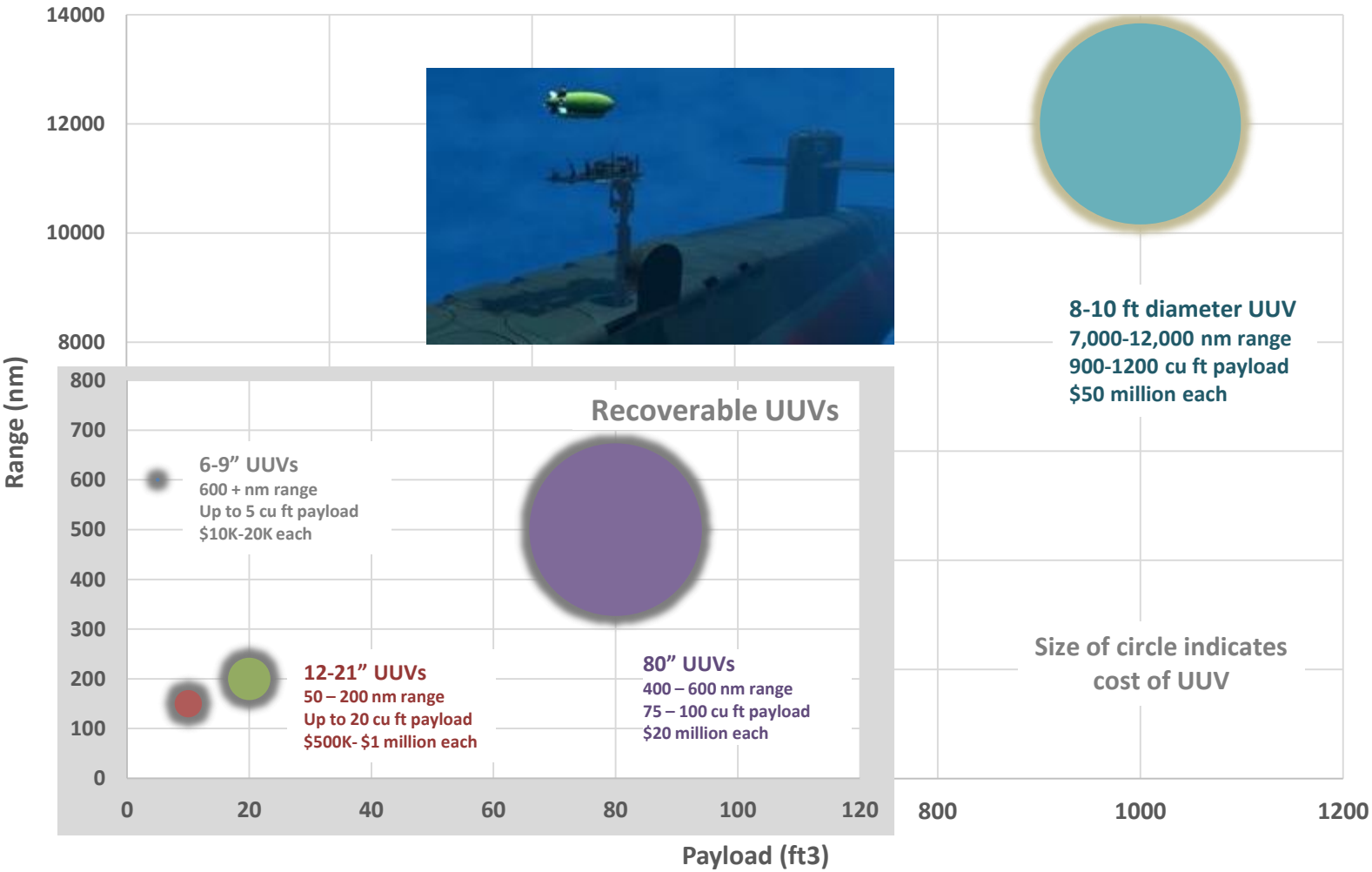

Large UUVs can deploy from outside contested areas and carry smaller payloads; small UUVs can use novel power tech or do one-way missions from long range

UUV autonomy constrained by sensor capability, and thus sensor size

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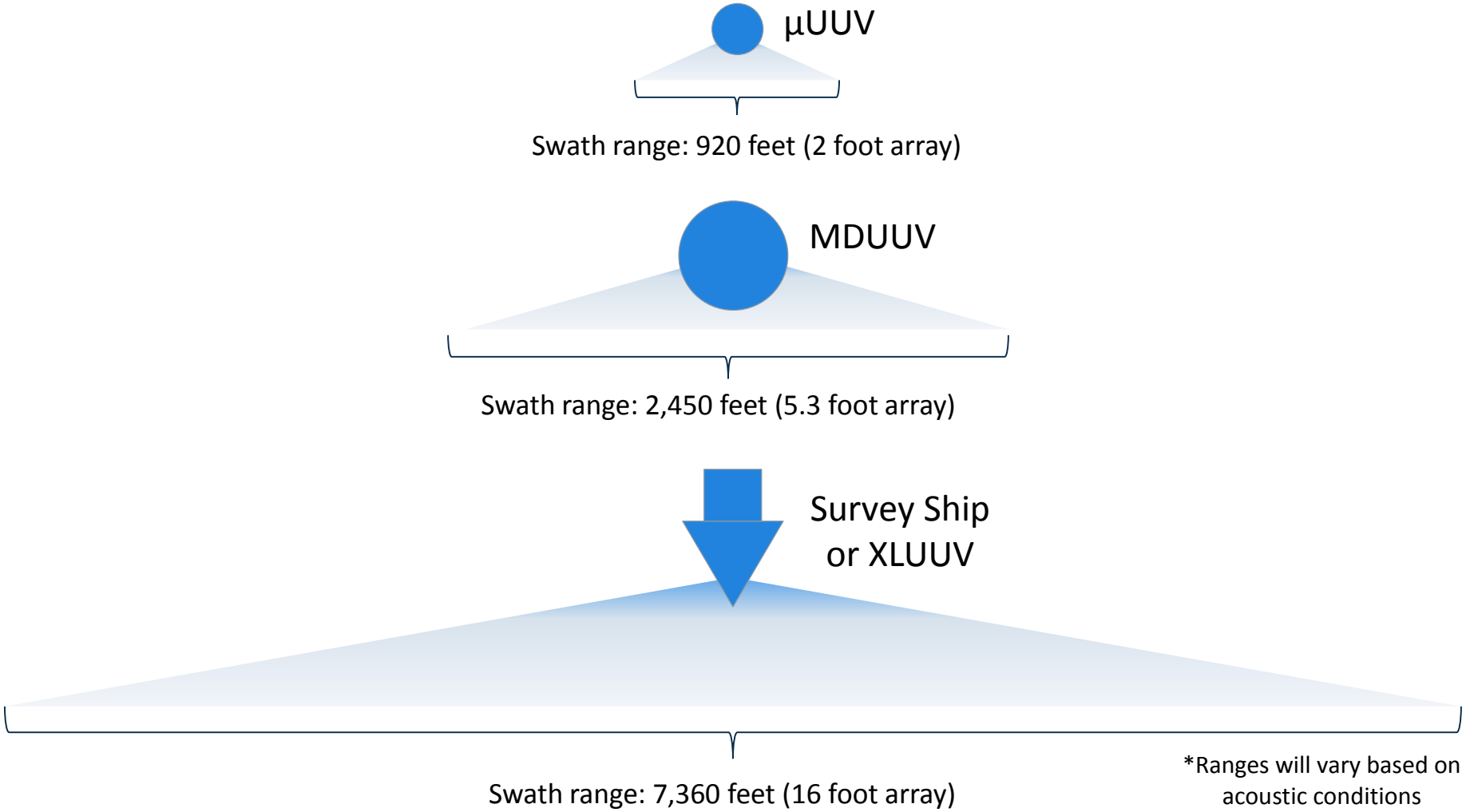

*Ranges will vary based on acoustic conditions

As mission sophistication increases, UUV may need to be larger to carry more effective sensors for better situational awareness and navigation

XLUUV capacity likely constrained by geometry & launch system

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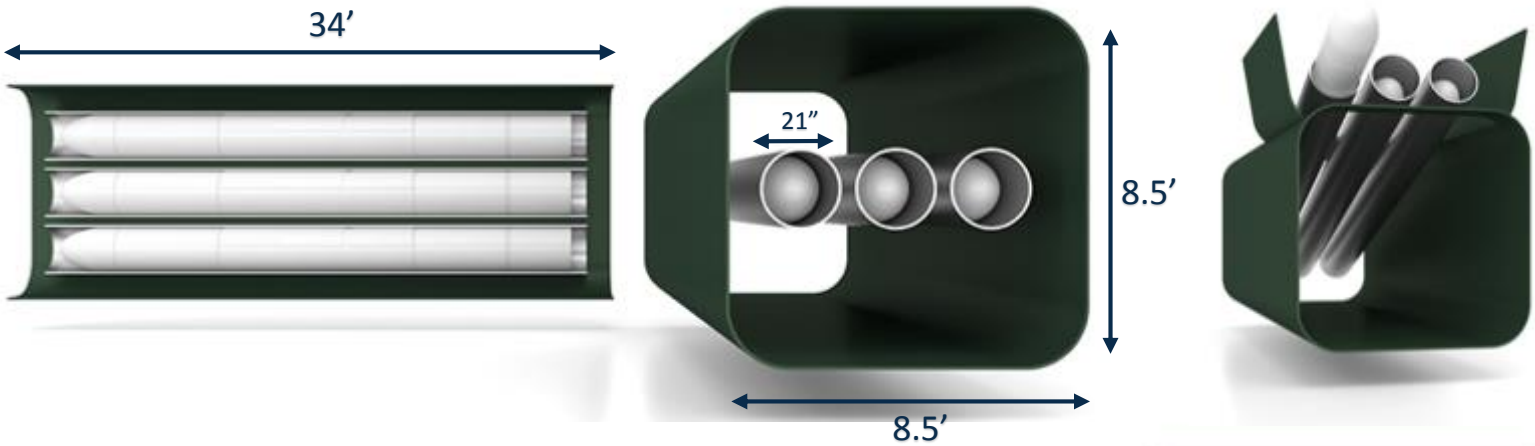

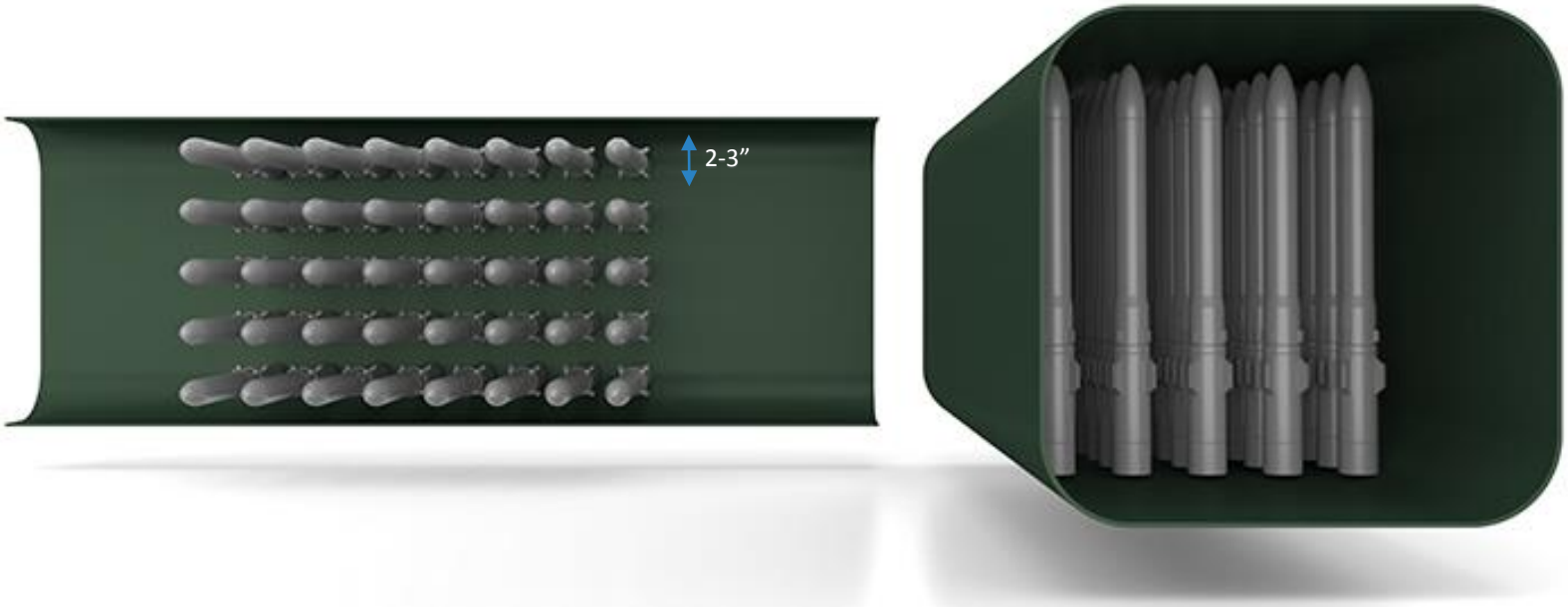

New operational concepts for undersea warfare

Offensive ASW forward increasingly with unmanned systems

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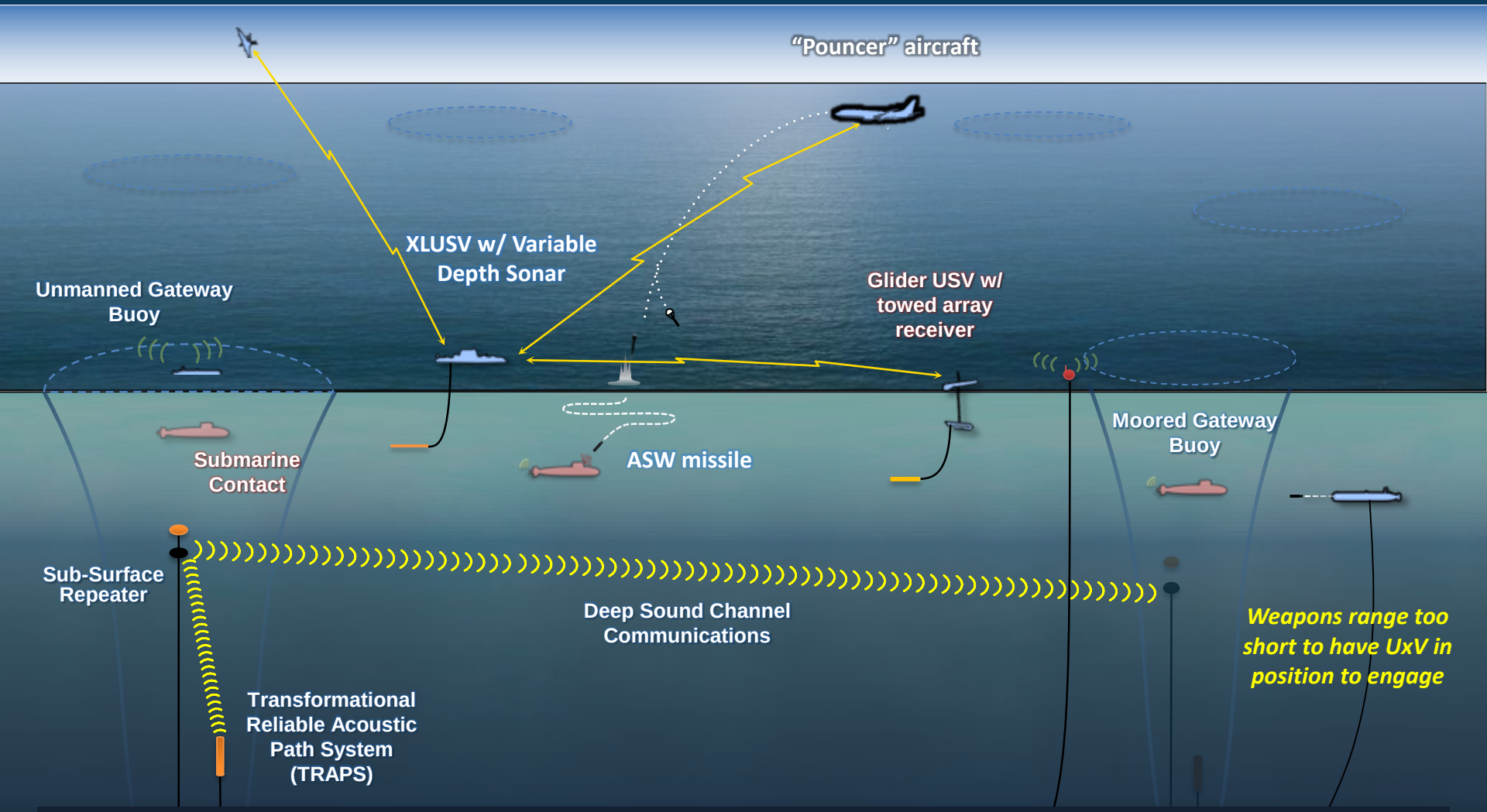

Passive TRAPS & Active LF sonar provide targets for manned and unmanned pouncer aircraft to engage

Defensive ASW shifting toward suppression rather than killing

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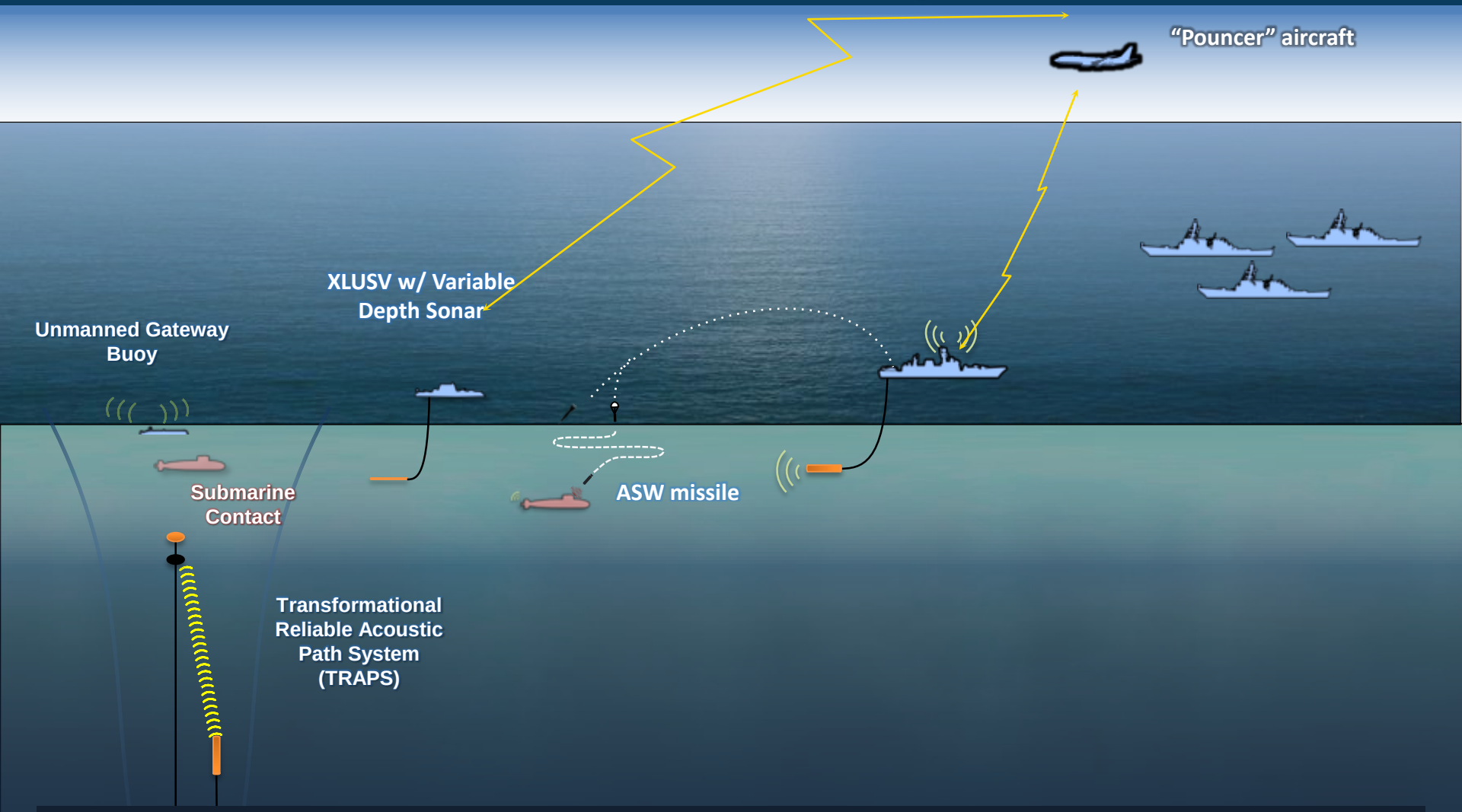

LF active sonar and unmanned sensors find subs; standoff or air-launched weapons suppress and drive them off

Homeland defense ASW search unsustainable

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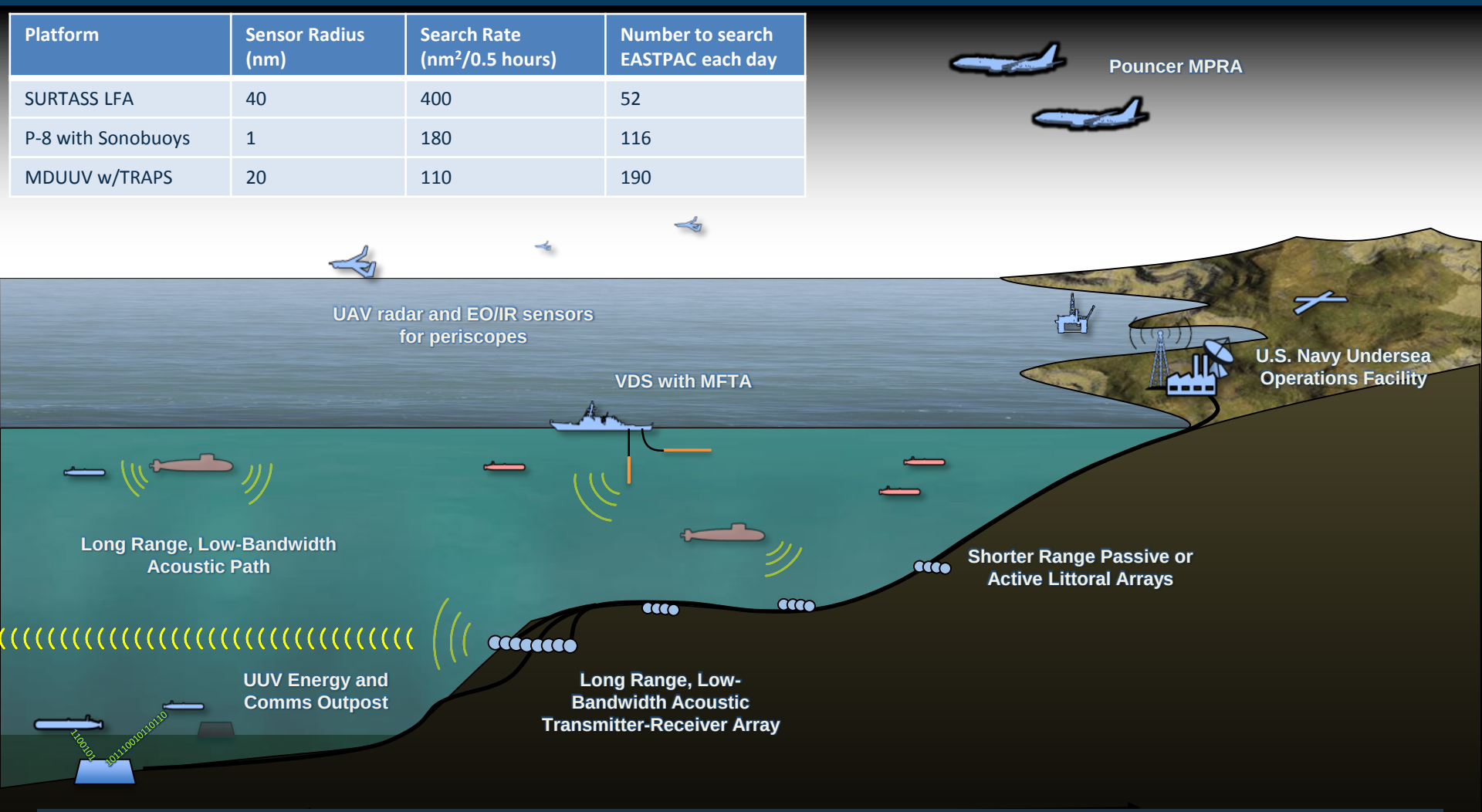
Platform	Sensor Radius (nm)	Search Rate (nm^2/0.5 hours)	Number to search EASTPAC each day
SURTASS LFA	40	400	52
P-8 with Sonobuoys	1	180	116
MDUUV w/TRAPS	20	110	190



With 1000 nm LACMs, ASW search area off U.S. coast covers 1 million square nm; would take entire available force

Offensive ASW and homeland defense depend on track and trail

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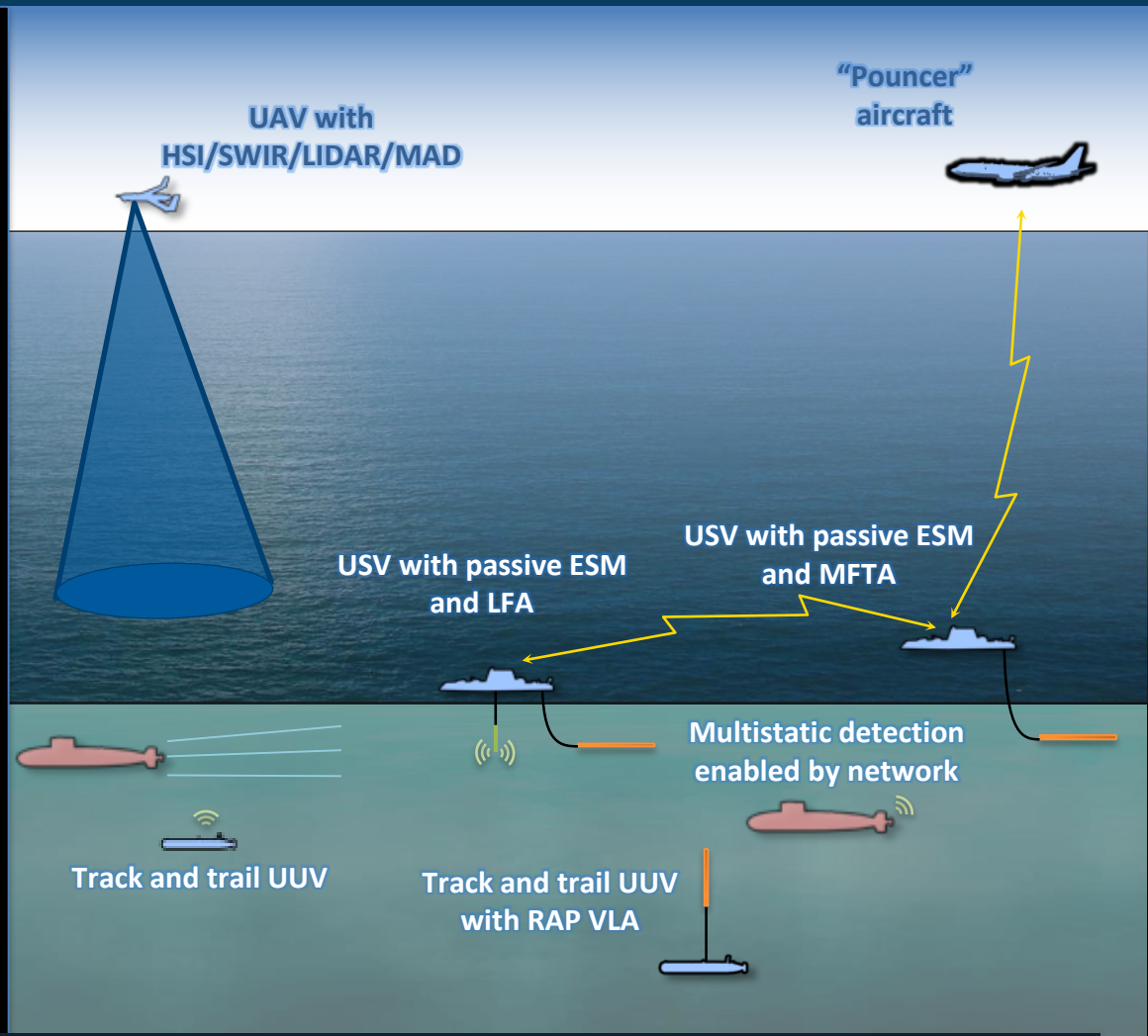
- *Trailing out of area deployers with U.S. SSNs unfeasible as adversary sub fleets grow*
- *UxS offer potential alternatives for track and trail operations*
  - *Wake homing UUV*
  - *Mobile RAP VLA UUV*
  - *UAV with MAD sensor*
- *USVs with LFA or passive towed arrays can trail at longer ranges*
  - *Better able to keep up with submarine target*
  - *Active multistatic tactics could increase detection range*



Adversary can use "gray zone" conflict to sortie submarines before ROE allow ASW forces to attack them; can become unlocated before conflict escalates

Mine warfare increasingly with unmanned systems

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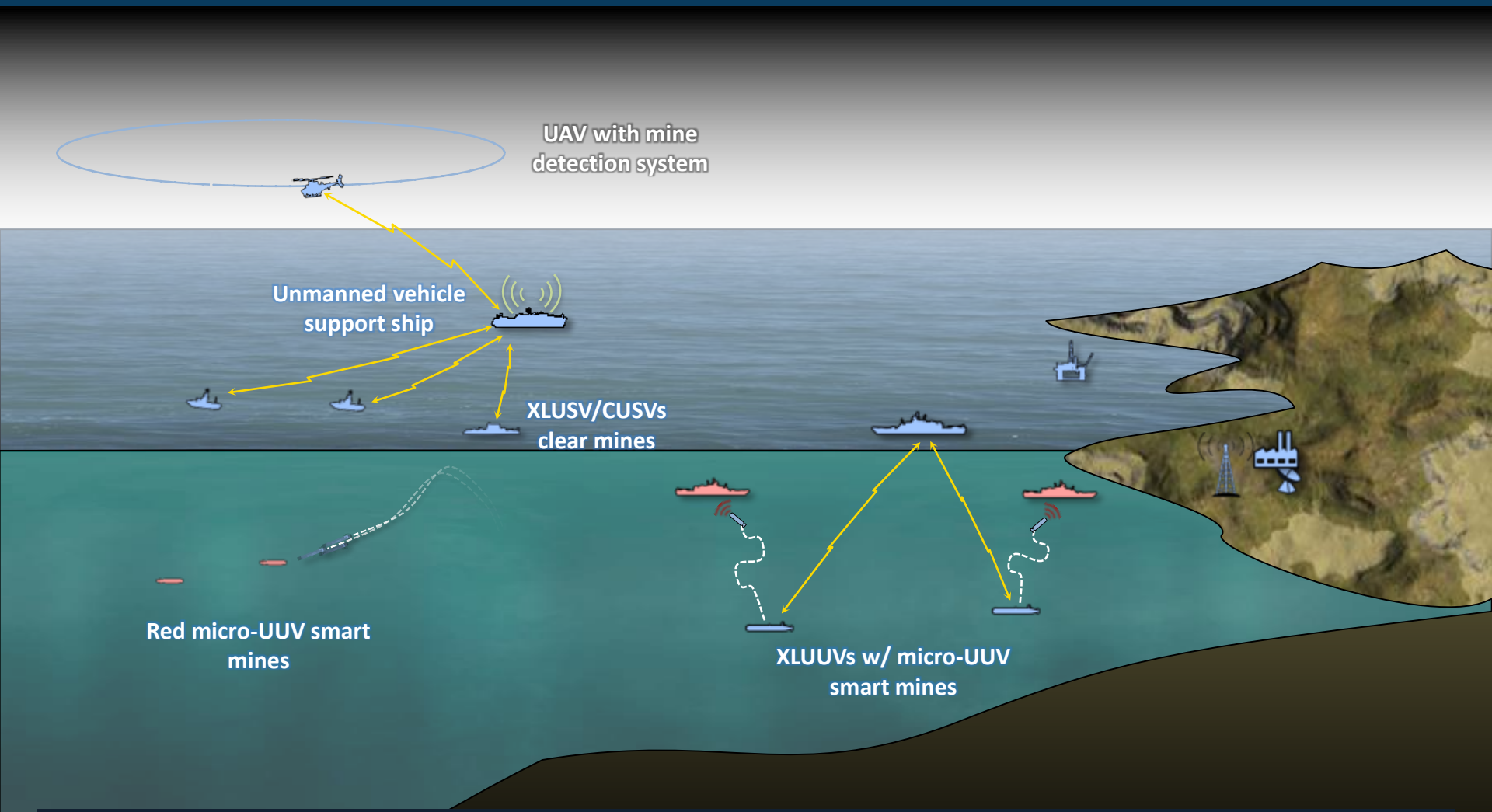

Mines and UUVs merging; will be deployed or found and cleared by larger UUVs and USVs; keeps manned ships out of minefield

Subs and XLUUVs can exploit proximity to launch larger salvos

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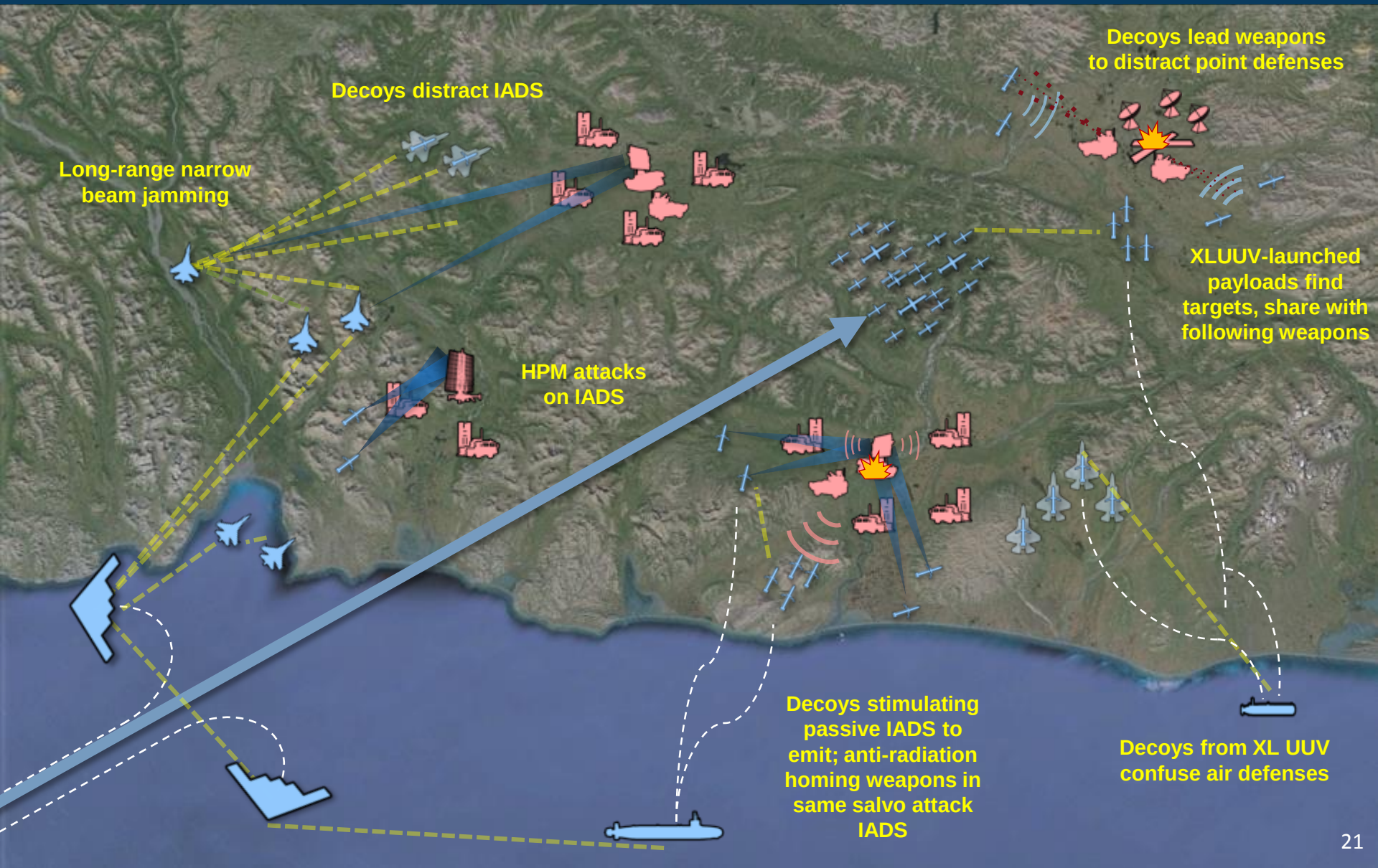
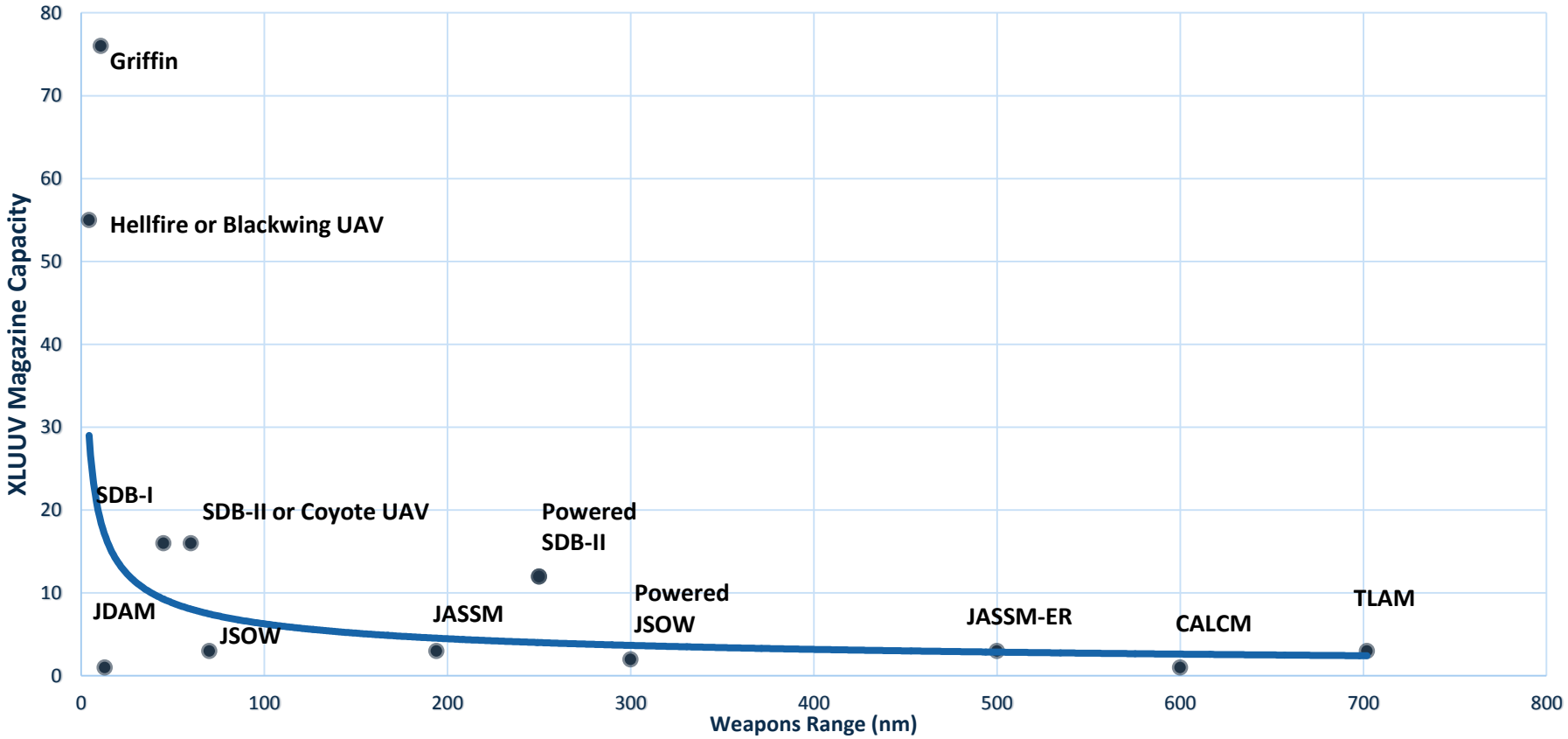


Subs and XLUUVs can launch more small weapons or UAVs



Smaller, shorter-range weapons may be less lethal, but can be used to grow salvos and consume defenses or to attack soft targets

Best use of undersea capacity may be small decoys and jammers

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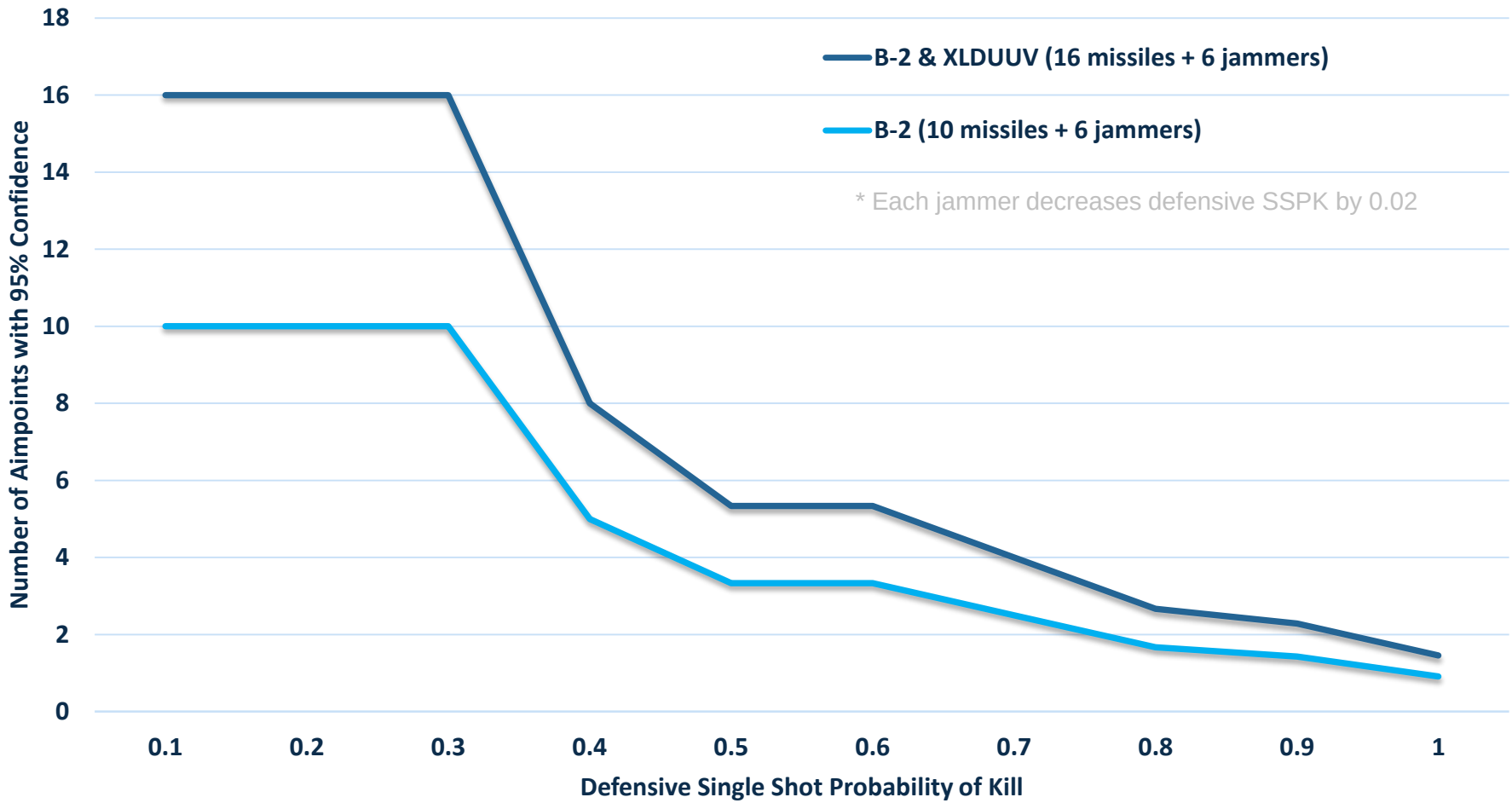

Offloading EW UAVs / missiles to sub or XLUUV maximizes bomber or ship capacity for large weapons, improves effective salvo size, reduces C2 challenge

Defeating UUVs requires a system of systems approach

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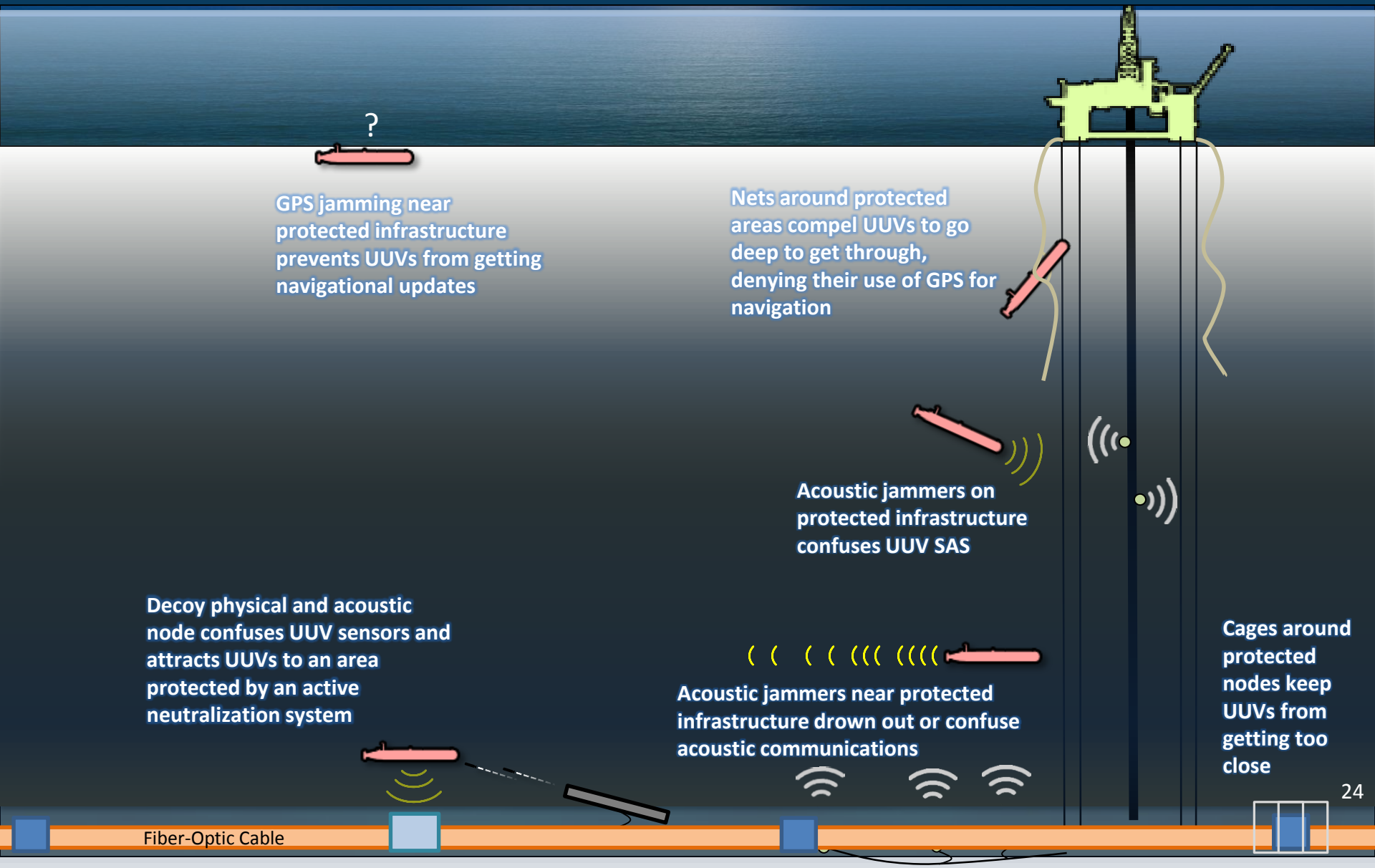

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