

The Concept of “Apps” as a Tool to Improve Innovation in e-Navigation

M. Bergmann
Jeppesen, a Boeing Company

ABSTRACT: The current systems supporting navigation on board of ships are built on the classic concept for equipment: The system is developed, tested, type approved, installed and from that time on used with no or little modifications. Looking at other industries a regime of software and system maintenance has been established which allows more rapid updates. The development in the IT arena moves more towards modular approached, encapsulating individual components for easier implementation and delivery with limited system wide impact. This key concept is lately often referred to as the “app concept”. The e-Navigation development asks for exactly that: a way to improve innovation while ensuring system stability for the navigational components used by the navigator on the bridge.

A key aspect of the success of new systems will be the ability to convert data into as information as needed in any given situation, creating knowledge for intelligent decisions increasing the competence of a navigator.

The paper will focus on the following topics:

- The classic “monolithic” Equipment paradigm
- Modern System Architecture using components and “apps”-concept
- Advantages of an approach using situational driven tool enhancements
- The “app”-concept supporting the situational centric information presentation

1 THE CLASSIC “MONOLITHIC” EQUIPMENT PARADIGM

The existing regulatory paradigm for bridge equipment is a driving factor for the development and implementation of systems used on the bridges of ships sailing under those regulations. The current regime requires full certification of the systems by the manufacturers. Those type approved systems need further certification prior to operational use. Figure 1 illustrates the concept.

IMO Convention SOLAS VI and V requires that Equipment

- must be “type approved by the administration”

- IMO Performance Standards are the minimum required
- IEC provide harmonised tests for these Performance Standards

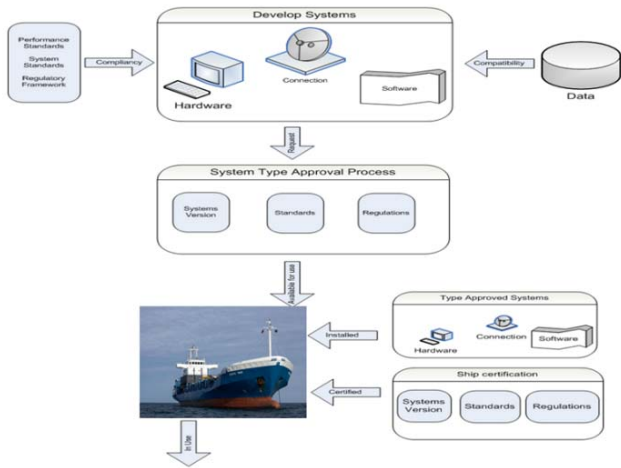


Figure 1. Current Type Approval Process – Michael Bergmann, 2015

For further clarification IMO has published the IMO MSC Circ 1221 where they specify the minimum steps required:

- 1 engineering evaluation;
- 2 witnessing the manufacturing and testing processes;
- 3 evaluating the manufacturing arrangements; and
- 4 issuing of a Type Approval Certificate generally valid for not more than 5 years which may be subject to annual inspections or verification of the manufacturer's process after all the above-mentioned procedures have been satisfactorily completed.

This certification process not only supports but rather requires long development cycles of new equipment which further leads to a reduction of development speed. Bringing new innovation on the bridge to help improve navigational safety and ship operational efficiency is not in the focus at all. As such the current bridge systems installed are often based on an aged architecture. This becomes even clearer for those knowledgeable of Marine bridge equipment look at other industries, where the use of state of the art systems is common. Figure 2 and 3 show build-in systems as well as the use of a tablet device in modern airline aircraft cockpits.



Figure 2. Integrated "Electronic Flight Bag" – Jeppesen, 2012



Figure 3. Tablet use in aviation – Jeppesen, 2013

Due to these circumstances current systems used on bridges, especially if they are already installed years ago without substantial updates, are often based on the classic monolithic system architecture which was standard architecture a decade or two ago. The systems are built of individual units, which may or may not be integrated in a "bridge frame". The integration of those systems is often just a matter of exchanging of data streams, but do not really integrate the different components.

During the last years the development is taking a change towards more integrated systems. In new Integrated Navigation Systems (INS) you will find displays with different display modes, where you can switch for example from a radar display to a ECDIS display or others. But even there due to the regulatory constraints mention above, you may find different systems just sharing the display rather than really integrated systems.

2 MODERN SYSTEM ARCHITECTURE USING COMPONENTS AND "APPS"-CONCEPT

In the last ten to fifteen years the electronic industry has migrated from the described monolithic approach to a component and application centric approach. Computer hardware is used to run various applications simultaneously. The systems use multitasking to allow seamlessly switch between applications and exchange. Sharing of data layers or utilization of same underlying database, even exchange of parameters is common praxis.

Systems are built in kind of "layer concept": The hardware is the base component. Within this "hardware layer", the system software creates the foundation. This software layer defines communication protocols based on common standards, which allows applications, to interface with each other and as such build an addition layer, which is using standardized "Application Programming Interfaces" (API) to exchange data and other relevant information.

This concept allows the development of different "building blocks", which can be group together to perform the requested functions. It also allows a more rapid updating of systems, the different components can be updated and exchanged without interfering

with other components as long as the communication external to the updated function stays the same.

But not only updating is easier to archive. Also adding other components and functions are easier to accomplish as additional building blocks can be added as long as they stay within their layer and are compliant with the standards and API structure of the overall system.

Within an integrated system there can be various levels of encapsulation. Both adding new hardware components as well as integrating new software functions are possible if the component based architecture is built accordingly.

This concept is not new and is already used in quite a few existing bridge systems. But the concept of encapsulation and its use for component based type approval is not necessarily enabled.

More recently the electronic industry moved towards an “App” architecture concept in appropriate areas. Everyone knows the app concept in consumer products like tablets, smartphones or similar devices. This is the logical next step of the component based architecture. Towards the beginning of our decade “Application Software” was introduced. The concept behind it is to develop software components, which are executing certain functions within a shell application. They cannot run by themselves, but run within the parent software. Prominent examples in the PC world are MS Word or MS Excel, which run within MS Office. The “parent application” provides commonly used functions, like “safe to disk”, “copy to clipboard” or certain UI functionality to only name three examples. At the beginning of our decade the abbreviation “App” was starting to get used, especially in the mobile computing world.

The key success factor in this new development is that the underlying parent application – the layer around the Apps – are encapsulating the different apps and as such prevent one app negatively affecting other apps. If correctly implemented, mainly if the parent application has a robust encapsulation method, new apps can easily being added or changed without affecting the use of existing systems.

As a large number of functionality is already handled by the parent application, for example general user interface or touch screen functionality, the app development can focus on the specific functionality. This concept highly increased the innovation speed in this kind of architecture.

In industries like aviation this concept is meanwhile well established. Since years a growing number of airplanes are equipped with so call “Electronic Flight Bags”. These systems are using “App” architecture to allow inclusion of additional functionalities with reduced type approval needs.

Aviation Electronic Flight Bag Integrated “App” Concept

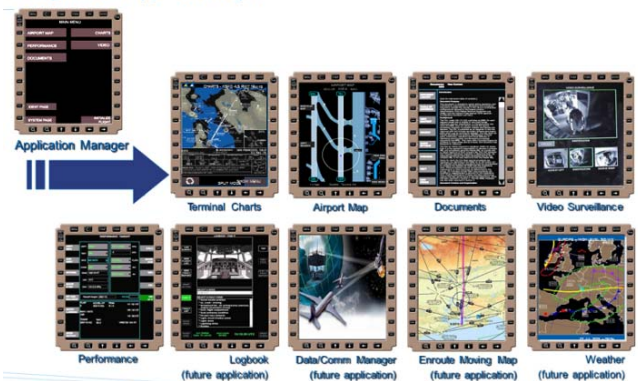


Figure 4. The Electronic Flight Bag – Jeppesen, 2012

With a focus on Human Centered Design this systems seamlessly allow both switching between apps as well as interchanging information between those.

The implementation of the “App”-concept drastically increase the speed of innovation as explained above. Continuously new mobile apps are launched which can be easily been downloaded and immediately been used.

Even in very strict environments, like the aviation industry, the speed of innovation is very much growing with the use of mobile devices and app driven systems.

A good starting point for this type of approach in the maritime domain is the current INS concept as well as the already established concept of multi-functional display. Here the mariner already sees part of the proposed concept as different display modes or better different applications can be switched. But the underlying concept is still build on different, independent applications.

For good reasons e-Navigation is building on INS. The proposed app concept will ease the addition of new functionalities while keeping user experience similar to what an INS or multi-functional display user already experiences today.

In order to be able to gain benefit of the “App”-concept in the maritime environment the type approval concept will need to be revisited. As stated above the current concept is limited the ability to introduce new systems. As stated it is focused to support the monolithic system architecture. Looking into possibilities to certify hardware and parent applications, ensuring necessary encapsulation routines, may allow a new level of type approval focused on certain apps rather than always on full systems.

If that is implemented in e-Navigation the maritime world can benefit from a large increase in innovation speed. This situation has been recognized by those groups working on e-Navigation, like the IMO e-Navigation Correspondence Group, the IALA eNav Committee or the CIRM e-Navigation Working Group.

3 ADVANTAGES OF AN APPROACH USING SITUATIONAL DRIVEN TOOL ENHANCEMENTS

Another development in recent years is the integration of sensor and real-time data to increase awareness of the situation around the person utilizing electronic tools. Let's look at the dilemma we are in in the maritime world:

We are faced with growing complexity by ever growing vessel sizes as well as traffic density.

While the ships are getting larger and more ships are sailing around the world, the available navigational space, especially in coastal areas, is shrinking. Offshore Wind Parks are prohibiting navigation in certain areas. Other sea areas are closed for navigation to protect endangered species or environmental sensible areas.

Besides this the economic pressure in the maritime industry is requiring an increased efficiency of the sea transport while the increasing utilization "just-in-time" logistics is putting pressure on the mariner for increased ETA accuracy.

These are only some of the pressures a mariner at sea is faced with. In order to cope with this situation, sensors are installed on the ships and data is delivered to the bridge. Also external real-time is send to the bridges, for example AIS data. On-shore data service providers are consolidating other useful real time data and providing this to the mariners frequently by sending semi real time data streams.

As the complexity grows the digesting of this additional data get more and more challenging.

But this is not a maritime only phenomenon. Same is true in aviation or in car navigation.

The industry has started to develop tools to help manage this situation. Most car navigation systems nowadays have functions, which analyze sensor data and react automatically to provide the driver with information as needed. The navigational system automatically zooms in or out depending on speed if that function is enabled. The system provides certain information in advance depending on speed:

It notes the next turn two kilometers ahead if on high speed or just hundred meters or less before the turn on very low speed.

In the train industry automatic brakes activation is commonly used already for a long time if a train is passing a stops sign or is driving too fast. The train driver will be overruled by situational driven tools.

Even more situational centric focus is used in aviation, especially in military combat systems where decisions have to be made in factions of seconds without a chance for the pilot to correctly analyze all incoming data.

While navigation of a ship is very much different than driving a car or a train or flying an aircraft, the task is not necessarily easier. As such the lessons learned in other industries have already inspired the maritime manufacturers to develop situational centric tools.

The discussion on certain aspects of e-Navigation context is moving in this direction as well. The close collaboration of active seafarer with engineers knowing about the situations centric paradigm and using the experience of other industries can create tools, which breaks the vicious circle. Situational centric tools can provide the mariner with the necessary information just as he or she needs it without endangering decision making through data overload.

While it is important for a mariner to stay on top of the decisions, situational centric tools will be of essence in future to enable the mariner digesting the necessary data. Only then he will receive the information needed to make the right decisions.

For further reference please see the article "Integrated Data as backbone of 2-Navigation" in TransNav, Volumn 7, Number 3 (see reference list)

4 THE "APP"-CONCEPT SUPPORTING THE SITUATIONAL CENTRIC INFORMATION PRESENTATION

One success factor of the "App"-Concept, which has helped that modern multi-functional mobile devices are almost all utilizing this concept, is the fact that the users are easily able to use well know static data but also situational centric information. Depending on individual needs different apps can be used to support the specific desires of the user.

The fact that the user can switch from situational centric to situational agnostic apps seamlessly can help the familiarization with increasingly situational centric apps.

Figure 5 shows different apps in the aviation "Electronic Flight Bag". The pilot is in a position to switch rapidly between different situational centric displays to better support the necessary speed in decision making, but easily switch back to a static display if seen beneficial.

The "App" Structure:
Different Situational Centric Solutions – Fast Switch



Figure 5. Aviation Apps and situational centric display – Jeppesen, 2013

Looking at the specific situation on a bridge as described above there are benefits if tools are available to the mariner which are providing situational centric information. At the same time the

speed of navigation allows in certain situation the mariner to reviewing data more closely than an aircraft pilot could do that.

The “App”-concept allows for seamless transition from one specific app to another. The parent application for navigational can integrate both situational centric apps for navigation as well as apps for detail analysis. This will allow the mariner to use situational centric apps for routine work and switch to detail apps if in doubt.

At the same time certain general functions could be developed to reduce data density and increase clarity of display in critical situations so the navigator can focus on the most important task on hand by receiving necessary advice.

Underlying apps could also, automatically or manual triggered, exchange ship data with short side services to allow “Vessel Traffic Centers” (VTS) to provide educated guidance.

Besides apps on a single device, the usage of different devices for different usage is also common and shows advantages in certain cases. In the monolithic ship environment we have currently the use of specific devices are very common, actually had been there from the start. In the app and situational centric concept the devices could communicate with each other but also allow simultaneous use to monitor different aspects of the current situation. In figure 6 an aviation handheld navigational device as well as a smart phone used to manage fatigue prevention is shown. While uninterrupted view of the navigational relevant information is possible, a quick check of the fatigue situation improve cockpit resource management is easily possible.

Situational Centric Device Design: Multiple devices for simultaneous use



Figure 6. Navigational and Fatigue prevention apps – Jeppesen, 2014

5 CONCLUSION

Maritime transportation is an increasingly complex industry. For mariners the growing challenge is to navigate safely and efficiently with larger ships in areas with a growing number of ships, especially large ships.

To be able to manage this challenges a growing number of data streams from ship sensors, but also from other ships and from shore are made available to the bridge teams. e-Navigation is intended to help manage this flood of data. In addition the maritime industry is changing at a pace not seen before and the speed of change is drastically increasing.

It is essential that modern systems on the bridges are addressing both concerns. They need to be able to handle and integrate a large number of data into meaningful information. They also need to present this information in a way so the mariner can easily digest it and make meaningful decisions. Another emerging requirement is that they need to be flexible enough to keep up with the growing speed of change and innovation.

But as this is not only a phenomenon of marine transport, the electronic industry already developed concepts to support rapid decision making. Electronics have moved away from monolithic architecture to component based architecture and towards an app structure. Through encapsulation of apps this enables easy integration of new functions and features without interruption of the existing running systems.

The development in electronic tools also is moving towards applications, which react and adjust based on the situation essential for any decision on hand. Situational centric system functionality can filter incoming data and integrate them into information as needed in time.

e-Navigation will benefit from this concepts and certain test beds are already looking at this topic. Besides the development of marine specific systems taking full advantage of these concepts, the regulatory framework, mainly performance standards, updating regimes and type approval concepts need to be reviewed for necessary adaptations to support this.

REFERENCES

- IMO, 2009, SOLAS (Consolidated Edition)
- IMO, 2008, MSC 85/26 Annex 20
- IMO Circular MSC Circ 1221
- IMO NCSR 1/9 “DEVELOPMENT OF AN E-NAVIGATION STRATEGY IMPLEMENTATION PLAN”
- IEC 60945, Fourth Edition 2002-08
- IEC 61023, Edition 3.0 2007-06
- IEC 61174 ed3.0 (2008-09)
- IEC 61924-2 ed1.0 (2012-12)
- IEC 62288 ed2.0 (2014-07)
- Bergmann M. (2013). Integrated Data as backbone of e-Navigation in: Weintrit, A. (2013). Transnav Volumn 7, Number 3, September 2013, ISSN 2083-6473
- Ceruzzi, Paul E. (2000). A History of Modern Computing. Cambridge, Mass.: MIT Press. ISBN 0-262-03255-4.
- Campbell-Kelly, Martin; Aspray, William (1996). Computer: A History of the Information Machine. New York: Basic Books. ISBN 0-465-02990-6.
- Frechette, Casey (2013-04-11). "What journalists need to know about the difference between Web apps and native apps". Poynter. Retrieved 2014-12-4