Kongsberg Maritime

Introducing K-MATE
For Maritime Autonomous Surface Ships (MASS)

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Kongsberg Maritime Autonomy Engine

- Joint project between KM and FFI
- Designed to offer new autonomous capabilities for MASS (Maritime Autonomous Surface Ships)
- Offering different operational modes:
  - Autonomous
  - Supervised
  - Direct control
- Includes modules for:
  - Control and guidance
  - Navigation and positioning
  - Scene analysis
  - Payload control
- Current capabilities
  - Autonomous Waypoint Following
  - Collision avoidance using Radar & Lidar
  - Virtual anchor, AUV following
K-MATE

Kongsberg Maritime Autonomy Engine

- Adaptable autonomy kit for almost any hull
- Scalable capability from waypoint following to collision avoidance and more
- Common architecture with HUGIN and MUNIN vehicles

MASS for Mapping/Survey  MASS for AUV Supervision  MASS for AUV launch and recovery  MASS for Towing Application  MASS for integrated MMCM
**K-MATE**

**OEM Autonomy**
- Basic autonomy engine
- Electrical integration with hull systems
- Available as a “MASS Autonomy Kit”
- Can be integrated with KM payload

**Small: 2-7m**
- For science or very shallow survey
- Opportunity for payload options:
  - GeoSwath 4
  - μPAP

**Medium/Coastal: 7-9m**
- For commercial, science and defence applications
- Integrated collision avoidance
- Ability to supervise AUVs
- Full KM payload suite:
  - EM2040P or C
  - HiPAP
  - MBR

**Large/Trans-Ocean: 10-15m**
- For commercial, science and defence applications
- Integrated collision avoidance
- Ability to supervise AUVs
- Full KM payload suite including:
  - EM302, 2040 or 712
  - HiPAP
  - MBR
K-MATE Components

Inputs:
- Navigation & Positioning
  - NavP/Sunstone
  - Seapath 136 GNSS & IMU
  - HiPAP/APOS
- Communications
  - Iridium/Inmarsat
  - Marine Broadband Radio
  - Remote Control
- Scene Analysis
  - AIS300
  - Radar
  - Cameras

Core Elements:
- User Interface
- Mission Plan

Outputs:
- Guidance and Control
  - Waypoint Following
  - AUV Tracking
  - Collision Avoidance
- Mission Implementation & Supervision
  - Real-time Status
  - Real-time Data
  - Goal Based Adaptive Control
- Payload Control
  - Multibeam/HISAS
  - AUV
  - HiPAP

Data Handling:
- KognifAI
  - Cloud-based data handling
  - KM Apps like Reflection
  - Third Party Apps
  - Requires comms link

- In-Mission Processing
  - SITAR
  - Pipe Tracking
  - Terrain Navigation
  - Automated Processing
K-MATE Goal Based Performance

Pre-Mission Goal Based Mission Planning
• Enable K-MATE to determine the best survey pattern
• Track spacing determined by simulated performance of multibeam echosounder
• Ability to determine a stand-off range from AUV or mothership

In-Mission Adaptive Control
• Modify survey pattern based on environment and sensor performance
  – Wind, waves and sea state
  – Track spacing adjustment based on real-time sonar performance monitoring
  – Adjust heading and speed to adapt to AUV or mothership
• In-mission processing algorithms e.g. target recognition
• Adaptive in-mission replanning

Conditions
• Safety is overriding factor
• Collision avoidance takes priority over mission plan or adaptive control
K-MATE Collision Avoidance

Scene Analysis
• Sensors:
  – Radar
  – AIS
  – Cameras (Infrared, day TV)
• Processes:
  – Data is fused on-board in K-MATE and potential collisions are identified
  – Traffic is always transmitted to control centre

Collision Avoidance
• Phase 1:
  – Alert operator
  – Sound horn, flash lights
  – Come to a stop
• Phase 2:
  – Open communications link to nearby traffic
  – Automated response in accordance with the rules of the road
  – mission plan or adaptive control
K-MATE: Applications

• Commercial
  – Hydrography
  – AUV Support
  – Oil spill monitoring and clean-up

• Defence
  – MCM
  – REA
  – ASW

• Scientific & Research
  – Oceanography
  – Hydrography
  – Environmental monitoring

• Miscellaneous
  – Search & Rescue
  – Marine salvage
K-MATE and KognifAI

Connecting the Ocean Through Data

- Real-time access to system performance and data globally
- Secure cloud-based data storage
- Apps for visualization and processing
  - KM Apps like Reflection
  - Third party Apps
- Sharing access and adding value
  - Transmitting meaningful data to minimize bandwidth
  - Accessing the full data set when possible
  - Requires smart processing on-platform
K-MATE: Yara Birkeland

Key Facts:
- Fully battery powered ship
- Prepare for remote control and fully autonomous operations
- Dimensions & Performance
  - LOA: >70 m
  - Beam: 15 m
  - Depth: 12 m
  - Draft: (full) 5m
  - Service speed: 6 Knots

Purpose and Performance:
- To replace road journeys
- Sail within 3 ports
  - Herøya to Brevik: 7 nm
  - Herøya to Larvik: 30 nm
- Controlled by:
  - YARA at Porsgrunn
  - Kongsberg Maritime

Schedule:
- 2017: design finalized
- 2018 Delivery & testing with small crew
- 2019: Remote operation
- 2020: Fully autonomous operation
**K-MATE: Hrönn**

**Key Facts:**
- Light duty, offshore utility ship servicing:
  - Offshore energy
  - Hydrography
  - Scientific
  - Offshore fish-farming
  - ROV or AUV support
- Capabilities and equipment:
  - DP
  - Navigation & positioning
  - Communications
- K-Chief automated bridge and K-Bridge ECDIS will be replicated in control centre

**Activities:**
- Design completed in 2017
- Testing in Norway’s dedicated autonomous trials area
- To be classed and flagged by DNV GL and Norwegian Maritime Authority
K-MATE: Odin

Project:
• Joint development between FFI and KM
• Can be manned or unmanned
• Multipurpose platform for defence research
  – Hydrography
  – Mine Countermeasures surveys
  – AUV launch and recovery
• Configured to carry an AUV

Equipment:
• Systems:
  – Dual engines
  – Electronic anchor
• Navigation, Communication & Collision Avoidance:
  – Seapath 136
  – AIS 300
  – Radar, Camera & LIDAR
  – MBR
  – Iridium
WORLD CLASS
through people, technology and dedication
Utilizing Kongsberg Maritime Solutions:

- K-MATE
- AIS 300
- Seapath 130
- Maritime Broadband Radio
- HiPAP Positioning and Communications System
- Multibeam Echosounders
K-MATE: SEA-KIT Trans-Ocean Survey

Dimensions:
• Length: 11 m
• Width: 3 m
• Height: 3 m
• Designed to carry a HUGIN AUV

Performance:
• Endurance:
  – Standard: >30 days
  – Enhanced: >300 days
• Speed: <8 Knots

Equipment:
• Systems:
  – Dual diesel electric generators
  – Dual stern thrusters plus bow thruster
  – Electronic anchor
• Navigation, Communication & Collision Avoidance:
  – Seapath 136
  – AIS 300
  – Radar & Camera
  – MBR
  – INMARSAT & Iridium