Results of ADS Communications Testing

Oceans 96 IEEE/MTS

24 September 1996

Lt. Gregory W. Johnson

David Pietraszewski

USCG R&D Center, Groton CT

Vessel Traffic Service

⭐ **Mission**

   ○ **"...to maximize the safe and efficient use of waterways through the power of information."**

⭐ **Current Operations**

   ○ **Radar Based**

   ○ **Voice**

      ➤ **used to determine identity of radar contacts.**

   ○ **VTS Upgrade**

      ➤ **UNIX (UB) based.**

      ➤ **Digitized radar overlay on electronic chart.**

ADS

✪ **Automated Dependent Surveillance**

○ **Automated**
  - ➤ Does not rely upon vessel operator; equipment onboard determines and transmits data without human involvement.

○ **Dependent**
  - ➤ The system requires that each participating vessel have ADS equipment installed (or carried onboard).

○ **Surveillance**
  - ➤ Data provided by all participating vessels is used to monitor the course, speed, and position of each vessel in relation to each other and hazards to navigation.

ADS Testing

★ **Narragansett Bay, RI — 1994**

★ **NY Harbor, NY — 1995**

★ **3 Communications Methods**

○ **AMPS Cellular**

➤ **Coastal, commercial dial-up access.**

○ **VHF-FM DSC**

➤ **Coastal, VHF-FM polling.**

○ **Newcomb Satellite**

➤ **CONUS, real-time satellite link.**

VTS Gateway

Link Control Computers

Communications
Links

Data Multiplexor

Transview
Geographic
Display
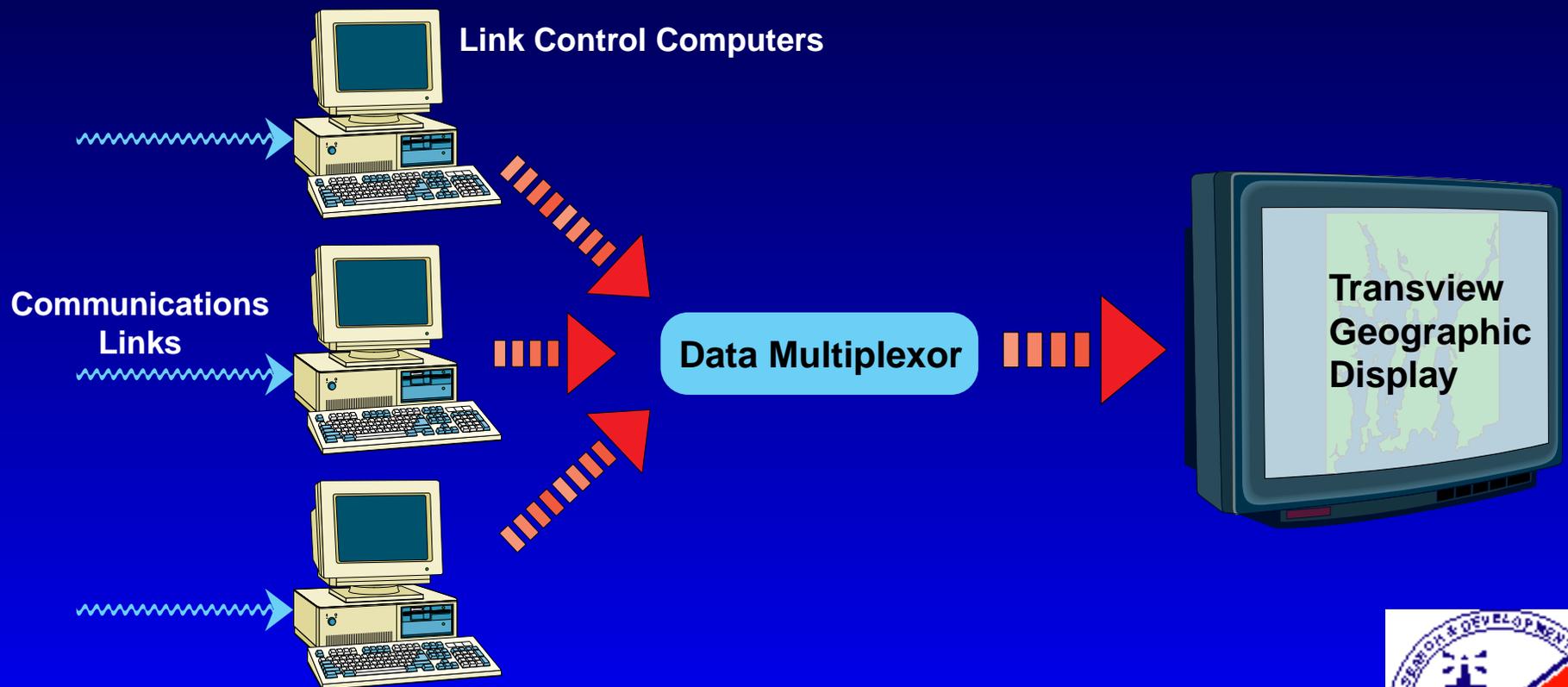
Vista Jubilee, Warren RI

USCGC Towline, Bristol RI

AMPS Cellular

☆ **Advanced Mobile Phone Service (analog cellular)**
  - ○ **30–45 seconds connect time**
  - ○ **virtual circuit (low latency)**
  - ○ **5 second report interval**
  - ○ **93+ hours of testing**
  - ○ **53,000+ reports**
  - ○ **~79% of packets successfully rcvd**

Cellular System Diagram

Cell Site

3W @ 824 –896 MHz

MTSO

Landlines

VTS Gateway
USCG R&D Center
Groton, CT
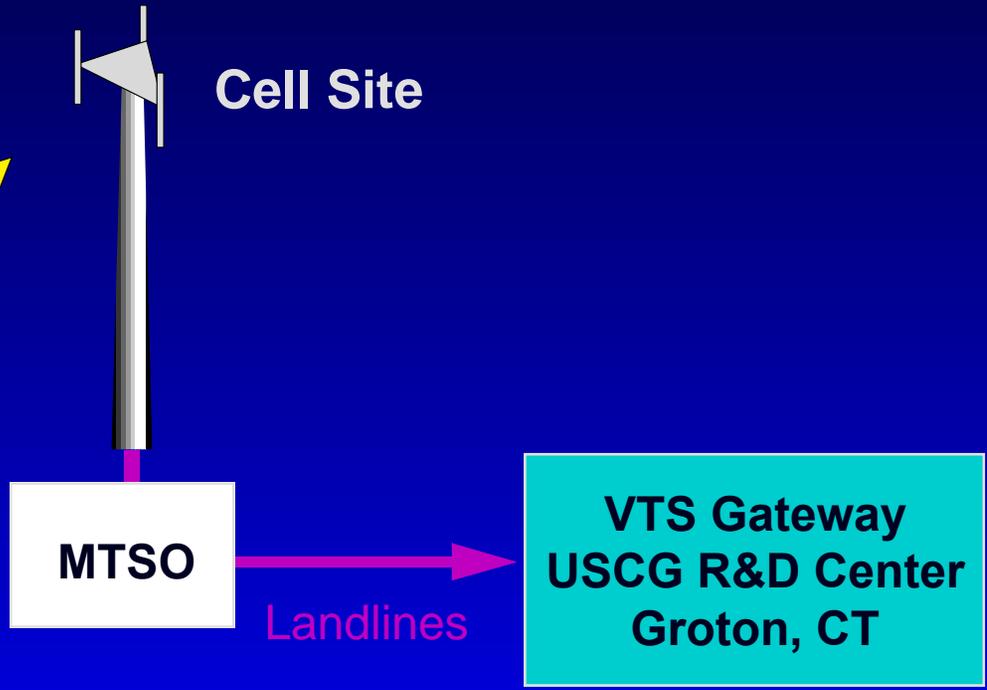
Cellular Coverage

Cellular Reliability/Integrity

Date	Hours	Raw Reports	Good Reports	% Data Error	Missed	Success %	Missed Max	Report Intervals Mean	Std Dev.
29-Aug	4.23	2,836	2,835	0.04%	192	93.66%	332	32.58	60.27
30-Aug	4.10	2436	2,435	0.04%	270	90.02%	748	47.00	129.33
31-Aug	3.86	2,423	2,422	0.04%	342	87.63%	547	63.33	121.52
11-Sep	2.54	1,468	1,323	9.88%	400	76.78%	334	16.39	34.66
15-Sep	8.80	4,887	4,419	9.58%	1884	70.11%	768	21.03	53.15
16-Sep	7.60	4,057	3,645	10.16%	1072	77.27%	420	16.55	1.33
20-Sep	6.52	3,727	3,282	11.94%	1384	70.34%	427	16.64	30.57
28-Sep	3.77	2,251	2,028	9.91%	668	75.22%	377	16.50	30.23
29-Sep	7.56	4,267	3,809	10.73%	1613	70.25%	344	16.97	27.59
7-Oct	3.52	2,193	1,965	10.40%	556	77.95%	240	14.86	22.10
8-Oct	3.51	2,268	2,053	9.48%	453	81.92%	280	14.15	23.79
12-Oct	4.04	2,473	2,219	10.27%	680	76.54%	227	16.14	23.62
14-Oct	5.33	6,457	3,071	52.44%	748	80.41%	370	16.06	31.74
22-Oct	3.61	2,290	2,034	11.18%	541	78.99%	435	14.58	29.79
Overall	68.99	44,033	37,540	14.75%	10,803	77.65%			

Cellular Conclusions

☆ **Negative**

- ○ **High cost**
- ○ **High complexity**
- ○ **Reliability problems**
- ○ **Capacity problems**

☆ **Positive**

- ○ **Largest information bandwidth**
- ○ **Low latency**
- ○ **Fastest reporting interval**

DSC

☆ **Digital Selective Calling**

- ○ **VHF-FM (Ch 70 - 156.525 MHz)**
- ○ **4–5 second latency**
- ○ **30 second report interval**
- ○ **Over 99 hours of testing**
- ○ **12,000+ reports**
- ○ **~92% success**

DSC System Diagram

25W @ 156.525 MHz

DSC Coast Station

Poll and Response

Landlines

VTS Gateway USCG R&D Center Groton, CT
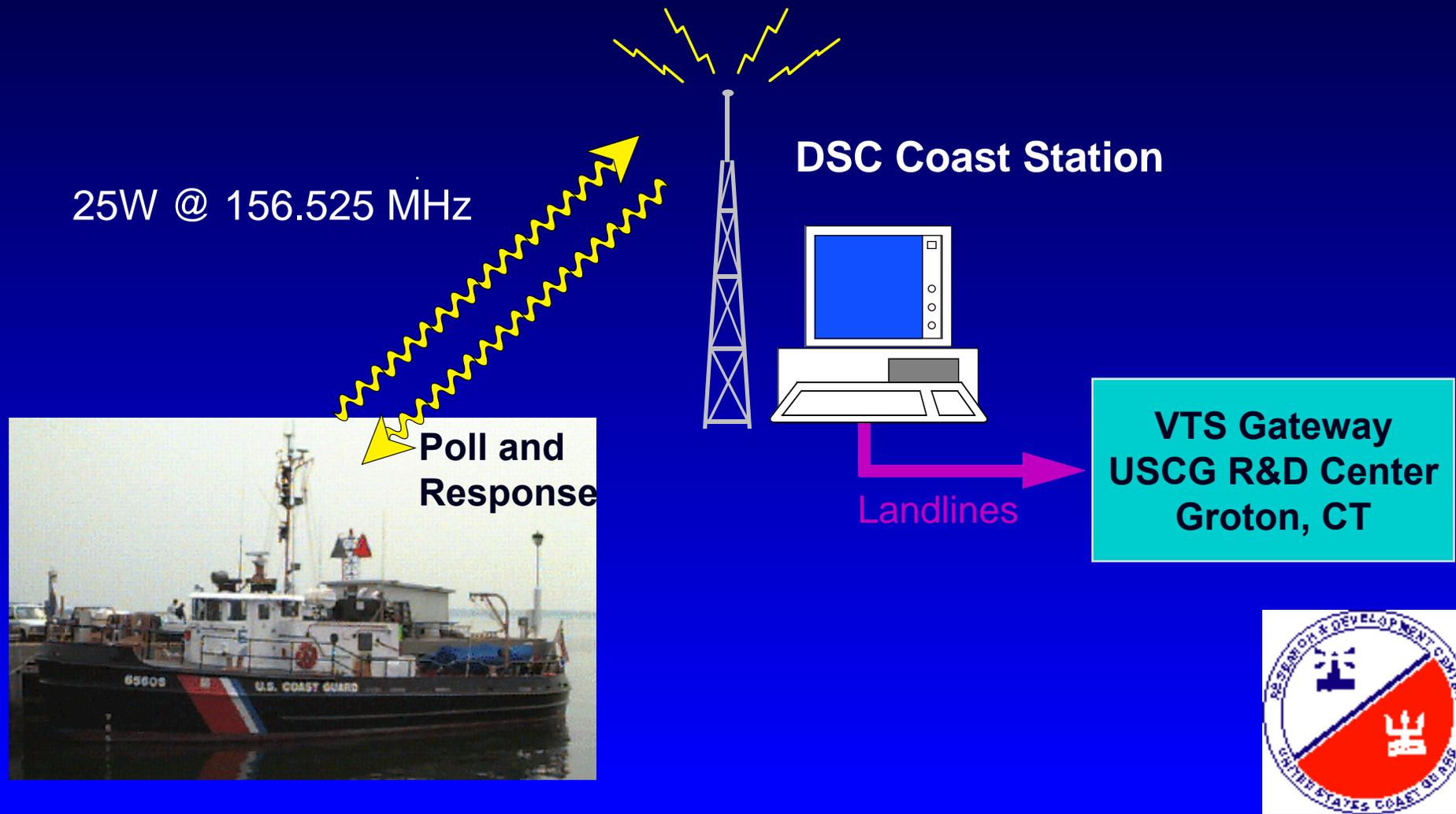
DSC Coverage Picture
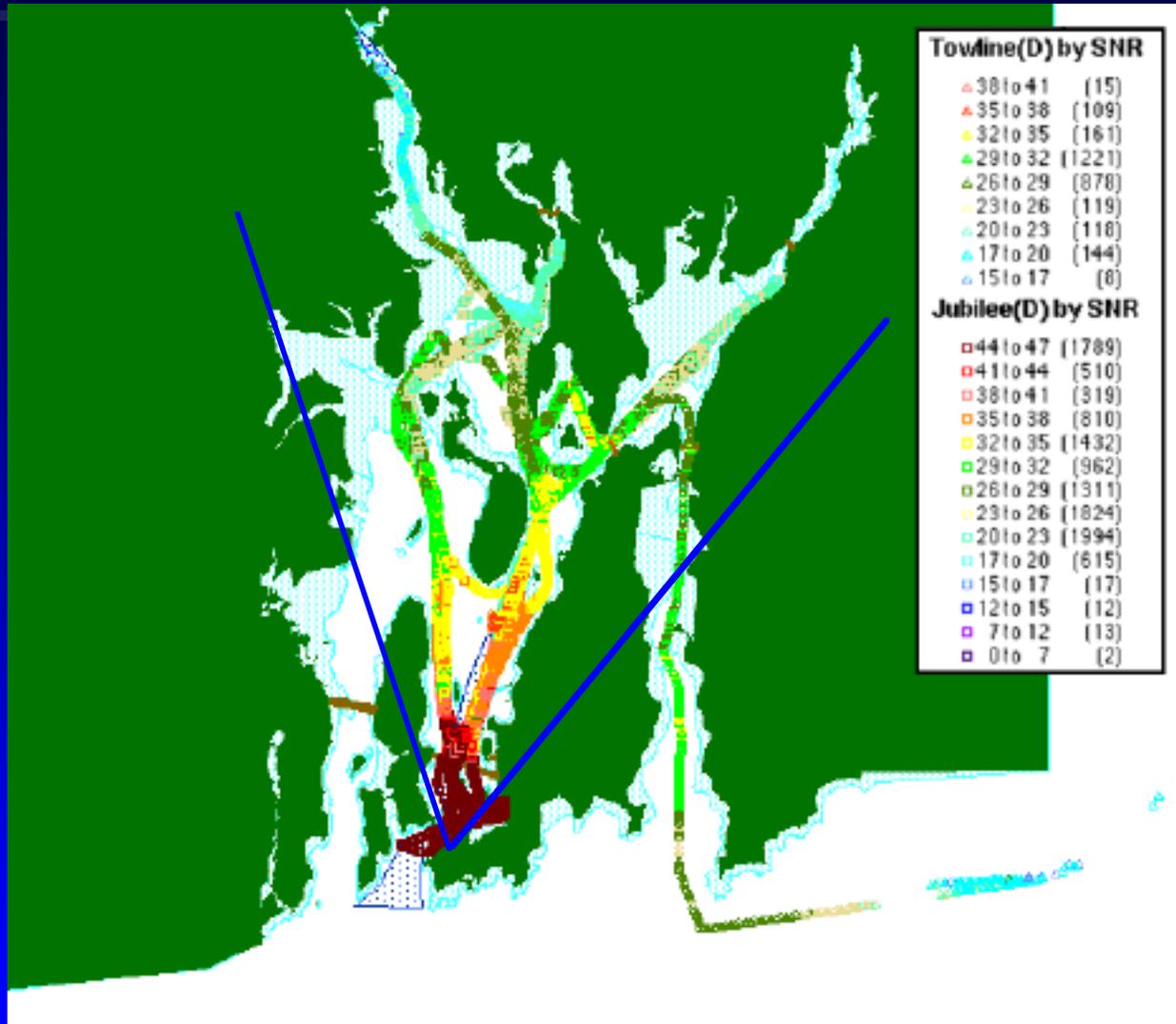
DSC Reliability

Date	Hours	Total Reports	% Incomplete Reports	Success %	SNR MIN	SNR MAX
25-Aug	4.09	351	0.00%	75.16%	8	46
26-Aug	4.49	510	0.58%	90.11%	18	47
31-Aug	3.85	429	0.46%	92.46%	22	47
15-Sep	3.01	333	9.51%	91.99%	19	32
16-Sep	8.71	845	10.77%	91.55%	15	47
20-Sep	6.38	661	10.80%	87.90%	21	47
27-Sep	5.68	649	8.85%	95.30%	19	23
28-Sep	3.58	413	9.43%	96.05%	18	47
29-Sep	5.66	741	15.12%	91.94%	17	47
7-Oct	4.01	452	15.20%	93.58%	15	47
13-Oct	5.28	619	13.55%	98.10%	17	47
13-Dec	5.52	565	11.86%	89.68%	13	25
Overall	99.06	10,834	7.43%	91.75%	8	47

NY DSC testing

★ **Working Channel (83A)**

- ❍ **Reduced poll response time.**

- ❍ **Variable report intervals.**

- ❍ **Initial calls made on Ch70 then switched to Ch83A.**

- ❍ **Periodic All-Ships calls on Ch70 to automatically acquire new arrivals.**
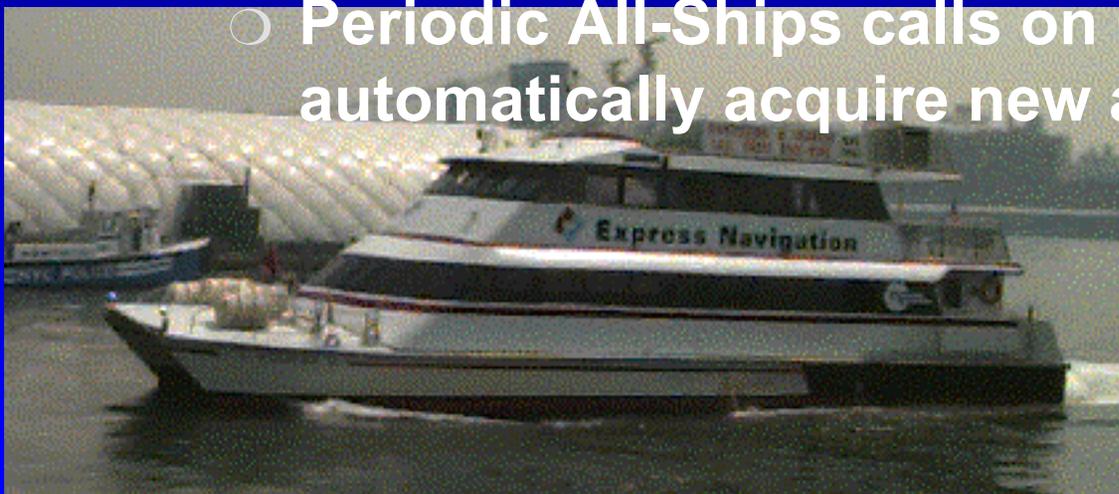
NY DSC Data
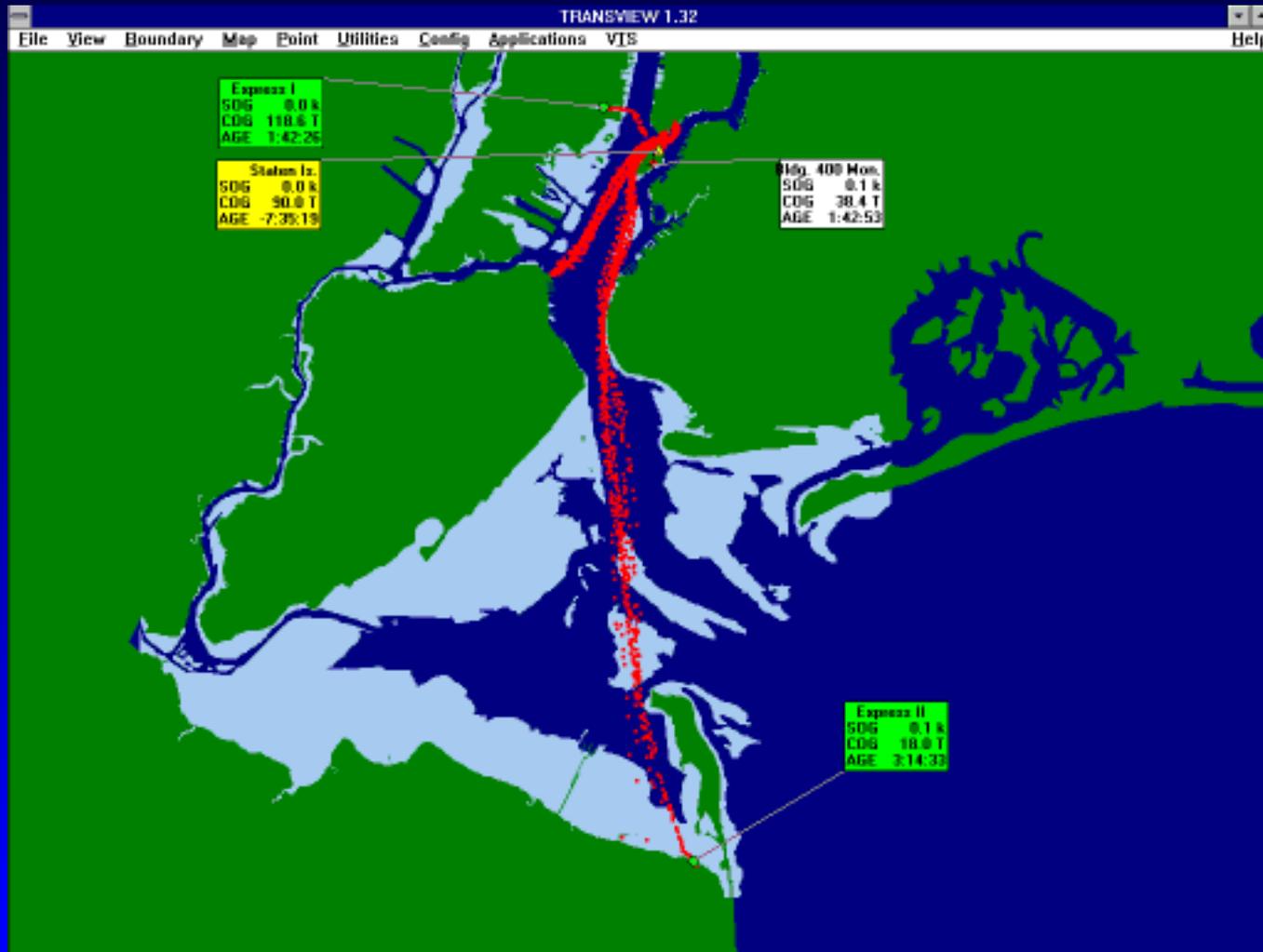
DSC Conclusions

☆ **Negative**

- ○ **Shore-side infrastructure needed**
- ○ **Cost is dependent upon traffic density and location**
- ○ **Capacity problems**

☆ **Positive**

- ○ **High reliability**
- ○ **Capacity can be increased**
- ○ **Low latency***
- ○ **International acceptance**

Newcomb Satellite

☆ **Developed under SBIR Contract**

○ **L-Band (1610–1626.5 MHz) Spread Spectrum Satellite System**

○ **1–2 second latency**

○ **10 second reporting interval**

○ **95+ hours of data**

○ **~ 96% of packets successfully received**

Newcomb System Diagram
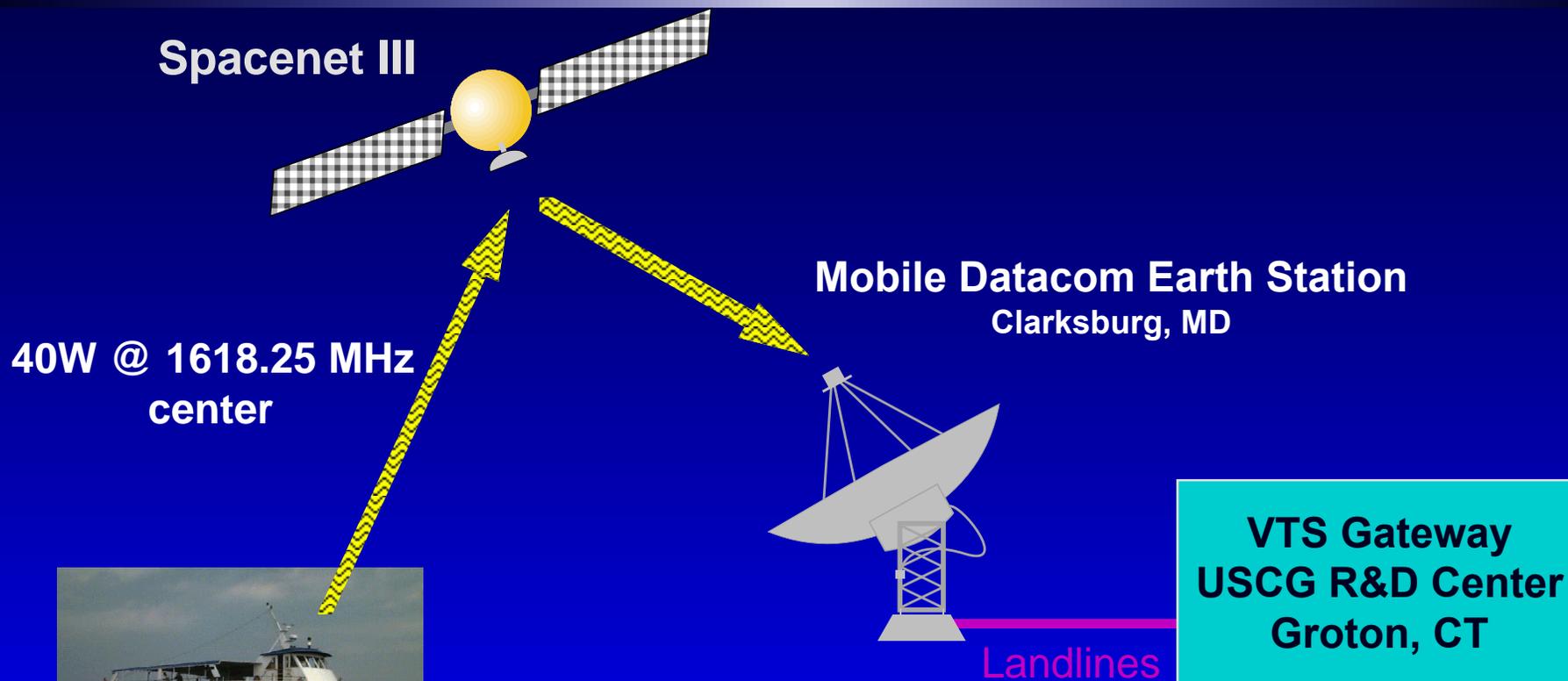
Newcomb Coverage Picture

Newcomb Reliability

Date	Hours	Reports	Success %	Max	Missed Report Intervals		# Intervals	% Single Misses
					Mean	Std Dev.		
25-Aug	5.24	1,715	95.92%	8	1.35	1.20	55	87.27%
26-Aug	4.36	1,357	96.86%	4	1.42	0.83	31	74.19%
30-Aug	5.69	1,867	98.31%	2	1.14	0.35	28	85.71%
7-Sep	4.01	1,268	94.70%	16	2.03	2.72	35	62.86%
11-Sep	2.33	751	97.03%	3	1.15	0.48	20	90.00%
15-Sep	8.38	2,658	95.58%	6	1.41	0.87	87	74.71%
16-Sep	6.32	2,023	98.25%	3	1.13	0.42	32	90.63%
20-Sep	6.87	2,076	96.69%	9	1.54	1.44	46	76.09%
29-Sep	6.65	2,120	95.24%	13	1.71	2.19	62	77.42%
8-Oct	3.89	1,204	93.19%	24	2.38	3.95	37	67.57%
14-Oct	5.33	1,704	98.16%	3	1.28	0.53	25	76.00%
13-Dec	3.85	1,236	96.79%	9	1.37	1.45	30	86.67%
Overall	95.21	30,326	96.35%	24	1.51	1.73	761	78.71%

Newcomb Reliability

Newcomb Data
Missed reports as a function of ship's course
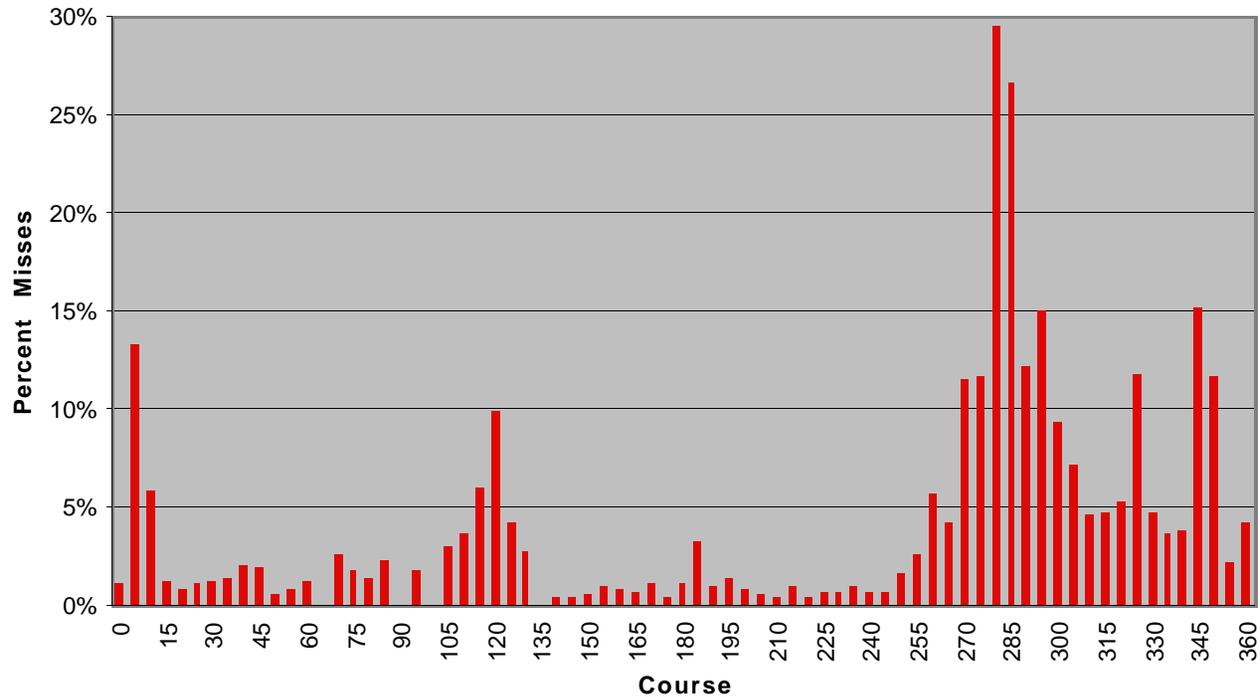
Newcomb Conclusions

☆ **Negative**

  ○ **Per packet cost**

  ○ **Frequency allocation issues**

☆ **Positive**

  ○ **Low latency**

  ○ **High reliability / secure**

  ○ **Easily installed / no infrastructure**

  ○ **Large coverage area**

  ○ **High capacity**

Voiceless VTS

☆ **Concept**

   ○ **VTS information should be automatically transferred between the VTS computers and the ships computer systems.**

   ○ **ADS is the transponder element of voiceless VTS.**

Normal Marine Piloting

PAPER CHART ← NAVIGATOR

PAPER CHART → PILOT

NAVIGATOR ← SHIPBOARD SENSORS

SHIPBOARD SENSORS → PILOT

VOICE COMMUNICATIONS ←→ PILOT

SHIPBOARD SENSORS

DGPS
Weather
RADAR
visual AtoN
Acoustic
etc.
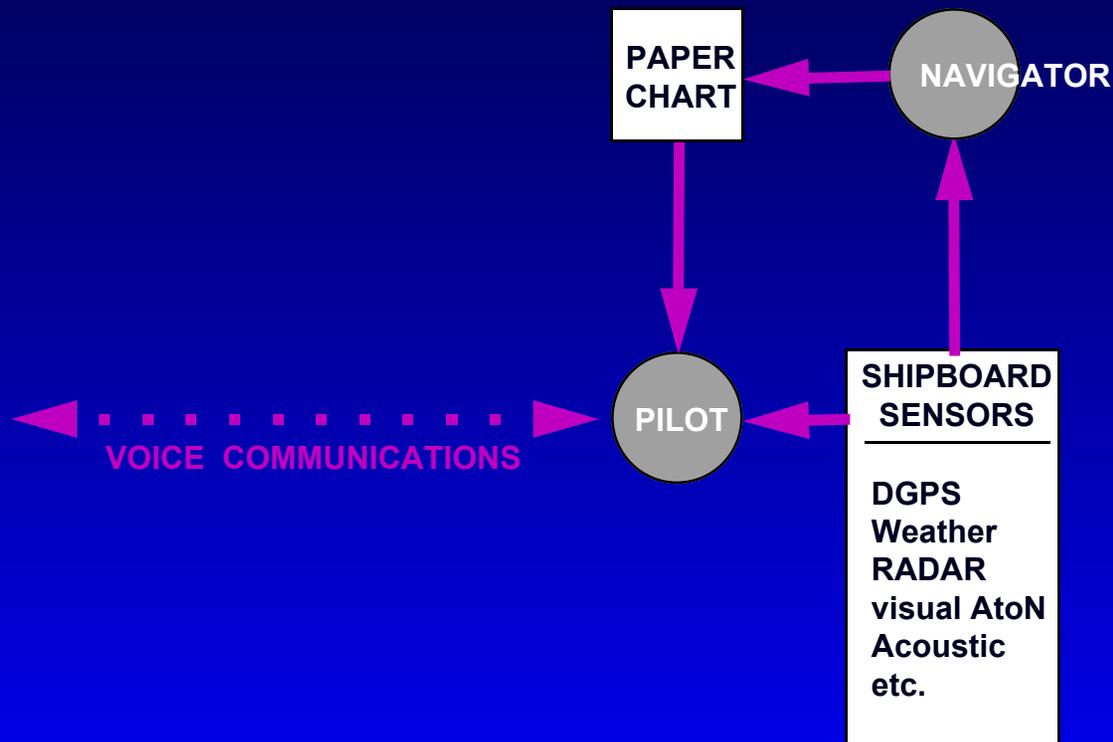
Marine Piloting w/VTS info

PAPER CHART ← NAVIGATOR

VTS DATABASE → VTS OPERATOR ⋯ VOICE COMMUNICATIONS ⋯ → PILOT ← SHIPBOARD SENSORS

SHIPBOARD SENSORS:
DGPS
Weather
RADAR
visual AtoN
Acoustic
etc.

— RADAR
— Video
— Hydrography
— Weather
— Transponders
— etc.
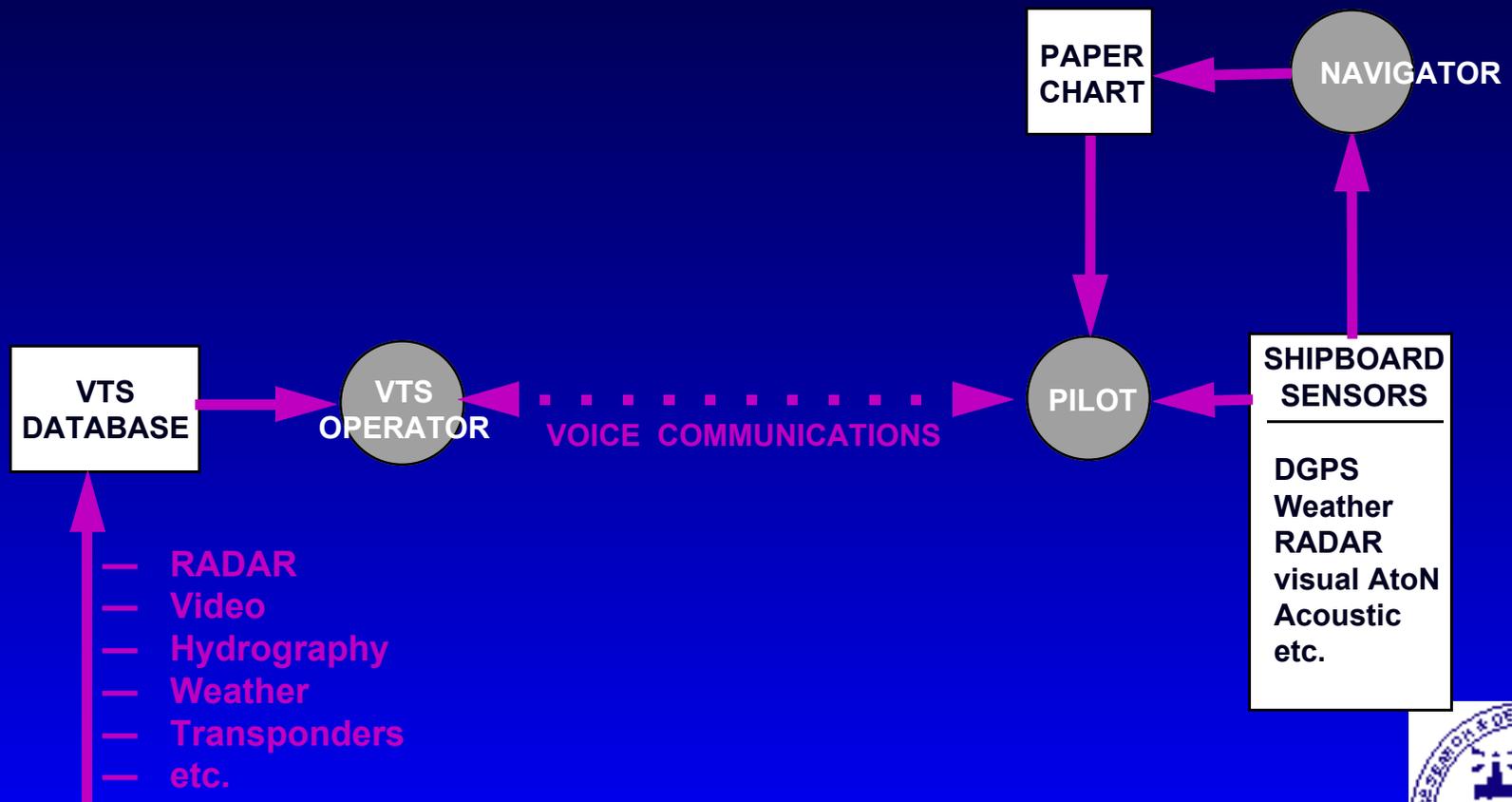
Marine Piloting w/ECS
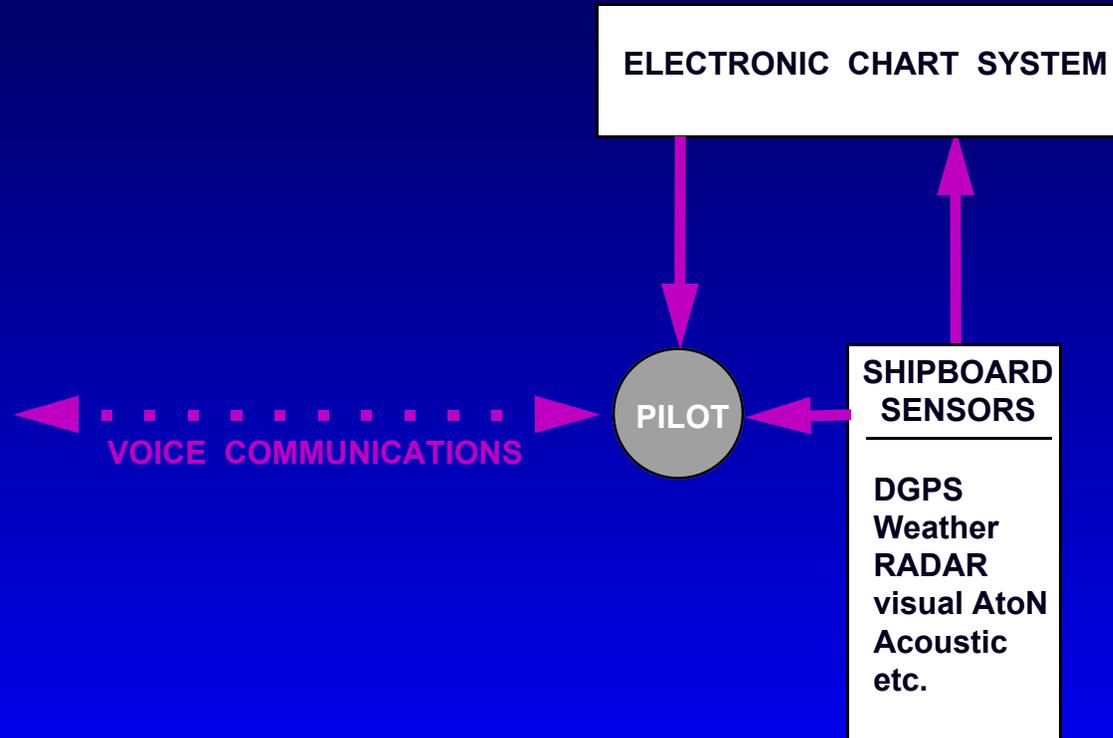
ECS & voiceless VTS
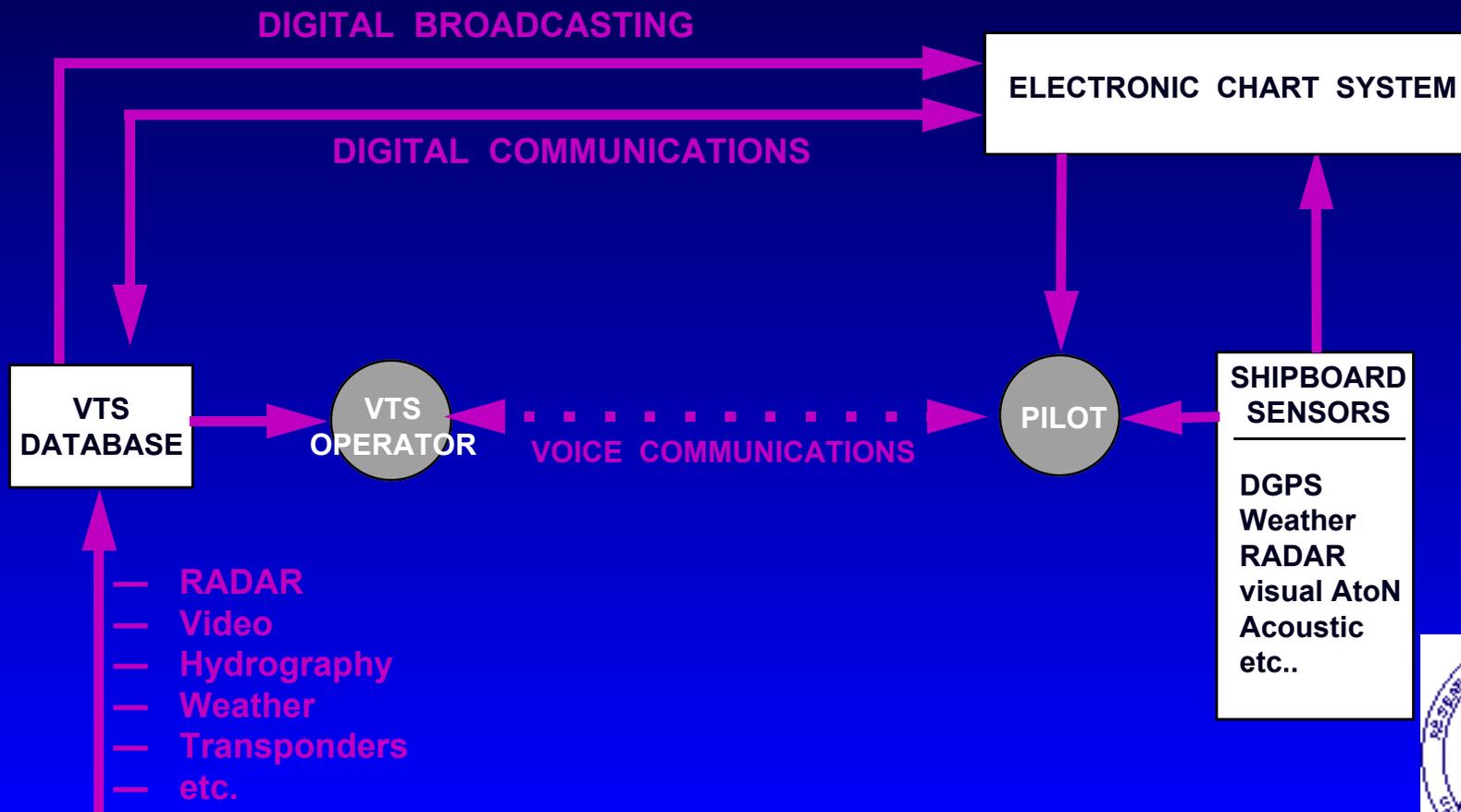
Conclusions

☆ **ADS**
- ❍ **works well**
- ❍ **valuable addition to VTS**

☆ **Benefits of Voiceless VTS**
- ❍ **Digital broadcasts as primary info source**
- ❍ **reduction in VTS operator workload**
- ❍ **improved VTS info quality**
- ❍ **automated VTS info transfer**
- ❍ **timely digital access to VTS info**

Questions?

⭐ **For further information:**

- ❍ **http://comms.rdc.uscg.mil/**
- ❍ **http://www.rdc.uscg.mil/**
- ❍ **gjohnson@gamma.rdc.uscg.mil**
- ❍ **dski@radioaids.rdc.uscg.mil**