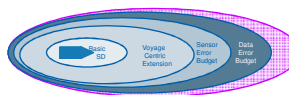# Data Supply Chain Certification

DQWG11 - Eivind Mong
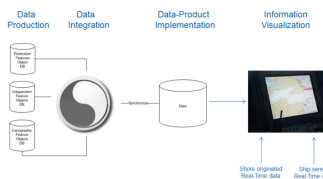
Agenda

- **Data Quality Definitions**

© Michael Bergmann, 2016

- **Data Supply Chain Certification**

1. Data Quality Definition

Basic SD · Voyage Centric Extension · Sensor Error Budget · Data Error Budget

© Michael Bergmann, 2016

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Situational Awareness
Safeguarding needs enhanced Support

- **Increasing complexity of nautical task**
  - Higher traffic volume and densities
  - Reduction of navigable space
  - Larger ship size
  - Reduction of bridge teams
  - Economical and ecological pressure
- **Increasing data volume**
  - Higher number of situation relevant data types
  - More data sources (sensors, other ships, shore…)
  - Higher resolution of data provision (spatial, temporal)

➡ **Necessity to prepare information**
  - Selecting and linking of relevant data
  - Evaluation and refinement of data
 - Human Centric Approach for presentation of information

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Situation Awareness
Data are the key element !

- **Data needs to be converted into information.**
- **Human Centered Design (HCD) intents to present information in digestible way.**
- **High error budgets in database cannot be rectified by the best systems.**
- **Data quality needs to be a prime focus area.**

©Michael Bergmann, 2012

http://www.satimagingcorp.com/gallery
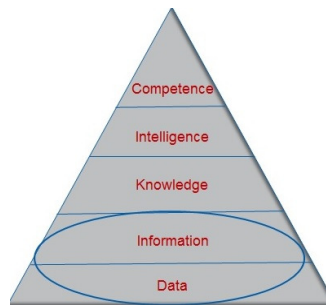
Predicted error budget (meters)	
Parameter	**Est. StDev.**
GCP error	1.00
Residual processing	0.50
Residual satellite	3.60
Feature capture	0.40
Terrain induced error	2.45
Est. Total error	**4.51**

© Jeppesen, 2005: Data Validation Project

Example

QuickBird is a high resolution satellite owned and operated by DigitalGlobe

Lima, Peru

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Reliance of Ship's Navigation
Navigator vs System

e-Navigation

Navigator
System

Historic — Traditional — Early systems (Radar...) — VTS Support — Advanced Bridge — ECDIS — Decision Support System — Advanced STMS — Remote Control — Autonomous Ships
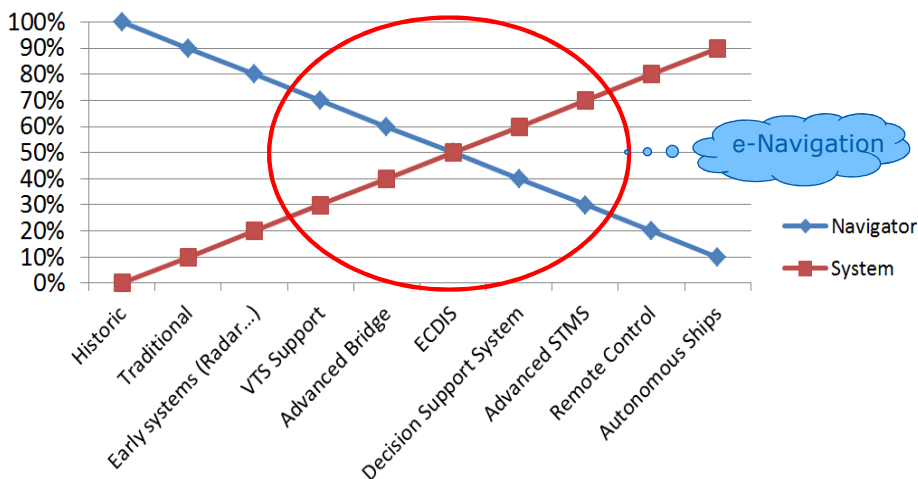
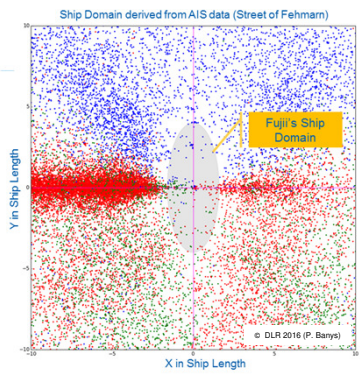Michael Bergmann, HSSC7, 12 Nov 2015

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Avoidance of Collision& Grounding
dCPA/tCPA, Ship Domain (SD), and Ship Arena (SA)

- **Open Sea Conditions**
  - dCPA/tCPA are usual identifiers of collision risk between ships (distance/time to Closest Point of Approach)
  - SD is the safety area around a ship not to be violated (ships and obstacles)
  - Diversity of SD models result from determination & considered impacts (object of research)
  - SA describes the area around a ship to be monitored for SD protection (taking into account the needed time for collision avoidance actions)

- **Restricted Waters, Port Entries, Narrow Fairways,….**
  - dCPA/tCPA approach unusable due to restricted navigation area
  - Special SD taking into account specific conditions & maneuvers (navigational area and maneuver possibilities)

Ship Domain derived from AIS data (Street of Fehmarn)
Fujii's Ship Domain
© DLR 2016 (P. Banys)

Dimension of Ship Domain
Influencing Factors

Ship Centric factors	Voyage Centric Factors	System Centric Factors
– Ship size (length, width) – Ship's static characteristics (wind susceptibility) – Ship's dynamic characteristics (maneuverability…)	– Cargo: dangerous goods – Passenger – Speed	– Human factors (navigator education, experience…) – Ship Sensor error budget – Data error budget (data quality indicator, CATZOC…) – Data Supply Chain error budget
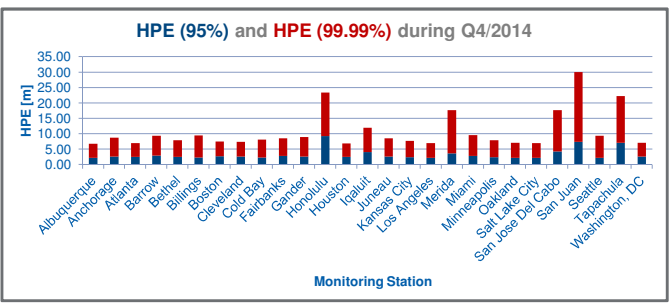
Example of error budget: HPE of GPS SPS

HPE (95%) and HPE (99.99%) during Q4/2014

HPE: Horizontal Positioning Error
GPS: Global Positioning System
SPS: Standard Positioning Service

© DLR 2016 (FAA GPS Performance Analysis Report · Report #86 · 2014)

HCD and SQA Guidelines
Reducing system error budget

HCD (Human Centered Design) and SQA (Software Quality Assurance) Guideline recommends standards for system quality to reduce system error budget

e-navigation quality design attributes

Managed through a Quality Management System

Product Quality | Data Quality | Meet User Needs | Security | Functional Safety

Based on ISO/IEC 27000)
Based on IEC61508

Guided through Software product quality based on ISO/IEC 25000 and Software process quality based on ISO/IEC 12207

Guided through Human Centred Design (HCD) process based on ISO9421-210

Guided through Software quality evaluation based on ISO/IEC 2504n and System and software assurance based on ISO/IEC 15026

Guided through Usability Testing Methods based on ISO/TR 16982

Covered by this guideline

IMO Guidelines on Human Centred Design and Software quality assurance (SQA) in e-navigation

- It addresses need of data quality but doesn't specify data quality standards

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Determining the dimension of the individual Ship Domain

(1) Ship's size & characteristics define the dimension of the basic domain.

(2) Voyage centric factors are increasing the basic risk and require an extension.

Basic SD | Voyage Centric Extension | Sensor Error Budget | Data Error Budget

Residual error budget in data supply chain (static and dynamic) have to be determined & monitored

© Michael Bergmann, 2016

(3) Each component used for decision support (Radar, ARPA, Compass, ENCs...) **contributes to SD's confidence.**

(4) In integrated systems (ECDIS, INS) **the data error budget may be accumulative.**

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2. Data Certification End-to-End

Data Production | Data Integration | Data-Product Implementation | Information Visualization

Shore originated Real-Time data | Ship sensor Real-Time data
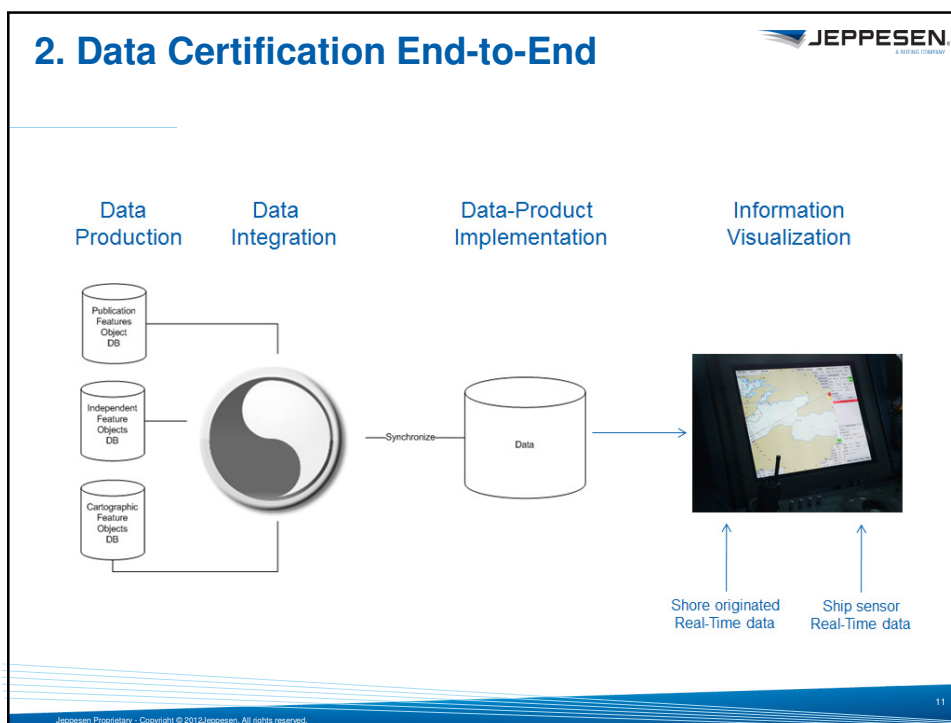
Data Quality at e-Navigation Systems
Part of the Guideline

3. Definitions

3.1 **Data Quality:** The degree to which quality characteristics of data have the intrinsic potential to satisfy stated and implied needs when data is used under specified conditions. It also refers to the degree to which data quality is reached and preserved within a computer system when data is used under specified conditions.

3.2 **Data Quality Assurance (DQA)**: A set of processes, that ensures that shore and shipboard based data used by e-Navigation systems meets and complies with required quality specifications. It is recommended that DQA is performed using a quality management system such as ISO/IEC 90003:2014 or relevant standards.

Source: IMO Guidelines on Human Centred Design and Software quality assurance (SQA) in e-navigation

IMOs position on data Producers:

JEPPESEN
A BOEING COMPANY

5.9 Producers of input data should have lifecycle management practices in place to handle possible data format changes during the lifecycle. These lifecycle management practices should include timely announcements to software producers and end users about such changes. As part of the DQA producers of input data should test all data in service for conformance with relevant international standards. (MSC.1/Circ.1512)

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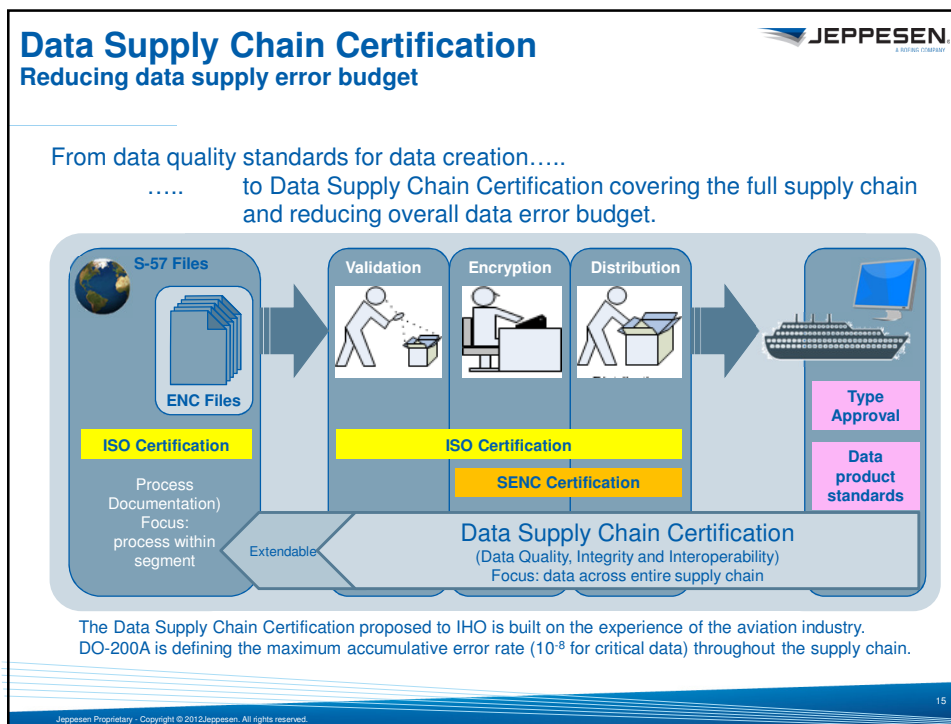## Further IMO Specifications:

JEPPESEN
A BOEING COMPANY

5.7 Software quality is also dependent on the quality of input data, which should conform to relevant international standards. ... (i.e. .. . IHO standards for nautical information including Electronic Navigation Charts (ENC))…

5.8 A systematic approach to ensure data quality is recommended, and can include:

defining and evaluating data quality requirements in data production, acquisition and integration processes; (MSC.1/Circ.1512)

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Data Supply Chain Certification
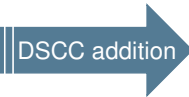**Reducing data supply error budget**

From data quality standards for data creation…..
….. to Data Supply Chain Certification covering the full supply chain and reducing overall data error budget.

The Data Supply Chain Certification proposed to IHO is built on the experience of the aviation industry.
DO-200A is defining the maximum accumulative error rate (10^{-8} for critical data) throughout the supply chain.

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A reminder:
Data Supply Chain Certification at IHO

Presented at WEND 11, 2008

- **Presented at CHRIS 20, 2008**
- **Both invited members to participate in a correspondence group**
- **HSSC1 invited further work from the DSCC-CG and invited it. (HSSC2 Action 2)**
- **The DSCC-CG had 36 members from HOs, IHO-WGs, related organizations and experts**
- **A draft of a Marine version of DO-200A has been developed and distributed to the DSCC-CG**

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Maritime Data Quality Aspects
Based on RTCA DO-200A in Aviation

1. **Accuracy**
2. **Resolution**
3. **Assurance Level**
4. **Traceability**
5. **Timeliness**
6. **Completeness**
7. **Format**

DSCC addition →

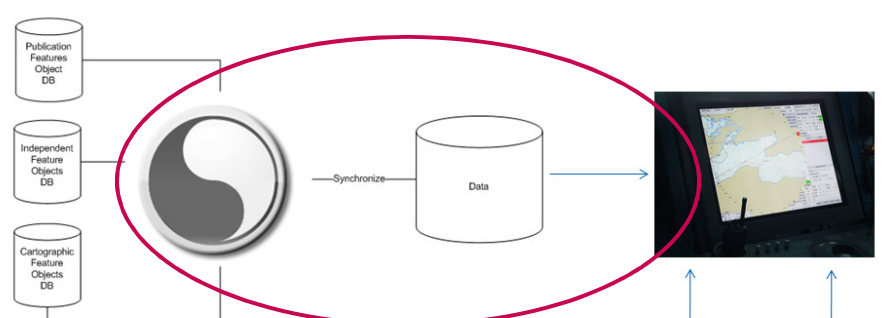**Data Integrity throughout the Supply Chain**

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DSCC in Integrated Systems
e-Navigation implementation

Data Production — Data Integration — Data-Product Implementation — Information Visualization

Publication Features Object DB

Independent Feature Objects DB

Cartographic Feature Objects DB

Synchronize — Data

Shore originated Real-Time data

Ship sensor Real-Time data

**Spanning full supply chain:
Data Producers -> End Users**

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**Suggestion from an
Industry viewpoint:**

- **A coordinated approach to DQA under the leadership of IHO in partnership with Industry and other key stakeholders**
- **Utilizing the work of the CG-DSCC**
- **Taking into account:**
  - Data quality aspect
  - Data security aspect
  - Supplementary data aspect

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