



Light years ahead in marine electronics technology

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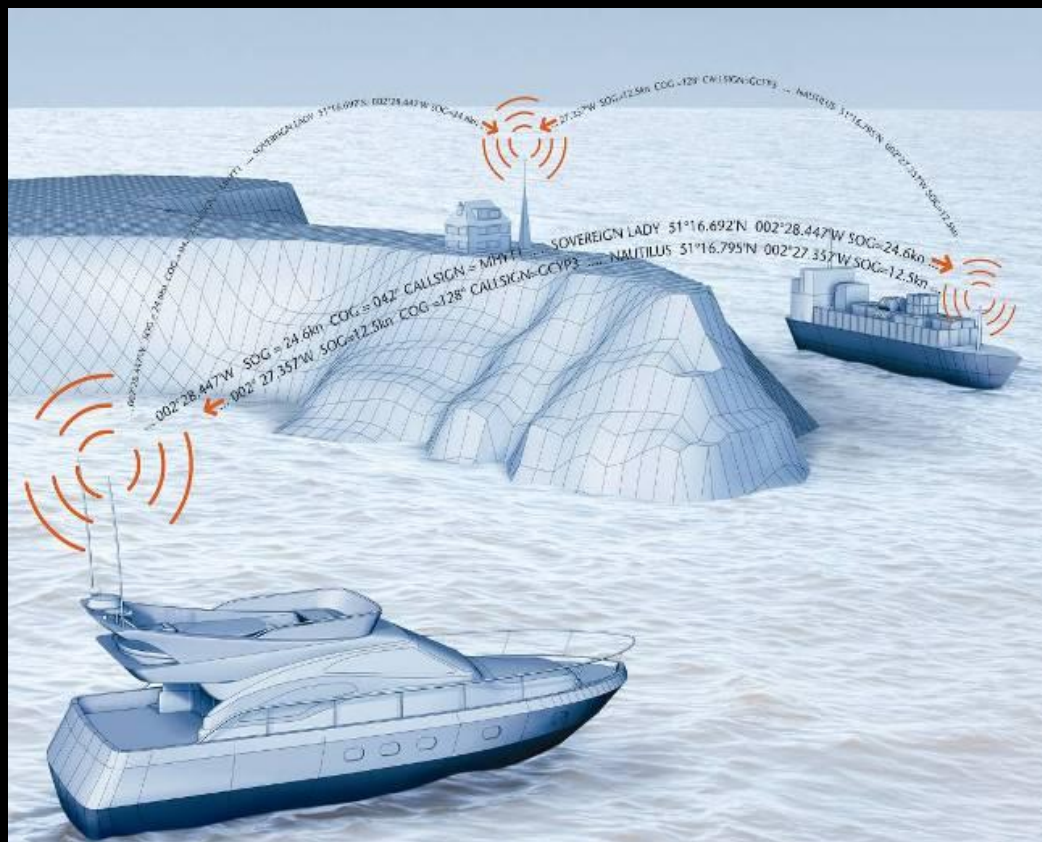
To AIS

Presented to the BMEA

19th October 2011

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- AIS (Automatic Identification System) is the latest and most significant advance in marine navigation aids since RADAR
- AIS uses GPS, VHF radio and DSP to automatically communicate between vessels
- Vessels can Transmit and Receive (Transponder) or just Receive (Receiver)
- An AIS transponder is mandatory fit on all vessels greater than 300 tons or that carry 12 or more fare paying passengers



What is AIS ?

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Class A Transponder



Class B Transponder



AIS Receiver



Types of AIS

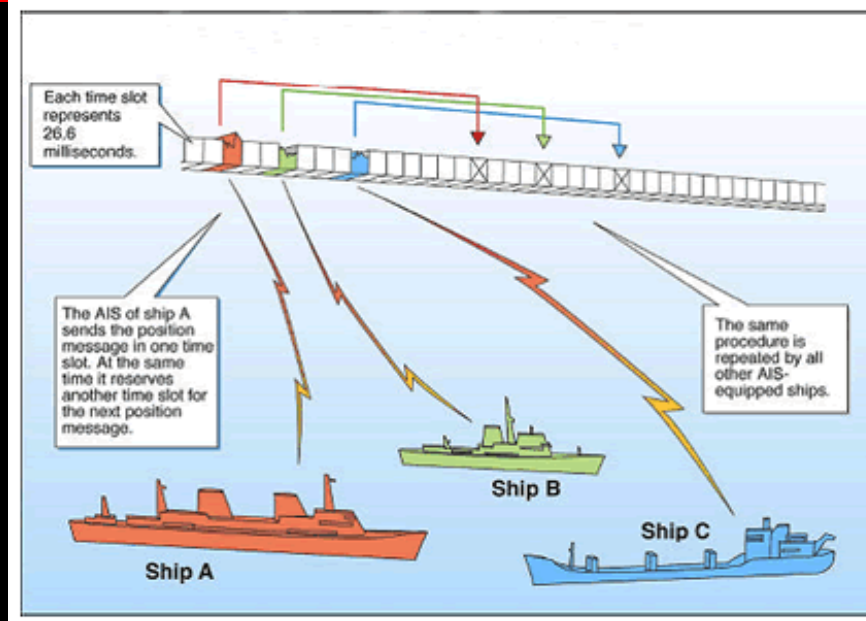


- **AIS uses two VHF frequencies;**
 - **161.975 MHz**
 - **162.025 MHz**
- **AIS is subject to the same constraints as VHF radio i.e. line of sight range**
- **AIS data is transmitted in NMEA 0183 serial protocol but at a higher 38,400 baud rate (NMEA = 4800 baud)**
- **There are two NMEA sentences reserved for AIS;**
 - **!AIVDM (other vessels)**
 - **!AIVDO (own vessel)**
- **A transponder must have a GPS position, whilst a receiver does not have to have one as it does not transmit its position**

AIS - The Technical Stuff

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- AIS uses a technique called TDMA* that allows multiple transmitters to grab available time slots during which they can transmit their information
- There are 4500 time slots every minute and if overloaded, Class A systems can share time slots and only vessels further away will be subject to drop-out
- Class A systems use “Self Organised” SOTDMA which gives them priority and effectively guarantees a time slot
- Class B Systems use “Carrier Sense” CSTDMA where they sense if a time slot is empty and quickly grab it, collisions can occur and Class B transmissions are not guaranteed
- How often a vessel must transmit its information is based on its speed, whether it is manoeuvring/underway/moored and the class of AIS



* Time Division Multiple Access – same technique as used In GSM mobile phone networks

How AIS Works

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There are three types of AIS data automatically and continuously transmitted and received by each unit on the two VHF channels dedicated to AIS

- *Dynamic Data*: such as position and speed automatically calculated by the transponder using its internal GPS or external sensors
- *Static Data*: programmed into unit at time of purchase: MMSI, Vessel name, size, contact info
- *Voyage Data*: programmed into Class A units before and/or during each voyage: Destination, ETA, Draught, Number on Board, Nav Status



AIS Data Types

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How often do AIS transponders broadcast position and static information reports?

Transponders send out position updates based on the speed over ground (SOG) of the vessel and updates occur at different intervals depending on whether a Class A or Class B transponder is used. Depending on whether you are using a single channel or dual channel AIS device, you should receive the data at the following update periods.

Class A AIS Transponder reporting intervals

Ship's Dynamic Conditions	Dual Channel Receiver	Single Channel Receiver
Ship at anchor or moored	3 min	6 min
SOG 0-14 knots	10 sec	20 sec
SOG 0-14 knots and changing course	3.3 sec	6.6 sec
SOG 14-23 knots	6 sec	12 sec
SOG 14-23 knots and changing course	2 sec	4 sec
SOG >23 knots	2 sec	4 sec
Ship Static Information	6 min	12 min

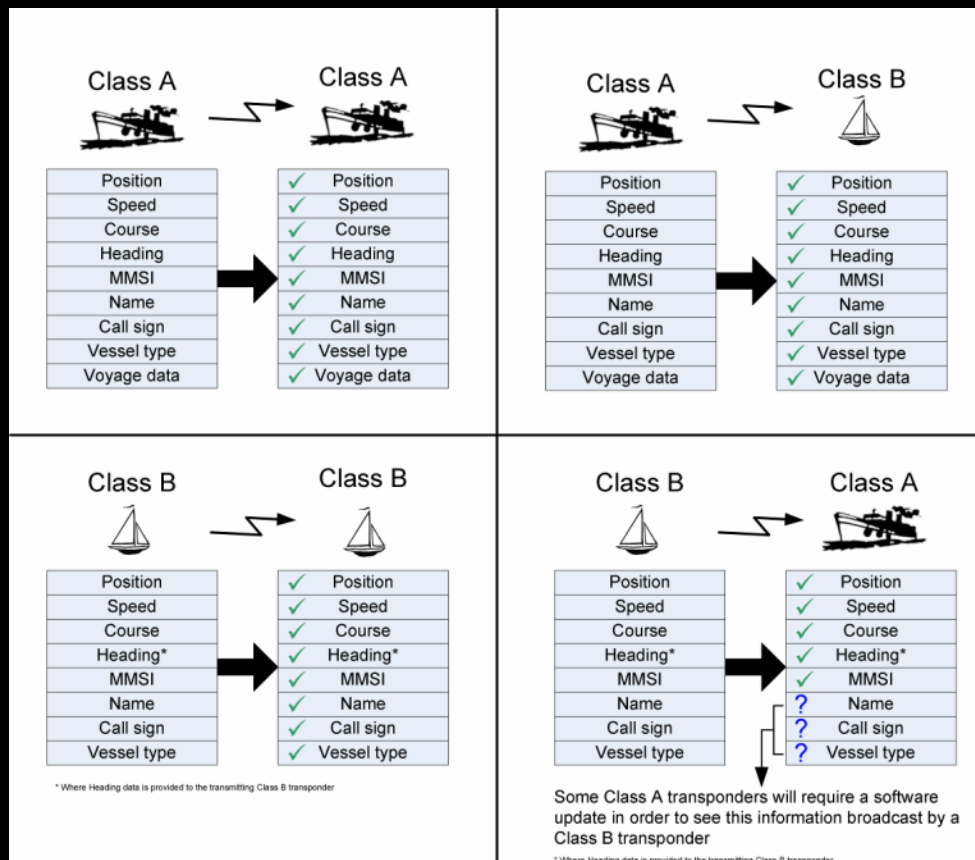
Class B AIS Transponder reporting intervals

Ship's Dynamic Conditions	Dual Channel Receiver	Single Channel Receiver
SOG <2 knots	3 min	6 min
SOG >2 knots	30 sec	1 min
Ship Static Information	6 min	12 min

Frequency of AIS Transmissions

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- The table shows what information is communicated between different classes of AIS



NOTE: in this last example 'Class B- Class A' there are some instances when a class A user may not see the name, call sign and vessel type of a Class B user.

However the users vessel will still be displayed in it's correct position. In this circumstance, the receiving vessels display may default to showing the MMSI rather than the vessels name.

This is generally only true on some of the older Class A equipment that do not read the Message24 that was added for Class B transponders

What data is communicated ?

There are two NMEA0183 sentences reserved for AIS;

- **!AIVDM (other vessels)**
- **!AIVDO (own vessel)**

The VDO message was intended to provide own ship data to a listening ECS or ECDIS but in reality very few systems read and use this message

The VDM sentence is transmitted each time an AIS message is received

!AIVDM,1,1,,A,177I?m9000`:Pk`<i`kh0ISd00R;,0*30

!AIVDO,1,1,,,B>eq`d@3wk?8mP=18D3Q3wv5sP06,0*6C

Unlike normal NMEA 0183 sentences that use human readable ASCII characters, the two AIS sentences use 6 bit binary encoding for the bulk of the sentence to reduce the amount of data

AIS NMEA 0183 Data

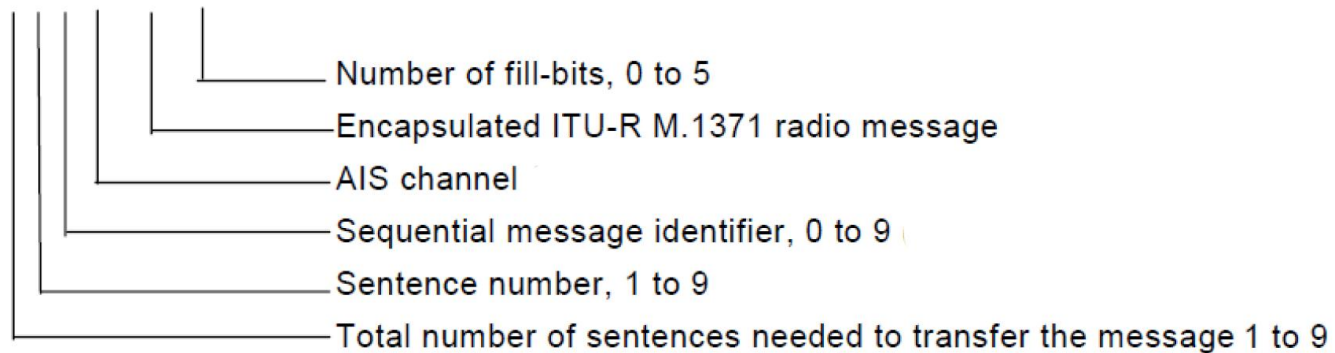


The first section of the VDM sentence is ASCII;

`!AIVDM,1,1,,A,177I?m9000`:Pk`<i`kh0ISd00R;,0*30`

So using the key below we can tell that the VDM sentence above is message 1 of 1 and it was received on AIS channel A

`!--VDM,x,x,x,a,s—s,x*hh<CR><LF>`

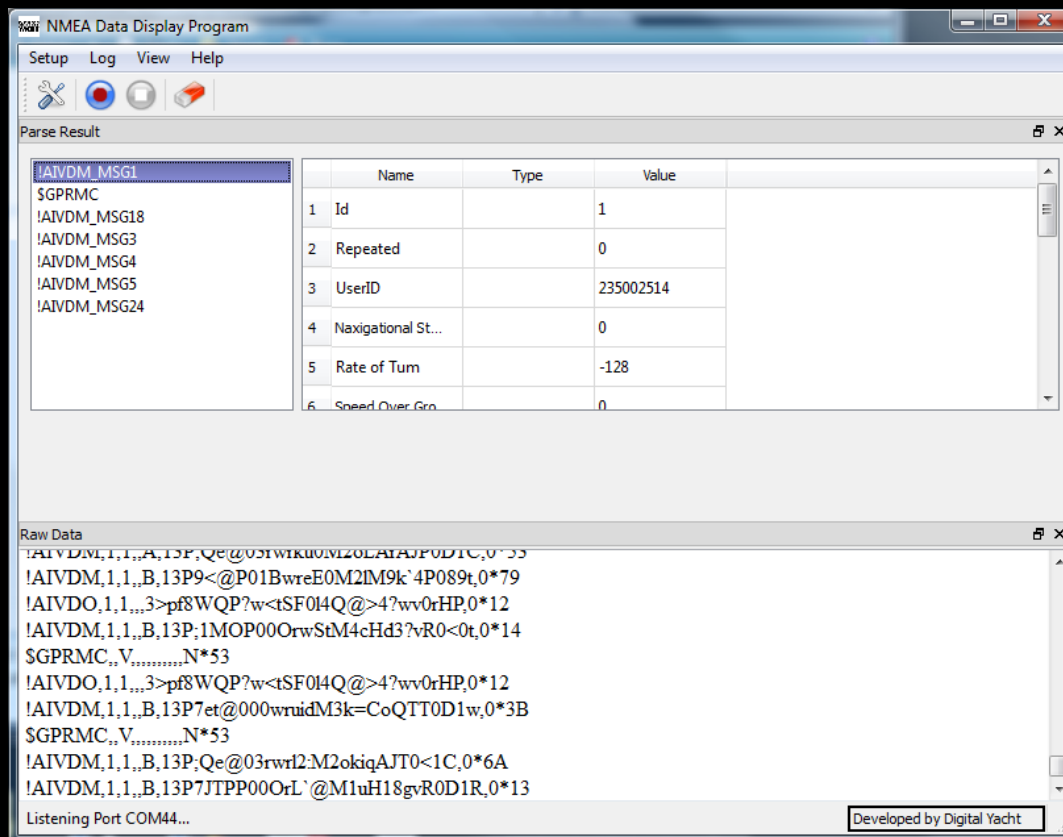


To understand more we have to decode the binary encapsulated message !

Breaking Down the VDM sentence

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As very few people can read 6 bit encoded Binary, Digital Yacht have created a simple, free NMEA Display program that does this for you....



Reading the Binary Data

- Inside the Binary Encapsulation will be one of the 26 AIS Message types
- Some of the messages are specific to a Class A or Class B transponder
- Other messages are specific to particular types of AIS targets;
 - Aids to Navigation (AtoN)
 - AIS SART
 - Search and Rescue
- Not all AIS units or Chart Plotters can read all message types
- This can lead to some products not displaying all AIS targets

Message ID	Name	Description
1	Position report	Scheduled position report; (Class A shipborne mobile equipment)
2	Position report	Assigned scheduled position report; (Class A shipborne mobile equipment)
3	Position report	Special position report, response to interrogation; (Class A shipborne mobile equipment)
4	Base station report	Position, UTC, date and current slot number of base station
5	Static and voyage related data	Scheduled static and voyage related vessel data report; (Class A shipborne mobile equipment)
6	Binary addressed message	Binary data for addressed communication
7	Binary acknowledgement	Acknowledgement of received addressed binary data
8	Binary broadcast message	Binary data for broadcast communication
9	Standard SAR aircraft position report	Position report for airborne stations involved in SAR operations, only
10	UTC/date inquiry	Request UTC and date
11	UTC/date response	Current UTC and date if available
12	Addressed safety related message	Safety related data for addressed communication
13	Safety related acknowledgement	Acknowledgement of received addressed safety related message
14	Safety related broadcast message	Safety related data for broadcast communication
15	Interrogation	Request for a specific message type (can result in multiple responses from one or several stations)(4)
16	Assignment mode command	Assignment of a specific report behaviour by competent authority using a Base station
17	DGNSS broadcast binary message	DGNSS corrections provided by a base station
18	Standard Class B equipment position report	Standard position report for Class B shipborne mobile equipment to be used instead of Messages 1, 2, 3(8)
19	Extended Class B equipment position report	Extended position report for class B shipborne mobile equipment; contains additional static information(8)
20	Data link management message	Reserve slots for Base station(s)
21	Aids-to-navigation report	Position and status report for aids-to-navigation
22	Channel management(6)	Management of channels and transceiver modes by a Base station
23	Group assignment command	Assignment of a specific report behaviour by competent authority using a Base station to a specific group of mobiles
24	Static data report	Additional data assigned to an MMSI Part A: Name Part B: Static Data
25	Single slot binary message	Short unscheduled binary data transmission (Broadcast or addressed)
26	Multiple slot binary message with	Scheduled binary data transmission (Broadcast or addressed)

AIS Message Types

- Last year the NMEA released a complete set of NMEA2000 PGNs for AIS
- Each AIS message has a PGN dedicated to it
- Some PGNs cover more than one AIS message type
- There are still a few messages that do not have a PGN (N/A) but they are generally not used
- Not all NMEA2000 Chart Plotters accept all of the AIS PGNs

Message	Name	Description	PGN
1	Position report	Scheduled position report; (Class A shipborne mobile equipment)	129038
2	Position report	Assigned scheduled position report; (Class A shipborne mobile equipment)	129038
3	Position report	Special position report, response to interrogation; (Class A shipborne mobile equipment)	129038
4	Base station report	Position, UTC, date and current slot number of base station	129793
5	Static and voyage related data	Scheduled static and voyage related vessel data report; (Class A shipborne mobile equipment)	129794
6	Binary addressed Message	Binary data for addressed communication	129795
7	Binary acknowledgement	Acknowledgement of received addressed binary data	129796
8	Binary broadcast message	Binary data for broadcast communication	129797
9	Standard SAR aircraft position report	Position report for airborne stations involved in SAR operations only	129798
10	UTC/date inquiry	Request UTC and date	129800
11	UTC/date response	Current UTC and date if available	129793
12	Addressed safety related message	Safety related data for addressed communication	129801
13	Safety related acknowledgement	Acknowledgement of received addressed safety related message	129796
14	Safety related broadcast message	Safety related data for broadcast communication	129802
15	Interrogation	Request for a specific message type (can result in multiple responses from one or several stations)	129803
16	Assignment mode command	Assignment of a specific report behaviour by competent authority using a Base station	129804
17	DGNSS broadcast binary message	DGNSS corrections provided by a base station	129792
18	Standard Class B equipment position report	Standard position report for Class B shipborne mobile equipment to be used instead of Messages 1, 2, 3	129039
19	Extended Class B equipment position report	Extended position report for class B shipborne mobile equipment; contains additional static information	129040
20	Data link management message	Reserve slots for Base station(s)	129805
21	Aids-to-navigation report	Position and status report for aids-to-navigation	129041
22	Channel management	Management of channels and transceiver modes by a Base station	N/A
23	Group assignment command	Assignment of a specific report behaviour by competent authority using a Base station to a specific group of mobiles	N/A
24	Static data report	Additional data assigned to an MMSI Part A; Name Part B; Static Data	129809 + 129810
25	Single slot binary message	Short unscheduled binary data transmission (Broadcast or addressed)	N/A
26	Multiple slot binary message	Scheduled binary data transmission (Broadcast or addressed)	N/A

AIS and NMEA 2000



- AIS uses VHF radio frequencies and is subject to the same range issues
- Higher the antenna and higher the transmit power, the longer the range
 - Class A Transponders transmit at 12.5W expect 20-25 Nm
 - Class B Transponders transmit at 2W expect 7-8 Nm
 - AIS SARTs transmit at 1W expect 3-4 Nm

AIS Range

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- Although AIS data is always the same, it can be displayed in a variety of ways



AIS Displays

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- By far the most informative and easy to use AIS display is when the data is overlaid on an Electronic Charting System (Dedicated or PC)

Each vessel is displayed in its position on the chart

Targets constantly moving to reflect real time position and direction

Warning of collision or 'close' proximity automatically provided

Your own position is displayed on the chart



By selecting any vessel displayed on the screen all static and dynamic data is displayed

AIS and Electronic Charts

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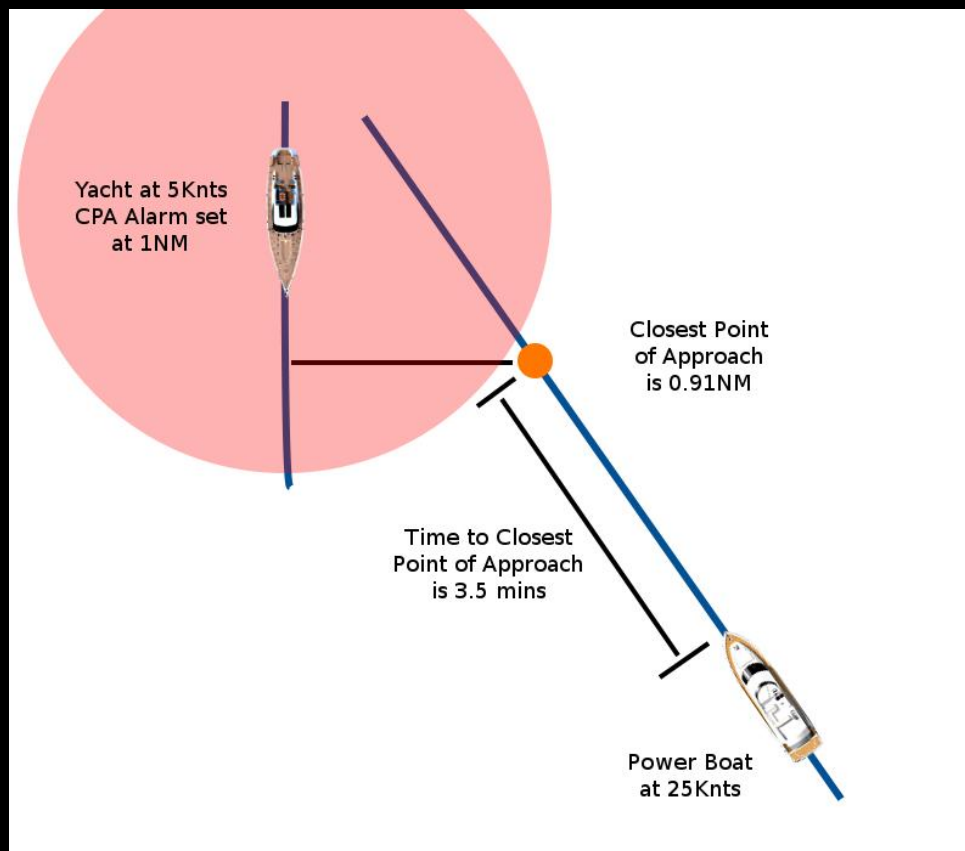
- Warnings of potential collisions based on course and speed can be automatically generated to warn mariners of the hazard



Benefits of AIS – Collision Avoidance

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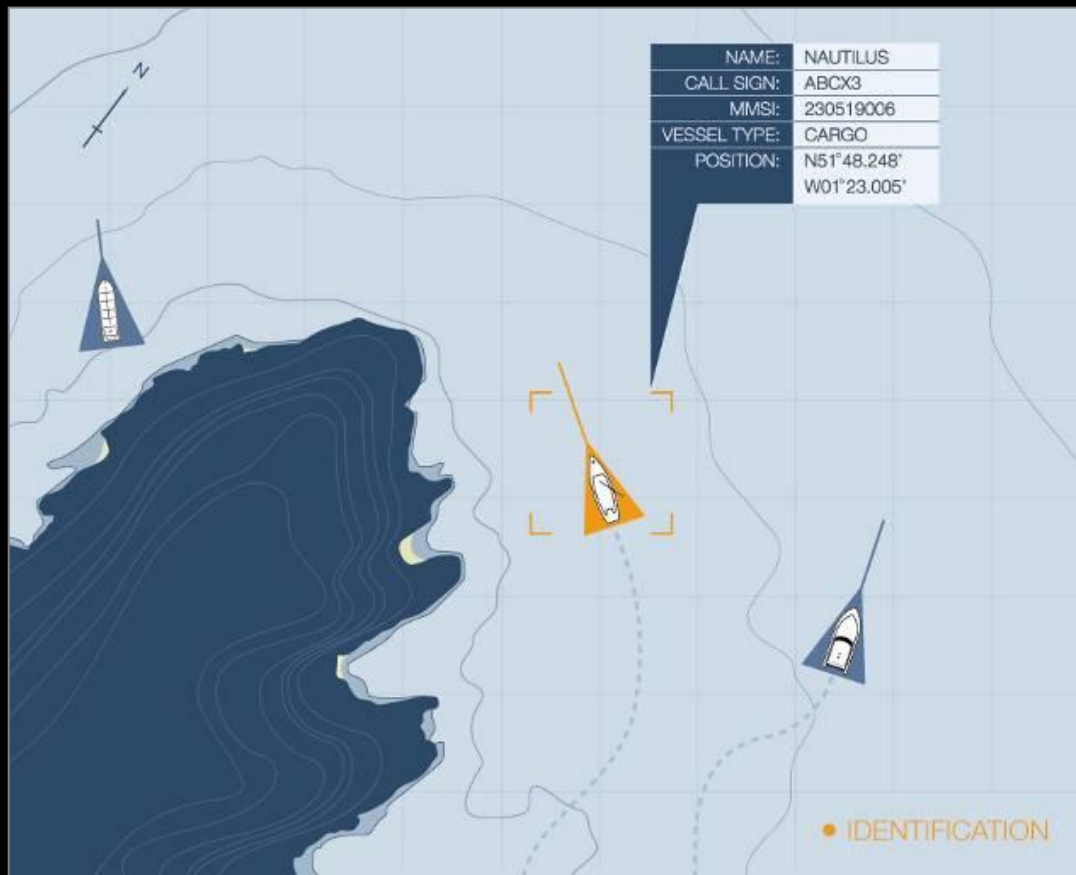
- Most but not all Chart Plotters and PC Navigation software that is AIS compatible have some form of CPA and TCPA alarm



Benefits of AIS – CPA and TCPA

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- Vessel to vessel identification has a range of applications including navigational safety, “buddy tracking”, Yacht racing and vessel to vessel communications



Benefits of AIS – Identification

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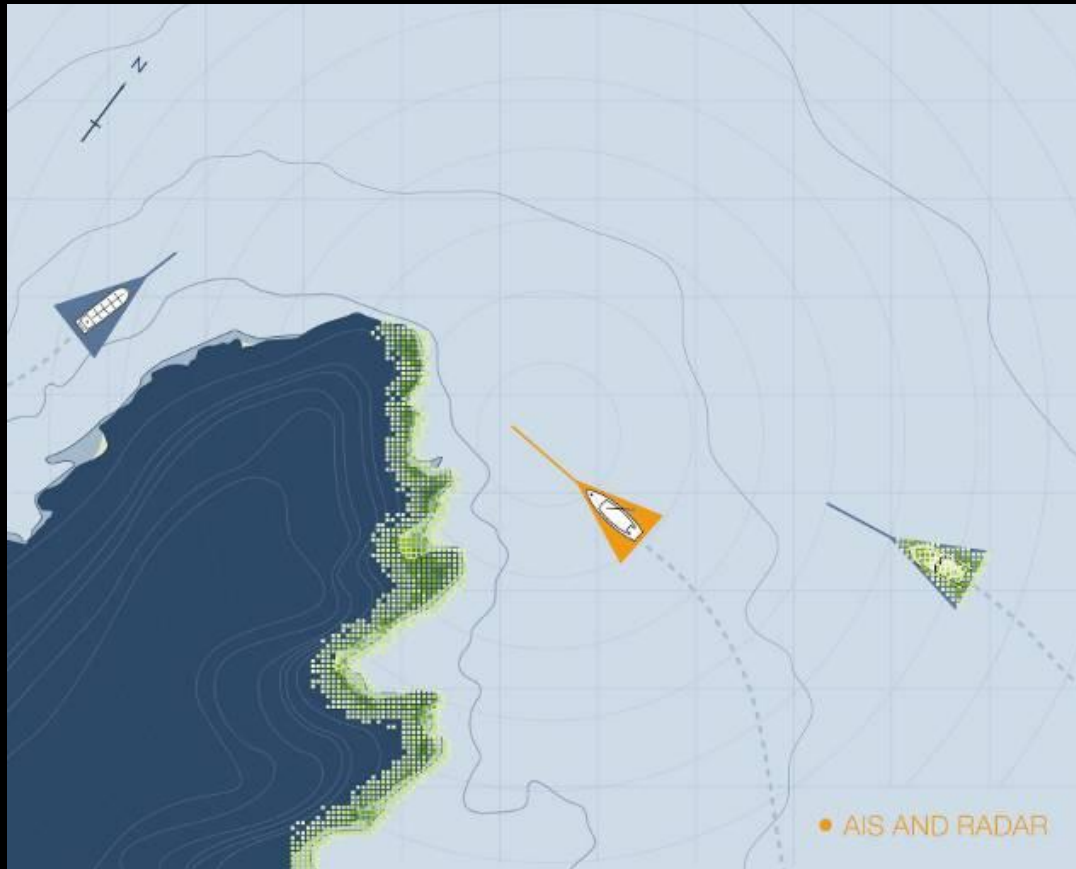
- Emergency services can use AIS to co-ordinate search and rescue operations, whilst shore stations can receive vessel details automatically and provide maritime services



Benefits of AIS – Safety + Security



- AIS can 'see round corners' and beyond the RADAR line of sight. The combination of AIS + RADAR gives the 'best possible picture' of the navigation environment



Benefits of AIS – “See Round Corners”

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- With only a £300 price difference between a Receiver and a Class B Transponder, many people will buy a transponder rather than a receiver
- Theoretically, if every small craft fitted a Class B Transponder tomorrow, we could see a reduction in the update frequency and range of Class B targets
- In reality, such a situation would require thousands of Class B Transponders in a very small area and such gatherings of small craft generally only occur in good conditions
- Diligent use of the “Silence Button” on Class B transponders, only transmitting in poor visibility or when crossing shipping lanes should be considered good practice



*To Transmit or not
to Transmit....that
is the question !*



Class B for Small Craft

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- Class A Transponders have been traditionally only found on commercial vessels that are mandated to have one
- This was mainly due to price (approx £4000) but recently prices have come down (approx £2000) and now some pleasure vessels are starting to look at Class A
- Class A does have some real advantages for certain pleasure vessels;
 - ✓ 12.5W Transmit Power
 - ✓ Fast Update Rate (2-3 sec)
 - ✓ Guaranteed Time Slot
 - ✓ Built-In display
- For large high speed power boats the 30sec update rate of Class B is too slow
- For Blue Water Sail Boats, the 2W transmit power of Class B does not give enough range



Class A for Small Craft

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Single Channel

- Some early and current AIS receivers are single channel e.g. Nasa AIS 3 and Smart Radio SR161
- One RF receiver that is switched between the two AIS channels every 30 secs or more
- Targets received on single channel receivers can take twice as long to update



Vs

Dual Channel

- All Digital Yacht AIS units feature a high performance Dual Channel receiver
- Two RF receivers each one dedicated to the two AIS channels
- Maximum number of received targets with no update delays or missed targets



Single Channel vs Dual Channel

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Pros

- Single Antenna
- Top of Mast for Maximum Range



Vs



Pros

- Optimum Performance for AIS
- Low Cost
- Back up for VHF

Cons

- 3x the Cost of a Dedicated Antenna
- Reduces Reception of VHF by 3dBs
- Misses Targets while VHF transmits

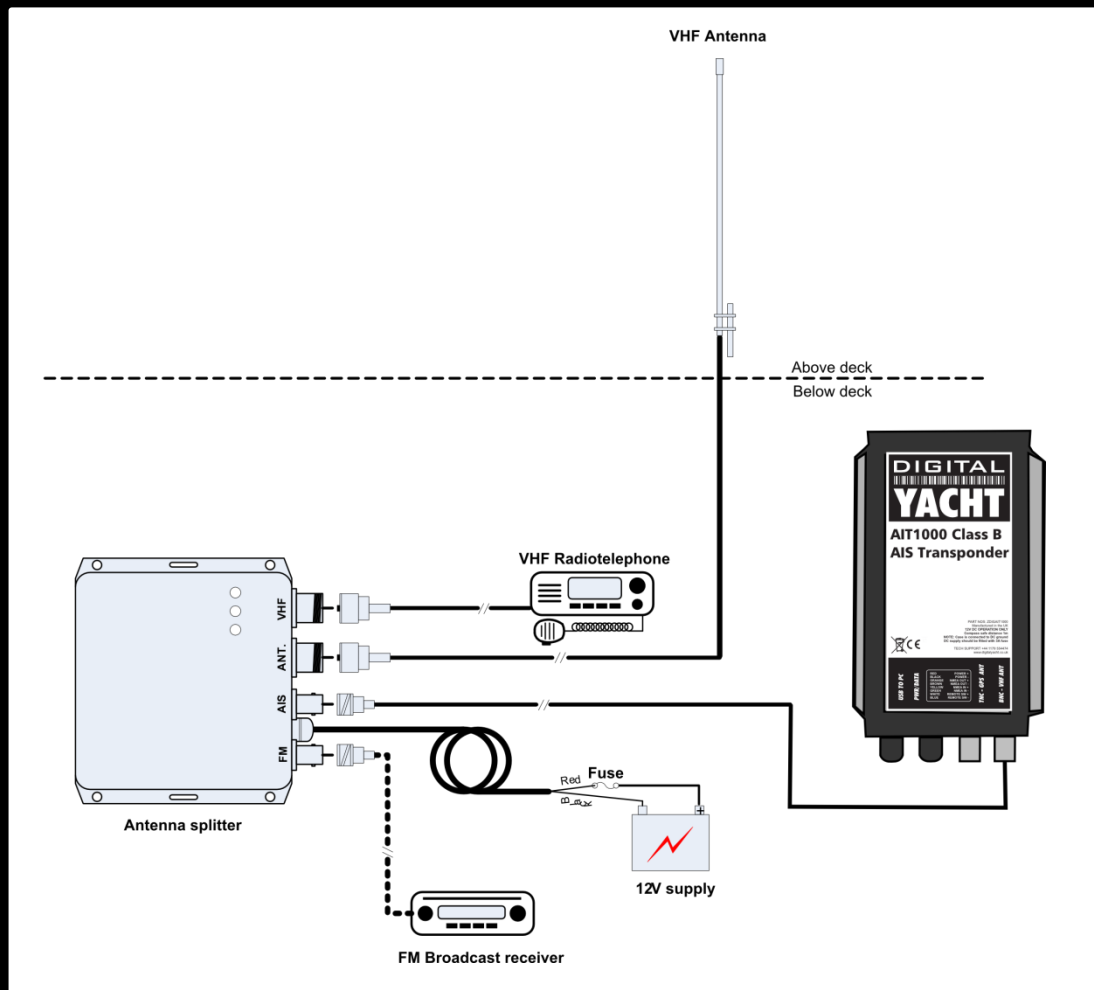
Cons

- Another Antenna
- Mounting at Deck Level loses Range

Splitter vs Dedicated Antenna

Splitter

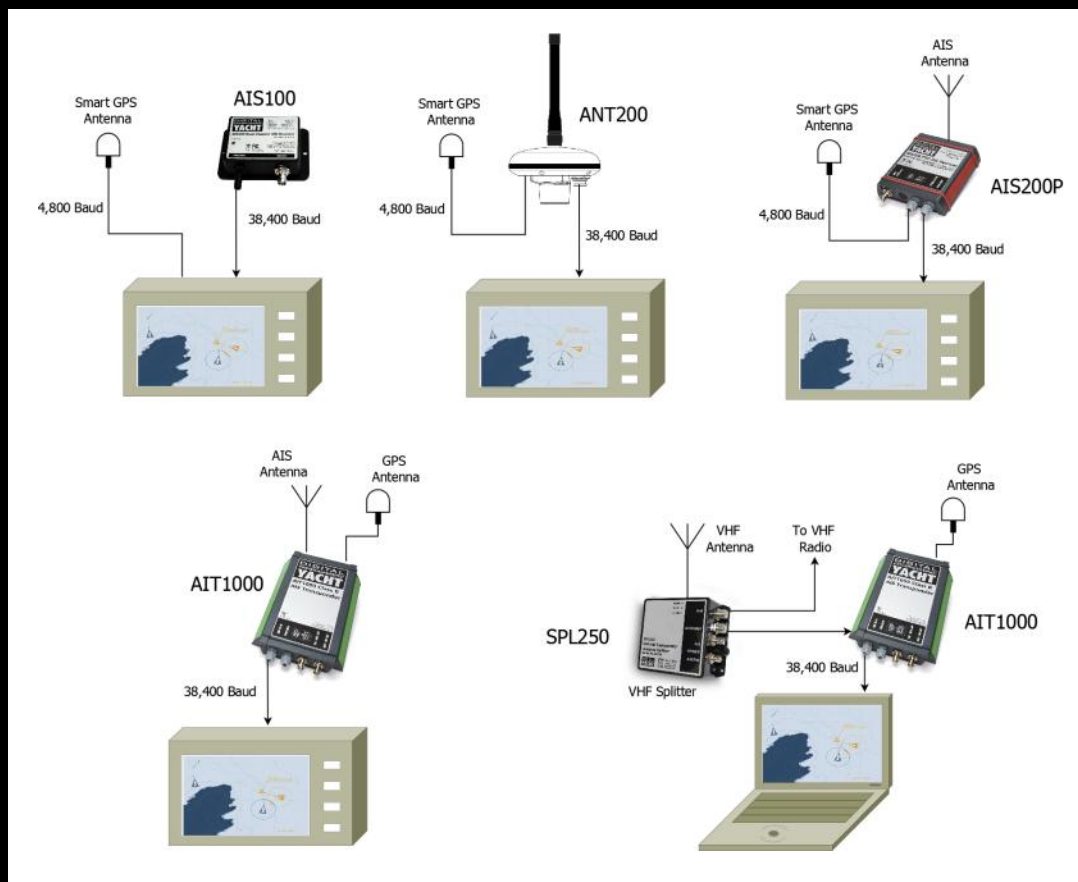
- Single Antenna is shared by the AIS and VHF
- Two intelligent switches inside the splitter sense when AIS or VHF is transmitting
- VHF gets priority and whilst transmitting no AIS reception is possible
- When neither system is transmitting both systems are connected to the aerial – which causes the 3dB loss in reception
- A typical Class B AIS transmission only lasts 26mS
- No losses in transmission as only one system connected to antenna



Splitter – how it works

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All-in-one AIS Receiver



Dual Channel Receiver

Multiplexed Dual Channel Receiver

Class B Transponder with Dedicated Antenna

Class B Transponder with Splitter

Connections

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- AIS SARTs have recently been approved for GMDSS use
- An AIS SART is basically a low power Class A transmitter (1W)
- It transmits its position every minute and also outputs a Safety Related Message (SRM) every four minutes
- Once activated, an AIS SART should start transmitting it's position within 1min and continue to transmit for 96hrs
- Battery life is 3 years and an AIS SART should be fully waterproof to 10m for 5mins
- When held 1m above sea level the AIS SART should be received by all AIS units within 5NM radius



AIS SARTs

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The screenshot shows the MarineTraffic.com website interface. The top navigation bar includes links for Live Map, Vessels, Ports, and Gallery. The main map displays the Southampton area, with a ship named RED FALCON highlighted. A pop-up window provides detailed information about the ship:

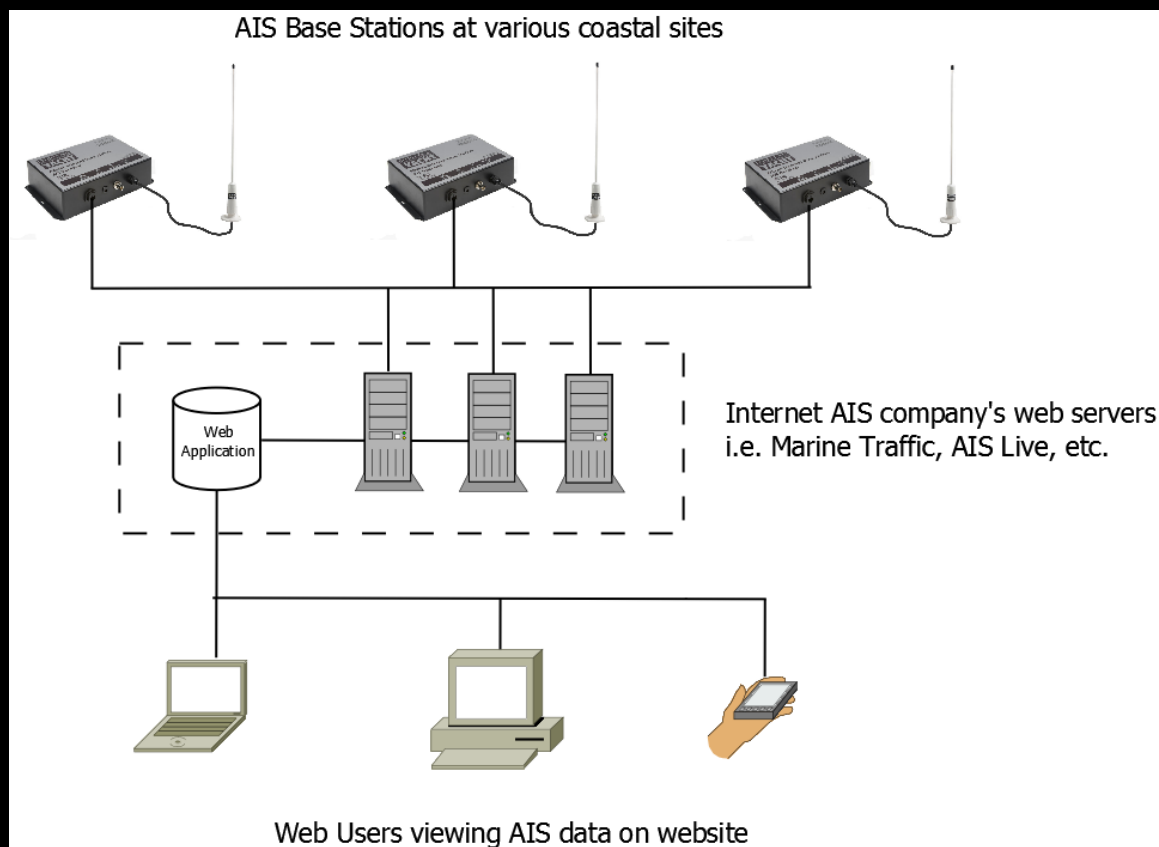
- RED FALCON**
- Flag: United Kingdom
- Ship Type: Passenger
- Status: Underway
- Speed/Course: 13.3 kn / 139°
- Length x Breadth: 94 m X 18 m
- Draught: 2.7 m
- Destination: SOTON-COWES-SOTON
- Received (487): 0h 2min 32s ago (AIS Source: pinkfoot.com)
- Links: [Show Vessel's Track](#), [Distance to...](#)
- Ship Photos: 22
- Upload a photo
- Vessel's Details
- All Actions

The left sidebar contains 'Ships Map' controls, including 'Go to Area...', 'Go to Port...', and 'Go To Vessel...' dropdowns. Below these are 'Notation & Display options' for showing ship names, fleet, and various vessel types (Passenger, Cargo, Tankers, etc.). A 'Quick Links' section at the bottom left provides links for MT for iPhone, Expected Arrivals, and Receiving Stations.

- Websites like Marine Traffic are a great source of AIS information and maintain ship databases with photos

AIS on the Internet

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- “Realtime” AIS is now available on-line at a number of websites
- Beware of holes in coverage and delays in updating but they are improving

AIS on the Internet



- AIS is an invaluable navigational safety tool
- Demand for AIS on Small Craft is increasing
- AIS is a simple and automatic system where the clever stuff is mostly hidden from the user
- An understanding of the underlying technology is key for Dealers to sell the correct system and diagnose problems

THANK YOU FOR LISTENING

Any Questions ?