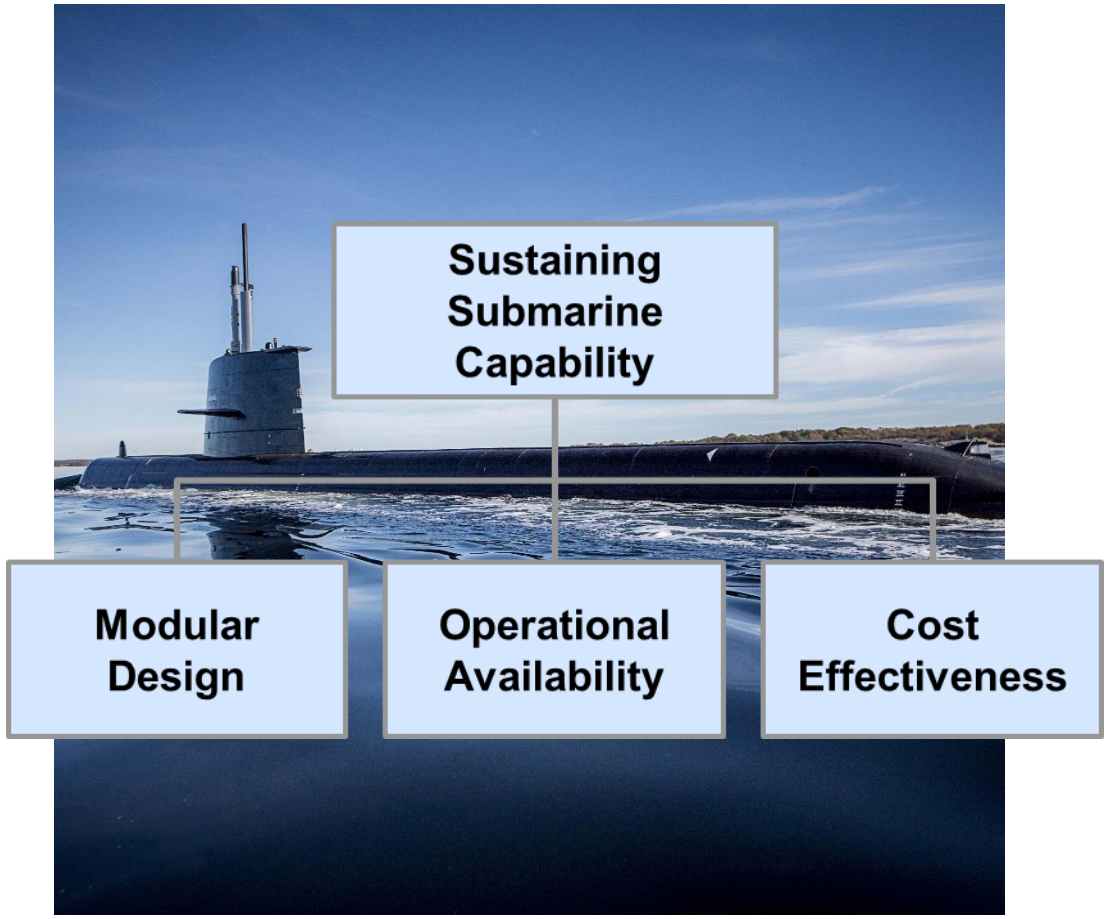
Linking reliability with supportability for enhanced availability

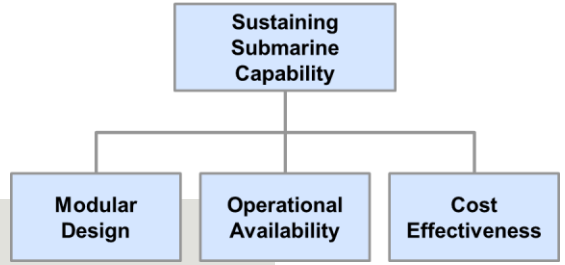
Sustaining Submarine Capability

TOMAS TERNSTRÖM

Sustaining Submarine Capability

- **Modular design**
  - Mission driven requirements
  - Prepared for future upgrades with design margins
  - Easy replacement and standardised interfaces
- **Operational Availability**
  - Focus early on maintainability and Maintenance access
  - Designed to minimize maintenance time
- **Cost effectiveness**
  - Replenishment effectiveness
  - Low manning requirements – highly automated
  - Planned and budgeted modifications and upgrades within Life Cycle Costing scope





Modular Submarine Design

- A design method with balanced requirements stated from operational needs - mission oriented
- A submarine enterprise, where stakeholders have complementary competences
- A design that takes the demands and needs for production and maintenance into account

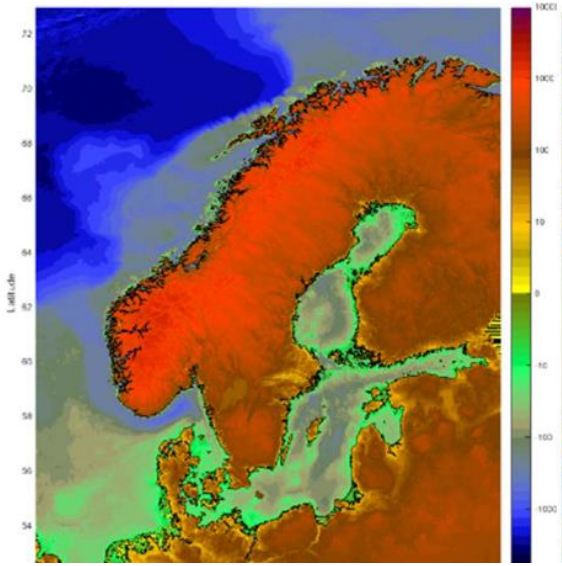
Modular Submarine Design

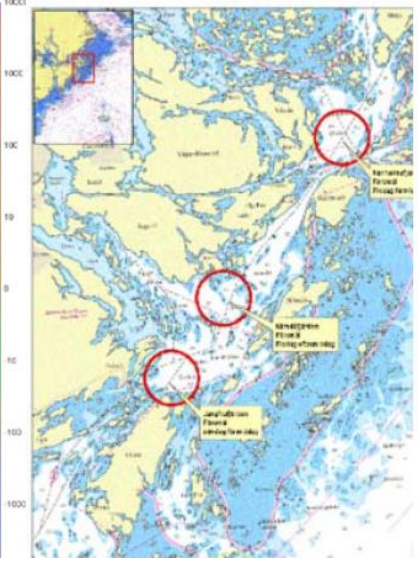
Very complex operational environment:

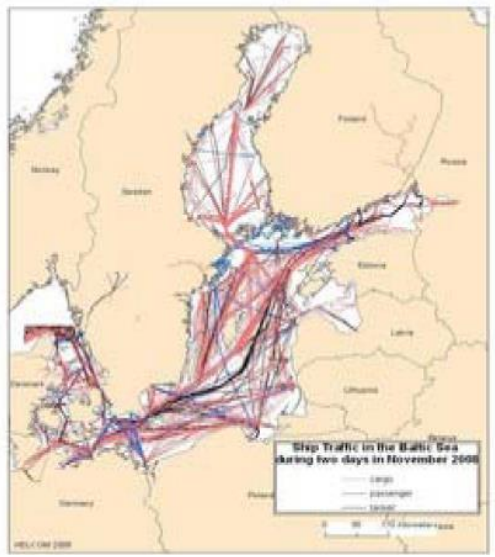
- Very shallow (50 m in average)
- Complex hydroacoustic conditions
- Complex archipelagos, heavy sea traffic
- Large # (>50 000) of mines and ordnances

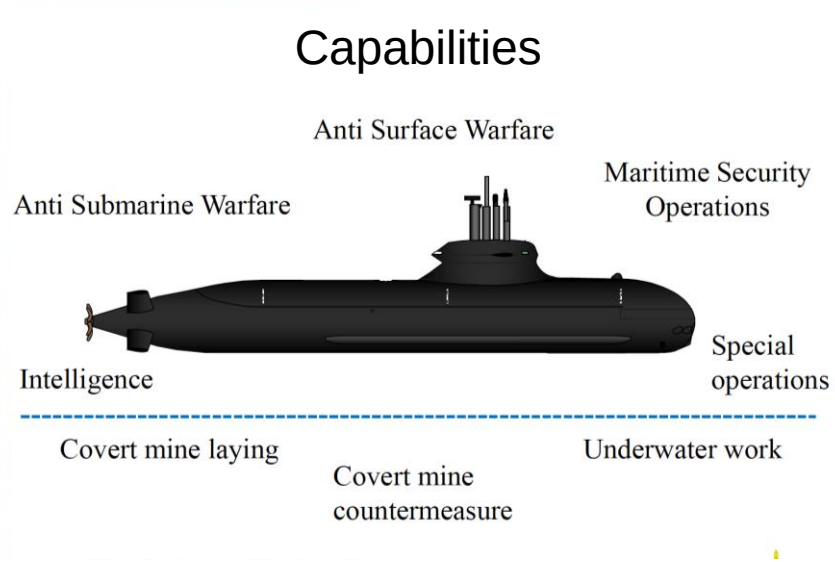
Naval technical requirements:

- Shallow draught, bottoming capability
- Sensors able to handle a cluttered situation
- High manoeuvrability - fast reaction times
- High shock resistance and low signatures









Modular Submarine Design

Evolutionary Design

Submarine Development
in Sweden since 1960

Stirling AIP

Modernisation

Stirling AIP
Signatures
Endurance

Stirling AIP
Tropicalisation

Endurance / AIP / Survivability
Flexible Payload / Special Forces

A26

Södermanland
Class

Modernisation

Sensors
Platforms
Weapon handling
Logistics

Gotland Class

Firepower
Computerised
Shock

Hull shape
X-rudder
One helmsman
Automation
Signatures

Näcken Class

Sjöormen Class

Västergötland
Class

Collins Class

Archer Class

Challenger Class

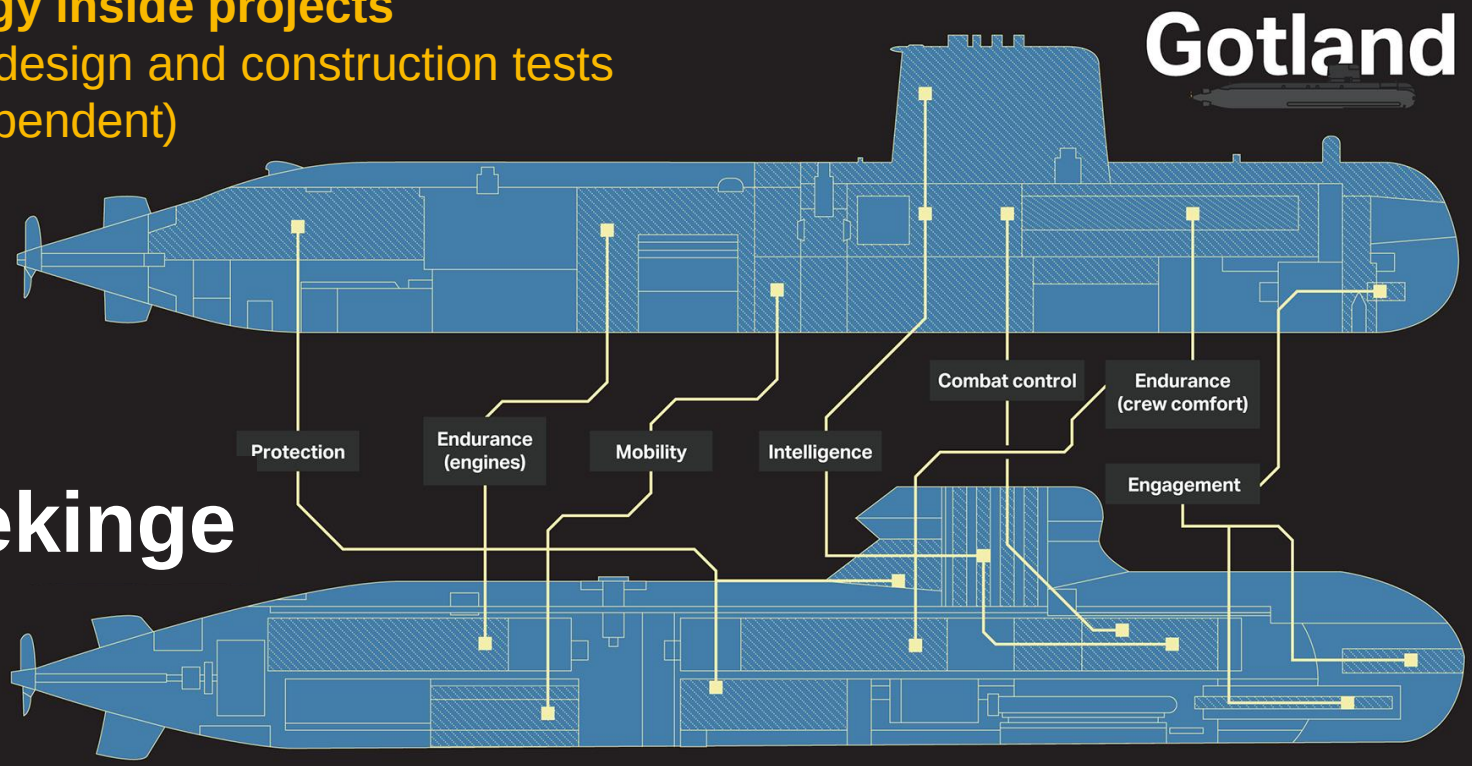
1960 1970 1980 1990 2000 2010

Modular Submarine Design

Use a verified Baseline of Technology inside projects
Minimize project risk through rigorous design and construction tests
Development outside the project (independent)

Many systems used in Gotland MLU are paving the way for Blekinge cutting edge capabilities.

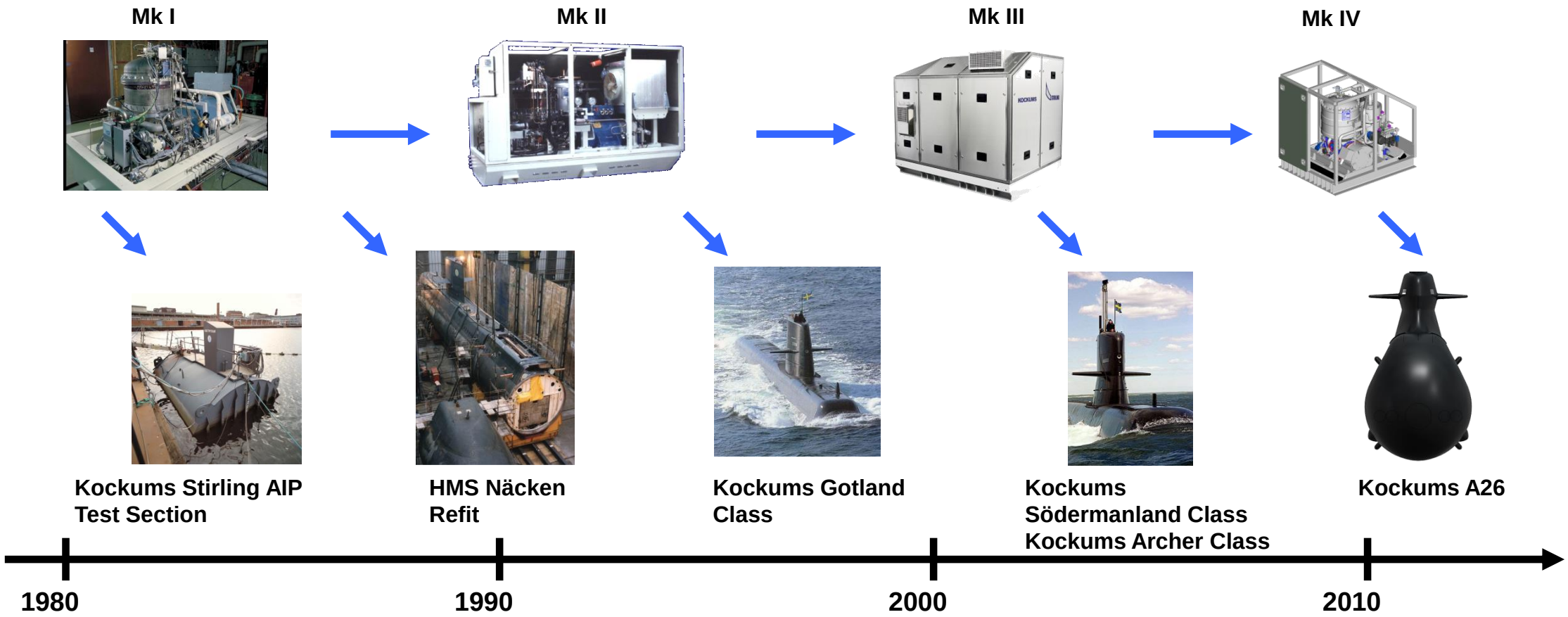
This makes Gotland a clear step in the evolutionary chain of submarines



Upgrades & Modifications - Parallell system development

Modular Submarine Design

Use a verified Baseline of Technology inside projects
Minimize project risk through rigorous design and construction tests - Development outside the project (independent)



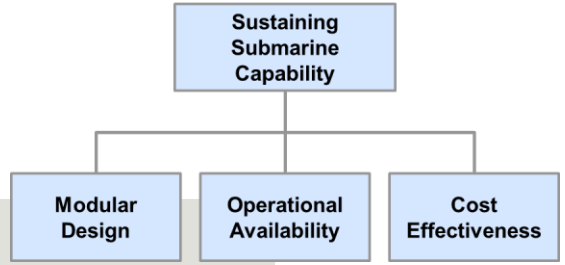
Modular Submarine Design

Availability in focus early in the design:

- Systems & Components - Reliability
- Integration - Maintenance access
- Modularity - Easy replacement
- Standardised interfaces - COTS solutions

The purpose of this is to ensure:

- Balanced life cycle cost - Affordability
- Optimum reliability and maintainability (R&M)
- Optimum design for maintenance and supportability
- Minimum maintenance training requirements



Operational Availability

- No large exclusive MLU. Instead major capability upgrades will be done during the Full Cycle Docking.
- Continuous Through Life Support framework agreement including obsolescence management
- Planned and budgeted modifications and upgrades within Life Cycle Costing scope

Availability and maintenance planning

Upgrades and modifications is introduced at the ID and FCD maintenance availabilities

FCD - Stepwise development

- All COTS procured in one batch.

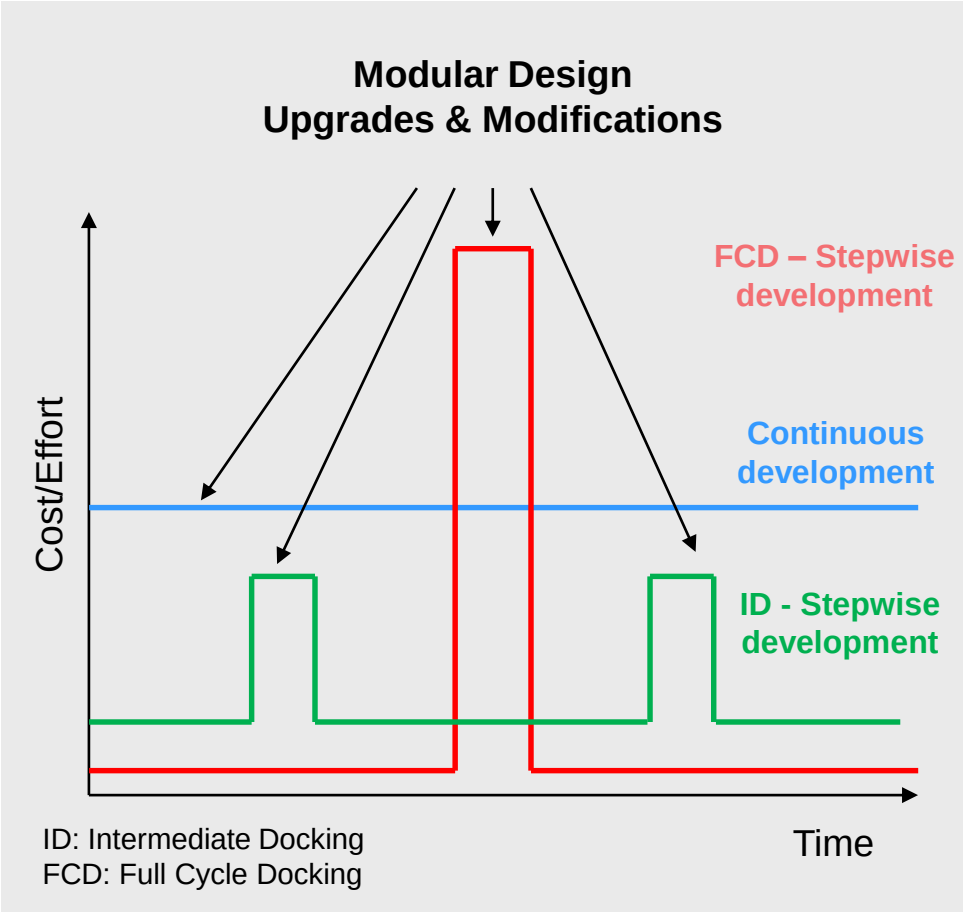
ID - Stepwise development

- Spares to cover the period until planned upgrade modernisation

TLS - Continuous development

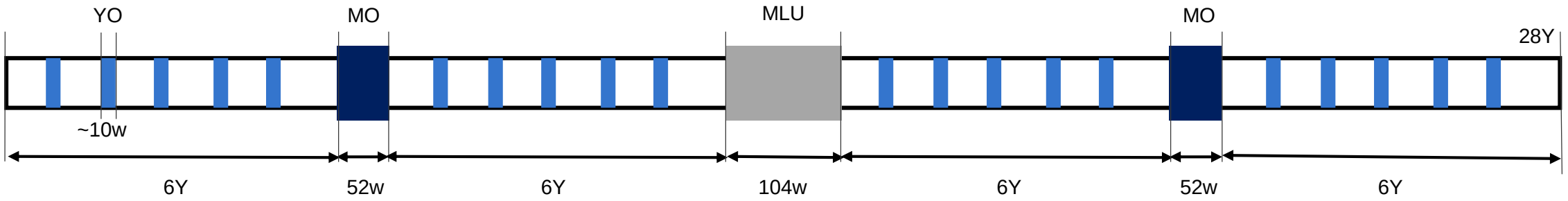
- Framework Agreement
- Yearly upgrades in HW and SW

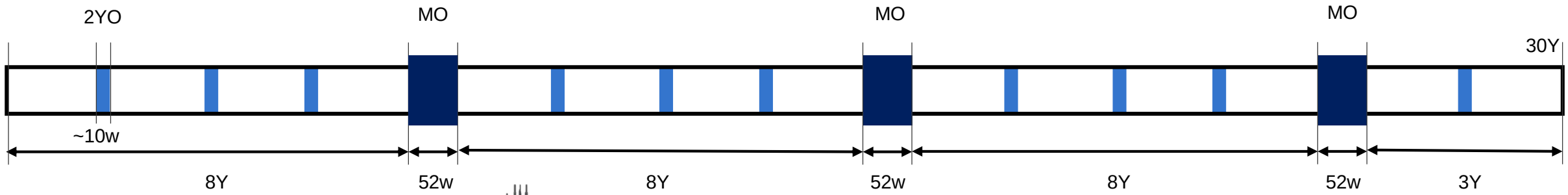
Planned and budgeted modifications and upgrades within Life Cycle Costing scope



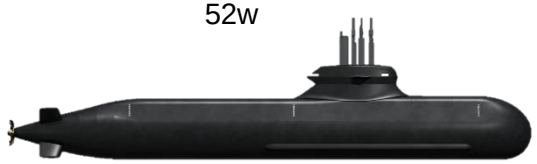
Availability and maintenance planning

Gotland Class

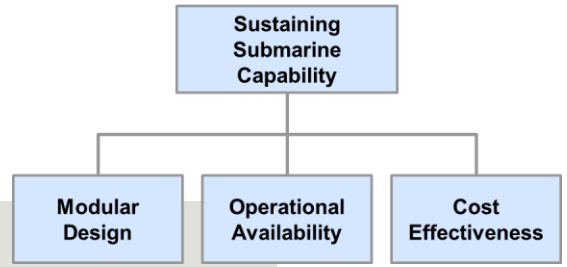




Blekinge Class



With the Blekinge class a 14 % increase in the operational availability A_o is expected



Cost Effectiveness

- Cost effectiveness is driven by reliability (i.e. how much performance can you get for your money?)
- Reliability [R] tells information about the failure-free interval (i.e. how many failures can you afford?)
- Operational availability [A_o] tells information about how you use time (i.e. how much can you afford to spend to avoid failures?)

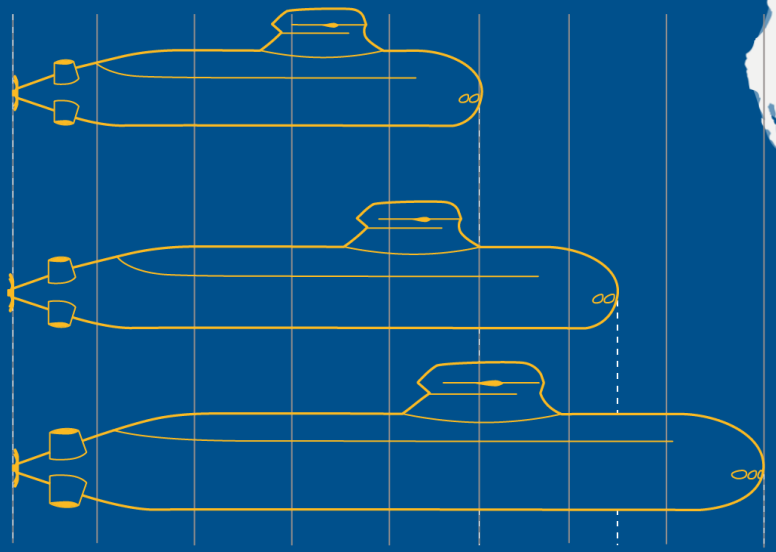
Cost Effectiveness

Operational Needs and Requirements

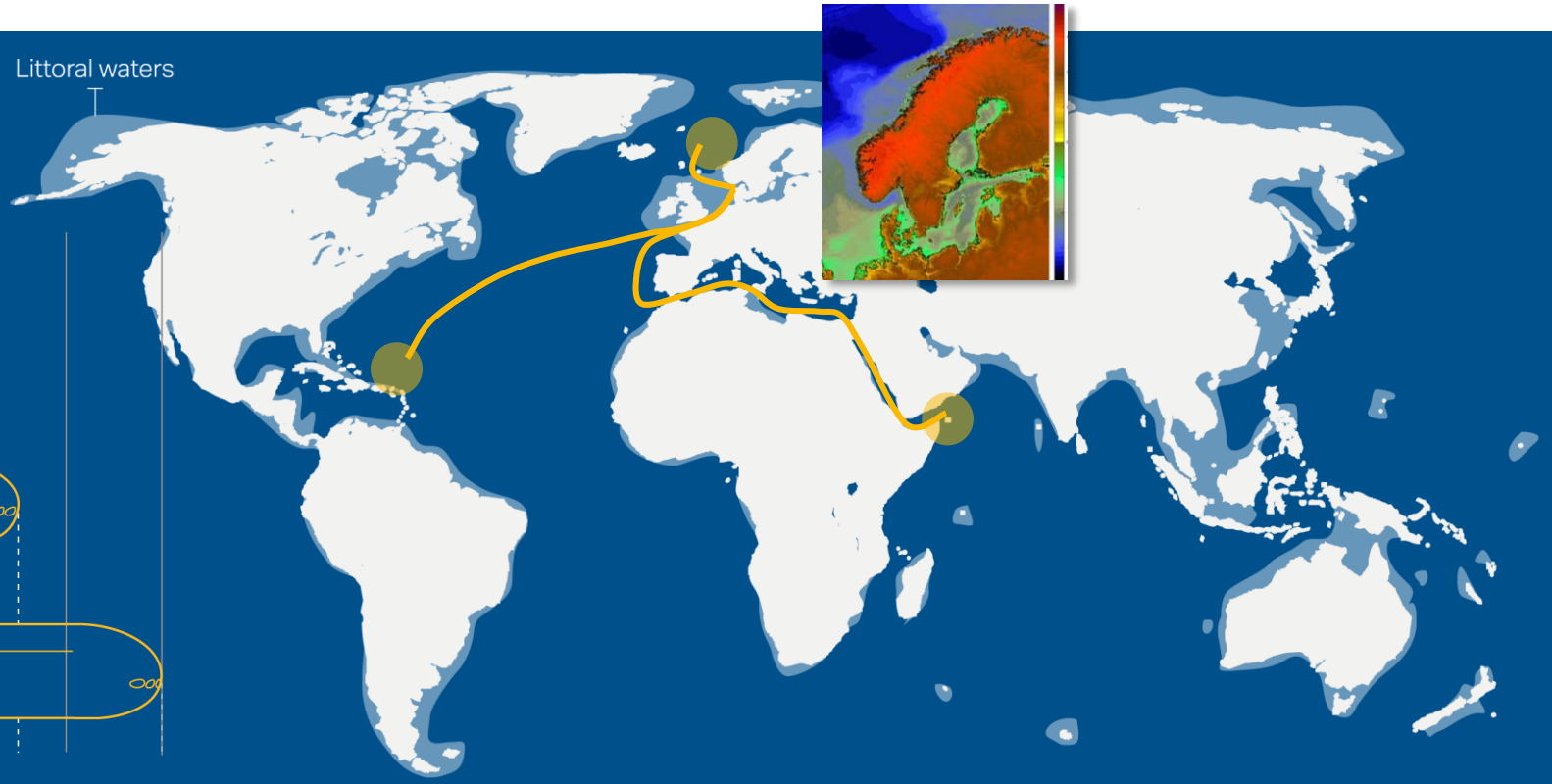
Define Functional Architecture

Performance Requirements

Define Physical Architecture



Purpose-designed to have optimized range and endurance

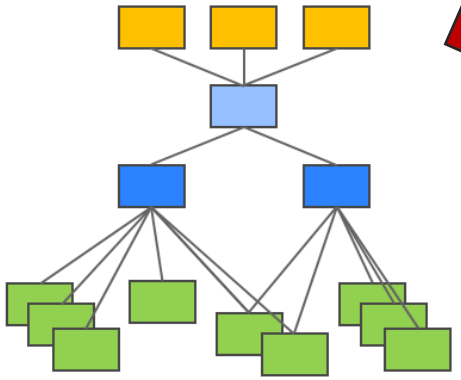


Operational Profile

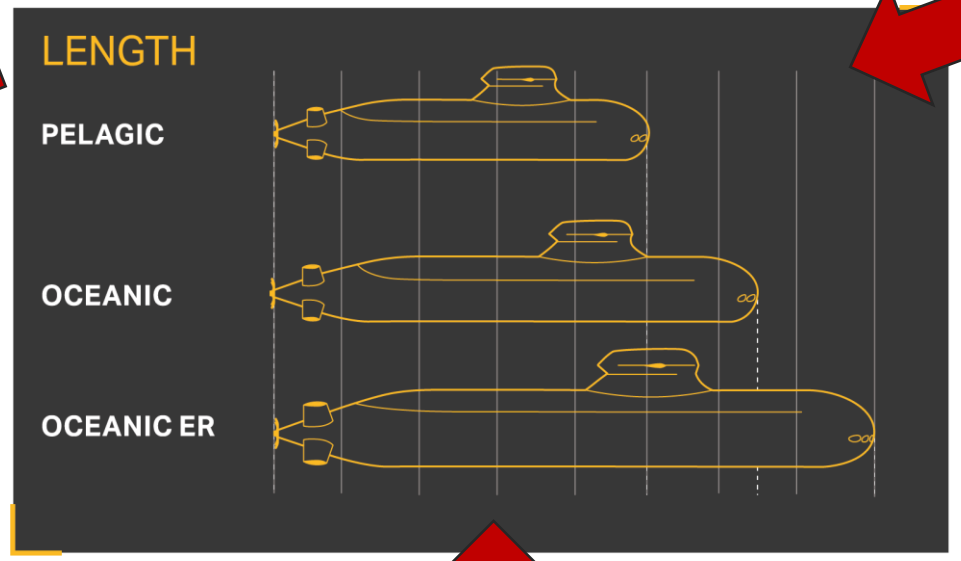
SAAB

Cost Effectiveness

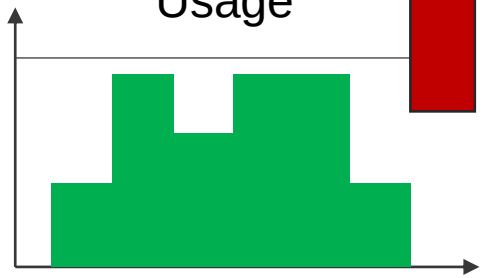
Maintenance Organisation



- Spare part availability
- Cost for repairs
- Transportation cost
- Turn around time
- Support equipment
- Facilities

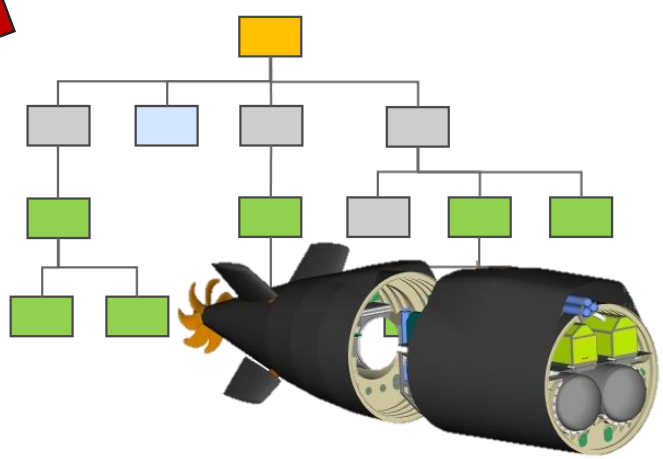


Usage



- Number of system
- Operating profile
- Operating theatre

Physical Structure/Model



- Rate of failure
- Maintainability
- Component price
- Preventive maint. need

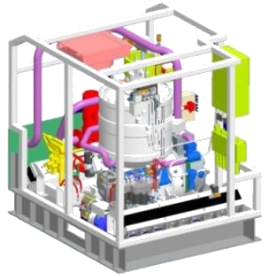
Cost Effectiveness

Low signatures
- Low noise
- No IR signature

High efficiency
- Further increased through waste heat recovery

Increases submerged endurance

Mk 3 Kockums Stirling module



A26 Kockums Stirling module

AIP replenishment at sea

Proven
- Operational since 1989
- Used in all RSwN submarines and by other navies

Low life cycle cost
- Cost effective solution
- Easy to maintain

Simple logistics
- Low sulphur diesel
- Standard LOX

Cost Effectiveness

AIP replenishment at sea

Cost Effectiveness

- Hydraulically powered with manual back-up for quick, safe and reliable operation.
- Central control station with remote control facilities.
- Low manning requirements – highly automated.
- The entire system is included on board the submarine. A simple crane is all that is needed ashore for loading.
- High reload stowage density.
- The reload equipment is resiliently mounted for protection against shock.
- Low noise signature enables the reload equipment to be used under silent running conditions.

Sustaining Submarine Capability

- With a mission-oriented approach complemented with parallel system development it is possible to integrate new and improved technologies at justifiable risk levels
- The purpose is to increase the number of days at sea and minimise the number of days at the shipyard.
- The overall objective is to provide the end user with a submarine with optimal availability, in the most cost efficient way.

Linking reliability with supportability for enhanced availability

Sustaining Submarine Capability

SAAB