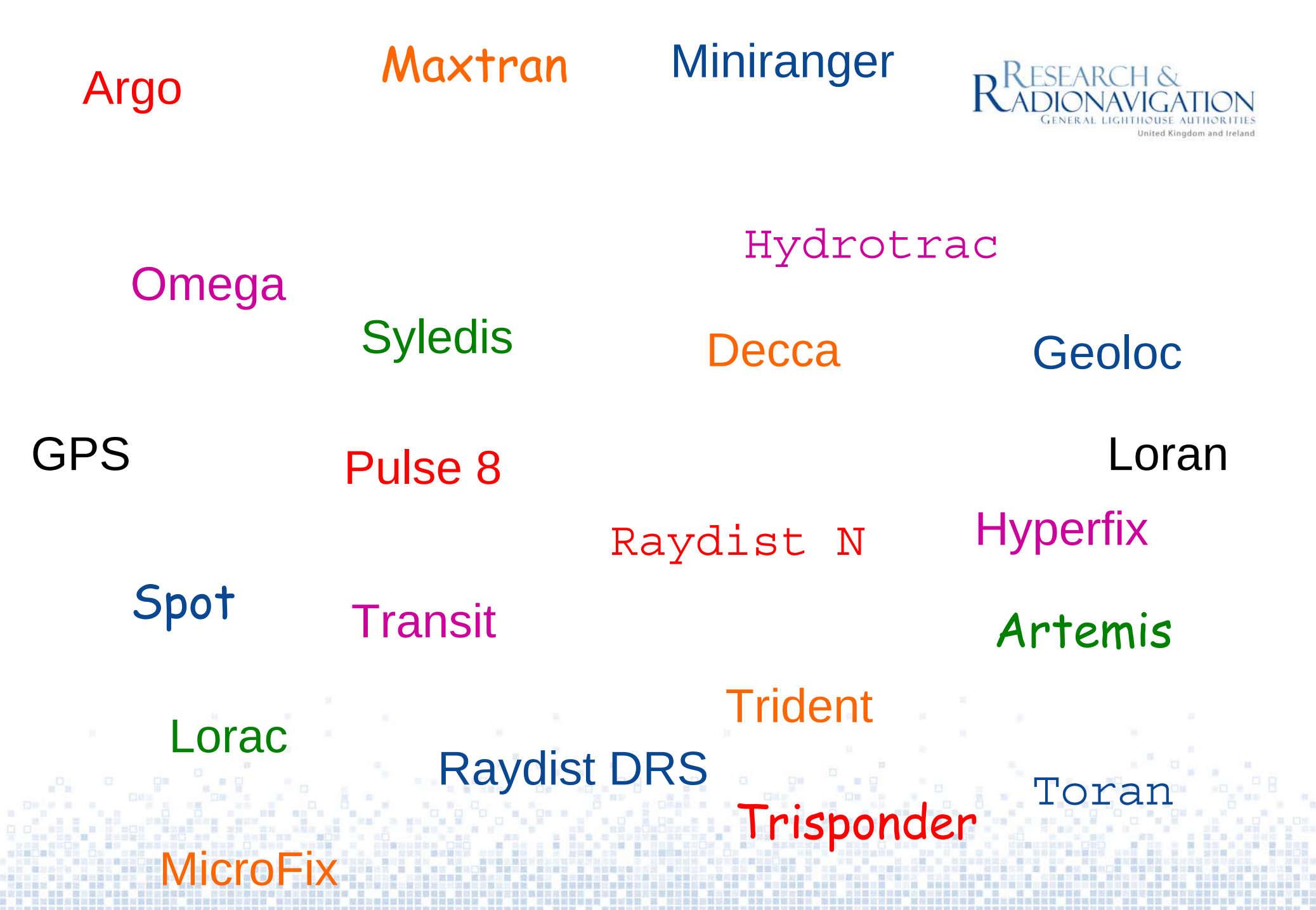
RESEARCH & RADIONAVIGATION
GENERAL LIGHTHOUSE AUTHORITIES
United Kingdom and Ireland

Robust and Resilient PNT: Today's Requirement

Dr Sally Basker

CGSIC, Savannah, 21 September 2009

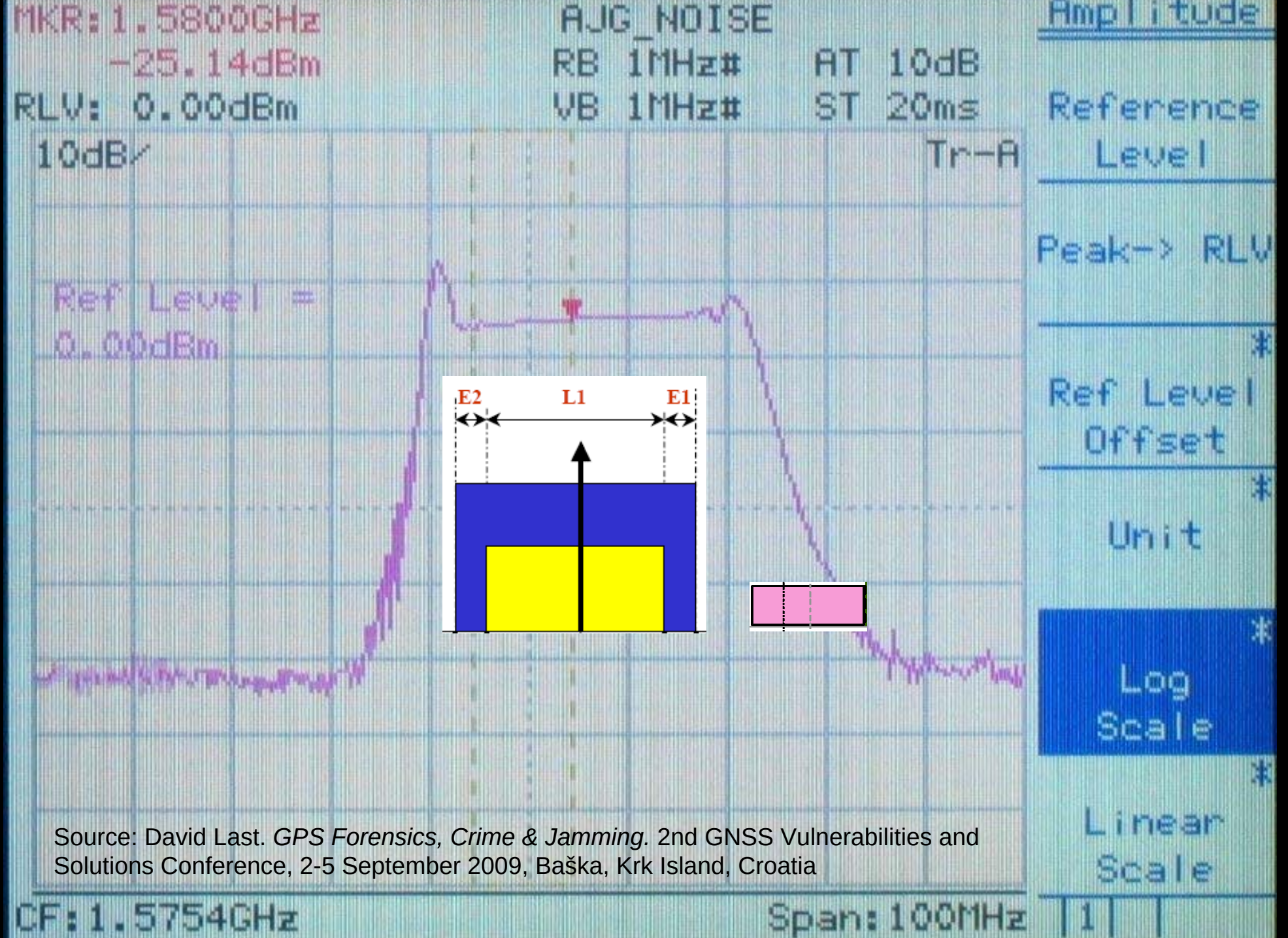

Argo
Maxtran
Miniranger
RESEARCH & RADIONAVIGATION
GENERAL LIGHTHOUSE AUTHORITIES
United Kingdom and Ireland
Hydrotrac
Omega
Syledis
Decca
Geoloc
GPS
Pulse 8
Loran
Raydist N
Hyperfix
Spot
Transit
Artemis
Trident
Lorac
Raydist DRS
Toran
Trisponder
MicroFix

Source: www.apple.com

GPS is vulnerable at system, signal and user levels

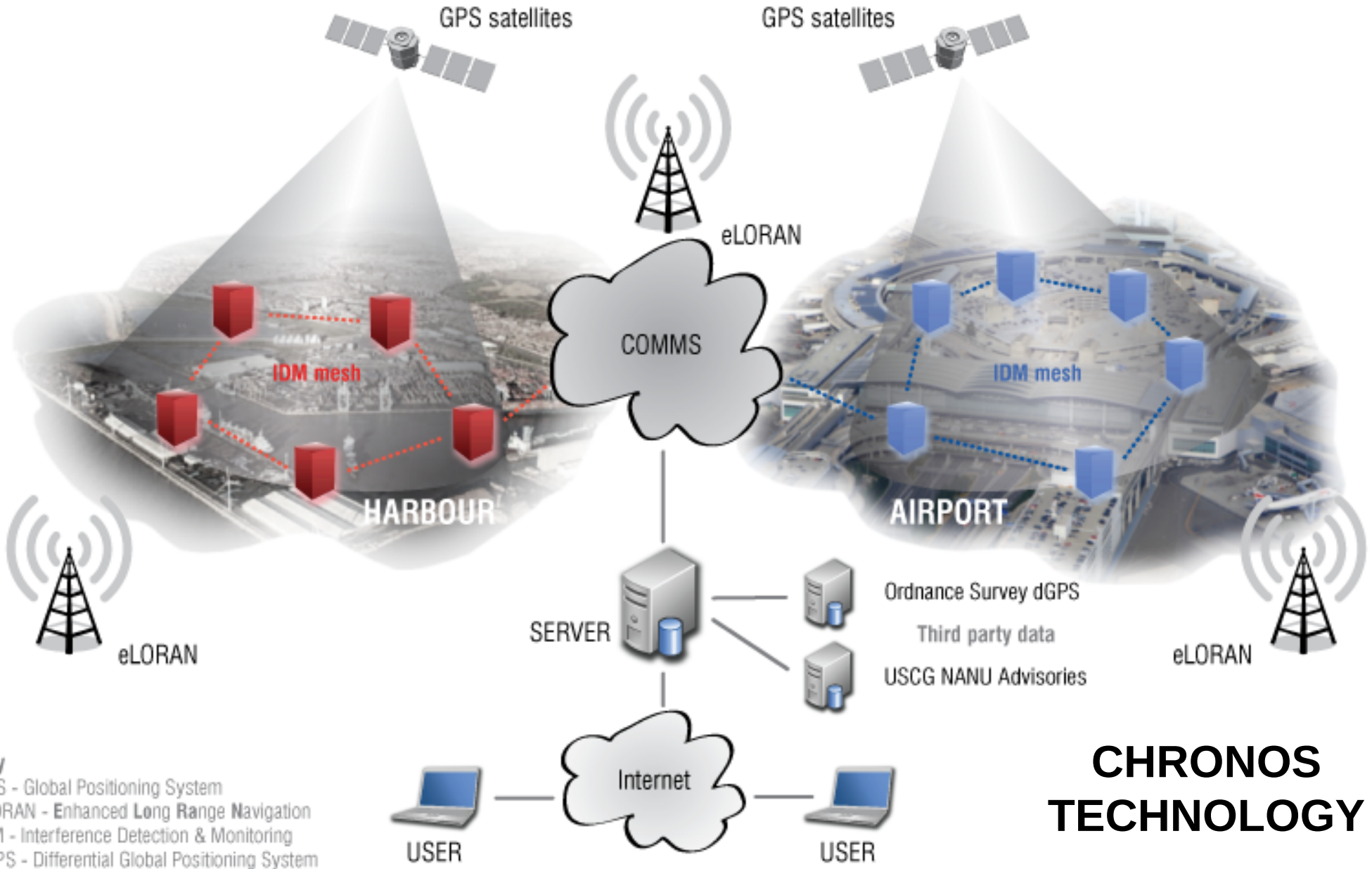
RESEARCH & RADIONAVIGATION
GENERAL LIGHTHOUSE AUTHORITIES
United Kingdom and Ireland

	Vulnerability Examples	Possible Mitigation
System	**Satellite clock failures** (e.g. SVN23, 1 Jan 2004)	**Second system or augmentation** (e.g. Galileo, eLoran, SBAS)
	Poor signal quality (e.g. evil waveforms)	**Second system or augmentation** (e.g. Galileo, eLoran, SBAS)
	Design flaws (e.g. Block IIR ranging code interruptions)	**Second system or augmentation** (e.g. Galileo, eLoran, SBAS)
Signal	**Intentional interference** (e.g. potential terrorism)	**Second dissimilar system** (e.g. eLoran)
	Unintentional interference (e.g. Moss Landing)	**Second system, other GNSS frequencies** (e.g. e-Loran, L2C, L5)
	Ionospheric effects (e.g. scintillation at high latitudes or equator)	**Second dissimilar system** (e.g. e-Loran)
User	**Equipment malfunction** (e.g. Royal Majesty, 1995)	**Second dissimilar system (e.g. eLoran)**
	Signal occultation (e.g. Urban canyons)	**More SVs &/or second dissimilar system** (e.g.Galileo, SBAS, eLoran)
	Local Interference (e.g. Manatoulin TV set)	**Improved siting &/or second dissimilar system**



Source: David Last. *GPS Forensics, Crime & Jamming.* 2nd GNSS Vulnerabilities and Solutions Conference, 2-5 September 2009, Baška, Krk Island, Croatia

GARDIAN



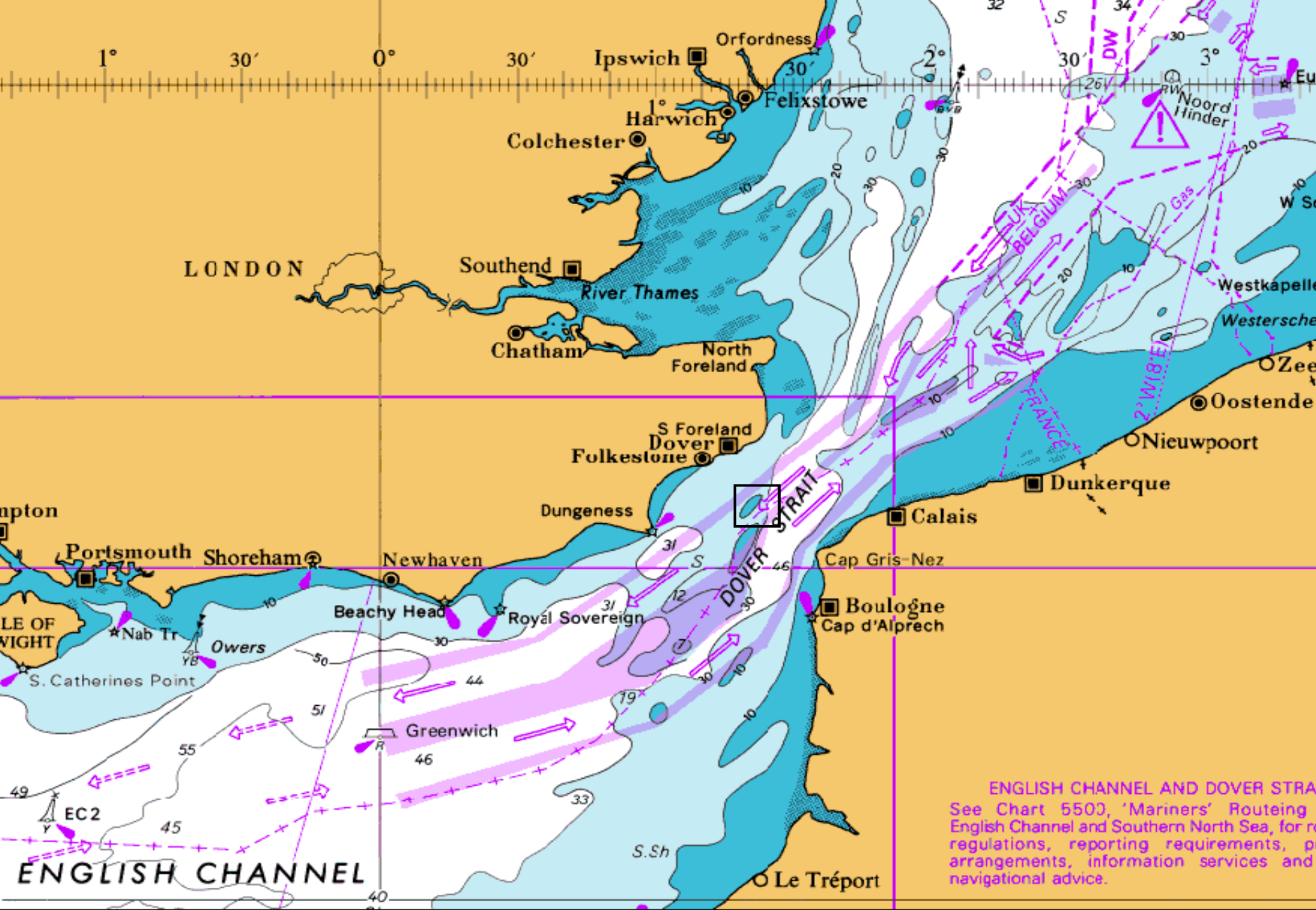
CHRONOS TECHNOLOGY

The Demand

RESEARCH & RADIONAVIGATION
GENERAL LIGHTHOUSE AUTHORITIES
United Kingdom and Ireland

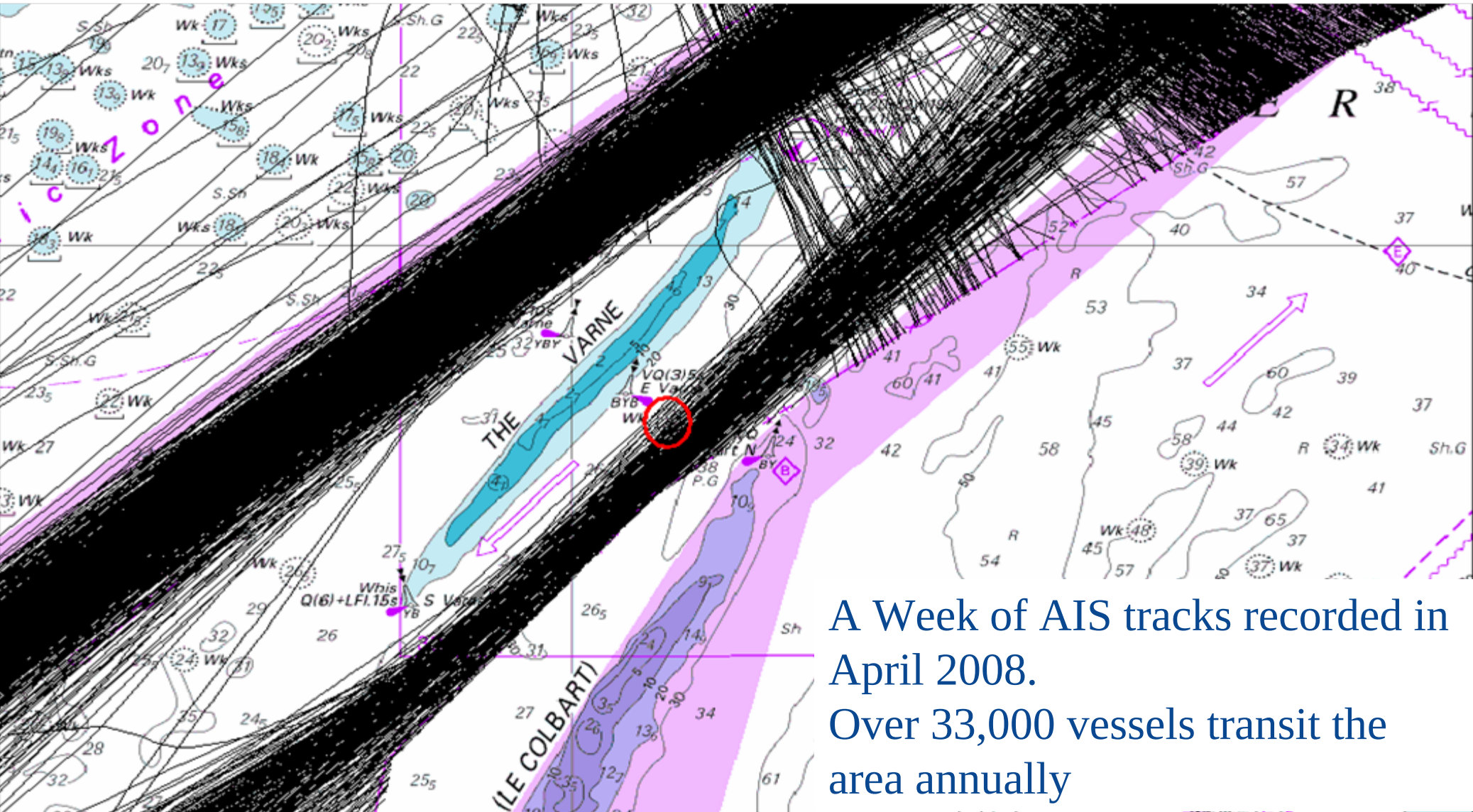






1° 30′ 0° 30′ 2° 30′ 3°
Orfordness
Ipswich
Felixstowe
Harwich
Colchester
LONDON
Southend
River Thames
Chatham
North Foreland
S Foreland
Dover
Folkestone
Dungeness
Portsmouth
Shoreham
Newhaven
Beachy Head
Royal Sovereign
Nab Tr
Owers
S. Catherines Point
LE OF WIGHT
Greenwich
EC2
ENGLISH CHANNEL
DOVER STRAIT
DW
Noord Hinder
UK
BELGIUM
FRANCE
Gas
Westkapelle
Oostende
Nieuwpoort
Dunkerque
Calais
Cap Gris-Nez
Boulogne
Cap d'Alprech
Le Tréport
ENGLISH CHANNEL AND DOVER STRA
See Chart 5500, 'Mariners' Routeing
English Channel and Southern North Sea, for r
regulations, reporting requirements, p
arrangements, information services and
navigational advice.

Trinity House moved UB38 in June 2008

RESEARCH & RADIONAVIGATION
GENERAL LIGHTHOUSE AUTHORITIES
United Kingdom and Ireland

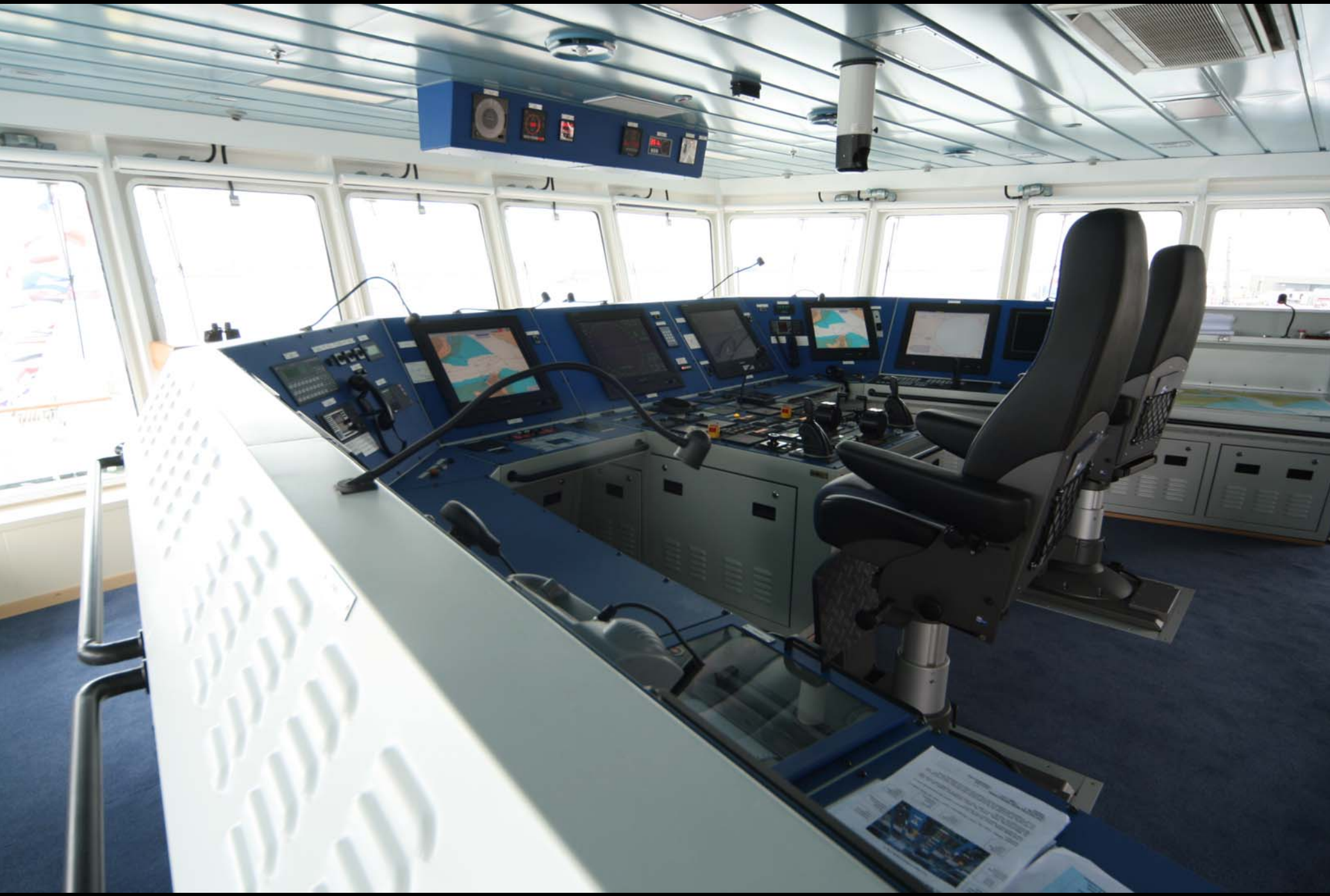


A Week of AIS tracks recorded in April 2008.
Over 33,000 vessels transit the area annually

LT Cortesia Grounding, 2 January 2008

RESEARCH & RADIONAVIGATION
GENERAL LIGHTHOUSE AUTHORITIES
United Kingdom and Ireland


EAST



Delivering a reliable, efficient and cost-effective AtoN service for the benefit and safety of all mariners