VICTORIA Class Submarine Human-in-the-Loop Experimentation Plan and Preliminary Results

Aren Hunter, Mark G. Hazen & Tania Randall
DRDC, Atlantic Research Centre

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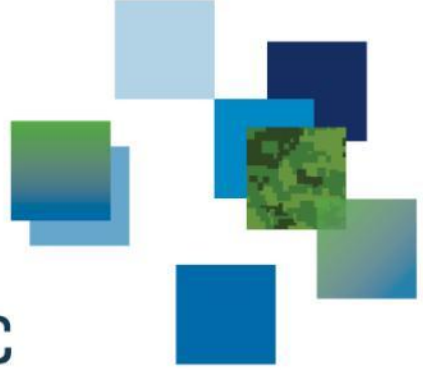

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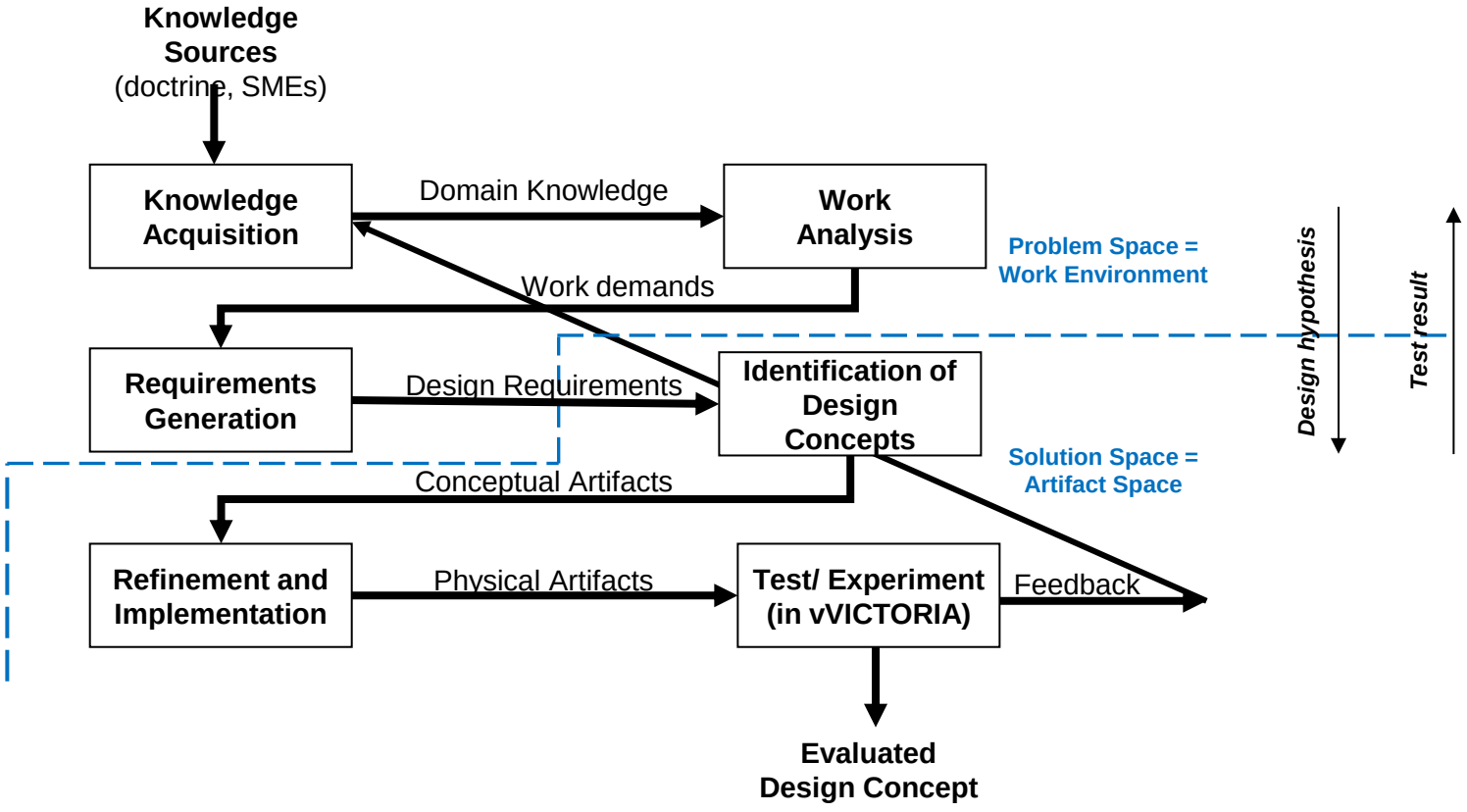
Concept Development Design Framework

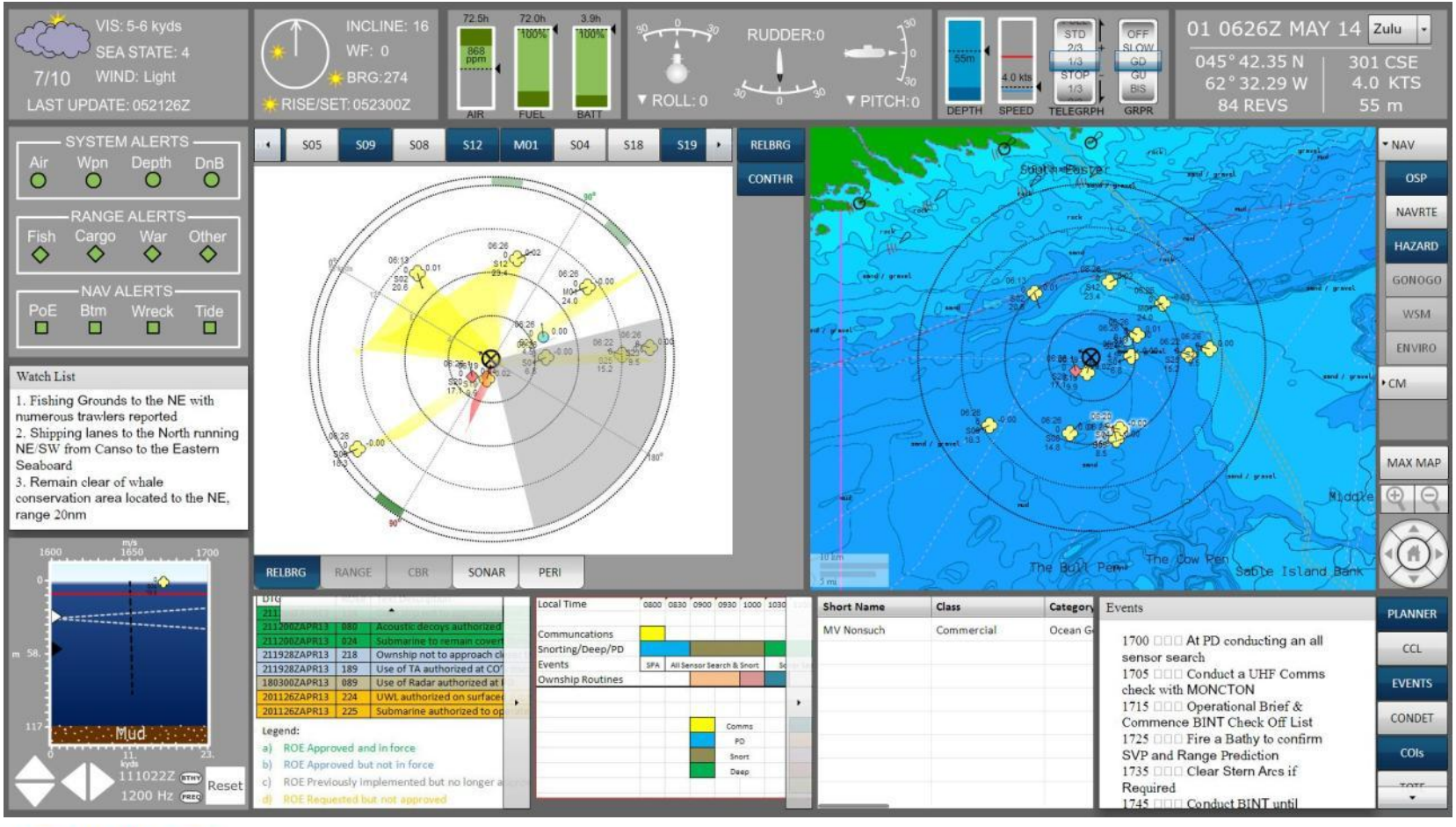


Ref: Chalmers

VICTORIA C2 Design Concepts

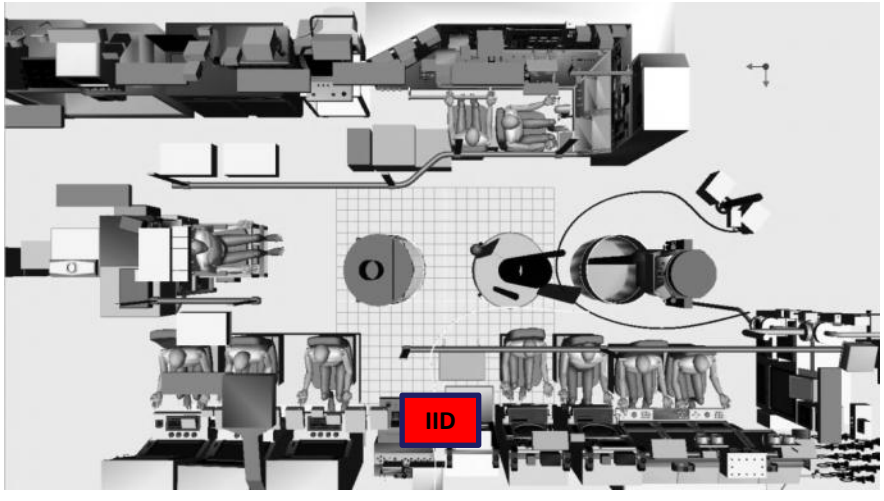
- Top Rated Concepts by SMEs
  - C2 Information Integration & Tactical Display
  - Automated Record Keeping
  - Integrated Planning Tool
    - Navigation, tactical planning, signature management, platform systems management, comms
  - Emergency Management Tool
  - Reliable & Flexible Internal Comms System
  - Platform Systems Display
  - Signature Management Display
  - Improved Collaboration Between Command Team and EW- various design options

Information Integration Display



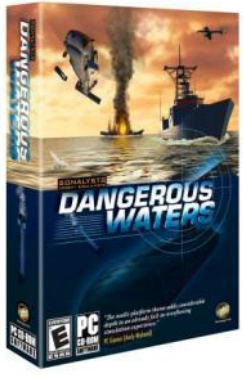
IID HIL Experimentation

- IID Placement in VCEL
  - Between Sonar and Fire Control.
  - Based on visual angle, and optimal viewing from various areas in the control room.



VICTORIA Capability Evaluation Laboratory (VCEL)

- Full Scale Plywood Mockup of VCS Control Room
- Simulation + Real Systems
- Audio, Video, Motion, Eye Tracking



Paper 075 for more details

Experiment

- Participants
  - Two Separate Teams
    - Watch Leader
    - 2nd Officer of the Watch (OOW)
    - Sonar Supervisor
    - Sonar
    - TMA
    - ECM*
    - Helm*
  - Team 1 had a more experienced WL (4.5years) vs. Team 2 (.25years) but overall team experience was similar (11 years vs. 10 years)
- Scenarios
  - Four Separate Scenarios
    - Same Operational Environment
    - Same Number of Contacts
    - Similar Mission (ISR)
  - Communication Analysis
    - Assessed the scenarios for similarity
      - SMEs rated communication trends and workload as being the same.
  - The majority of participants assessed their workload as average across all scenarios.

Procedure

- Day 1: Training Day
  - Both teams received training
  - Crew received Dangerous Waters training
  - Watch Leader received IID training
- Day 2: Team #1

  Completed Four Runs
  - 2 Experimental Condition (IID)
  - 2 Control Condition (No IID)
  - 1.5 hours each
  - Debriefing session and questionnaire after each run.
- Day 3: Team #2

  Same procedure as Day 2
  - Conditions and scenarios were counterbalanced.

Data Collection 1/2

- Watch Leader was equipped with SMI Eye Tracking Glasses
- Data was used to evaluate where the WL was looking on the IID.

Data Collection 2/2

- Audio, Video, Motion
  - Four wall-mounted video cameras + single mike
  - MP3 to record audio
    - Each team member
  - Microsoft Kinect
    - Measure movement in and around the control room.
    - Secondary Video Source
- Screen Capture
- Debriefing Questionnaires
  - Completed by each crew member after each run
  - 5 pt. Likert Scale
- Simulation data
  - Actual scenario state
  - Combat system data

Analysis Plan

- SME Evaluation for Performance and Situational Awareness
- Scenario based Warfighting performance metrics
- Behavioural Changes
  - Heat maps of OOW/2OOW movement
- IID Specific Assessment
  - Eye tracking data for actual usage
  - Correlation with tactical decision making by SME
  - Participant evaluations

SME Evaluation

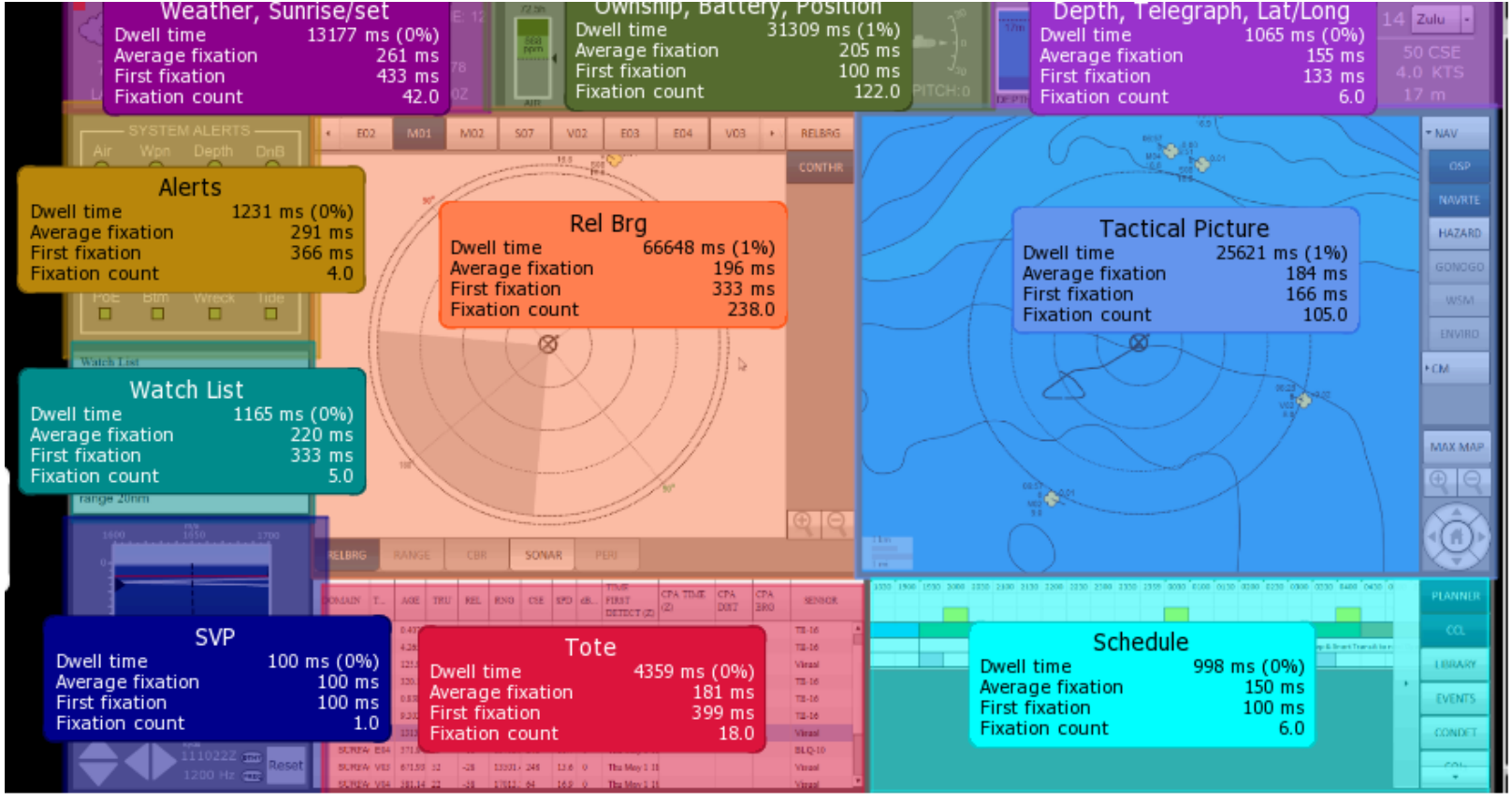
- Former RCN Submarine Commander and Current Submarine Tactics Instructor
  - Took notes and evaluated behaviour during experimentation
  - Completed SME evaluation questionnaires every 30 minutes.
    - Ex. How would you rate the watch leaders situation awareness?
    - Ex. How would you rate the watch leaders workload?
    - Ex. How would you rate the assignment of priority to contacts?

- Reviewing audio/video to reconstruct WL/2OOW situational awareness.

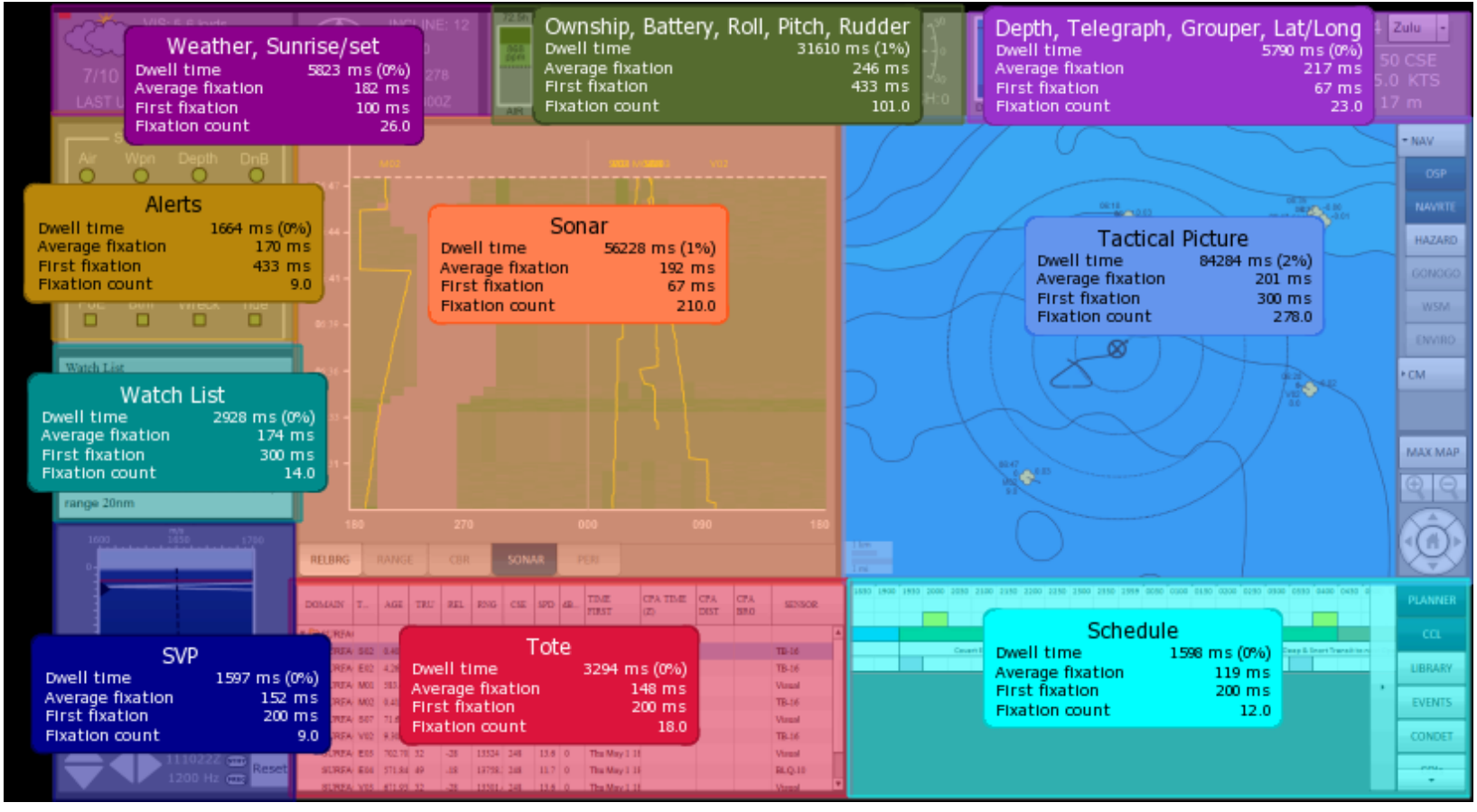
Scenario Based Metrics: Mission, Safety, Covertness

- Covertness metrics
  - Time spent at periscope depth (PD), number of counter detections, and frequency of cavitation.
- Contact management metrics
  - Number of lost contact incidences, number of contacts detected vs. number in scenario, number of contact re-classifications, false alarms, or repeated contacts etc …
- Planning metrics
  - Duration of the mission vs. the planned mission.
- Safety metrics
  - Collisions with vessels or land, accuracy of closest point of approach, look interval duration, frequency of going deep, and accuracy of pilotage.

Preliminary IID Eye Tracking Results



Preliminary IID Results 2/2



Conclusions

- Developed and executed small sample HiTL experiment
- Investigated the utility of the Information Integration Display concept.
- Demonstrated a full development cycle of the C2 capability development framework.
- Demonstrated use of Mobile Eye tracking for C2 assessment.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