Wir machen Schifffahrt möglich.

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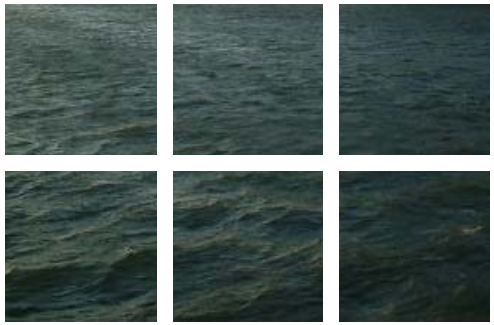
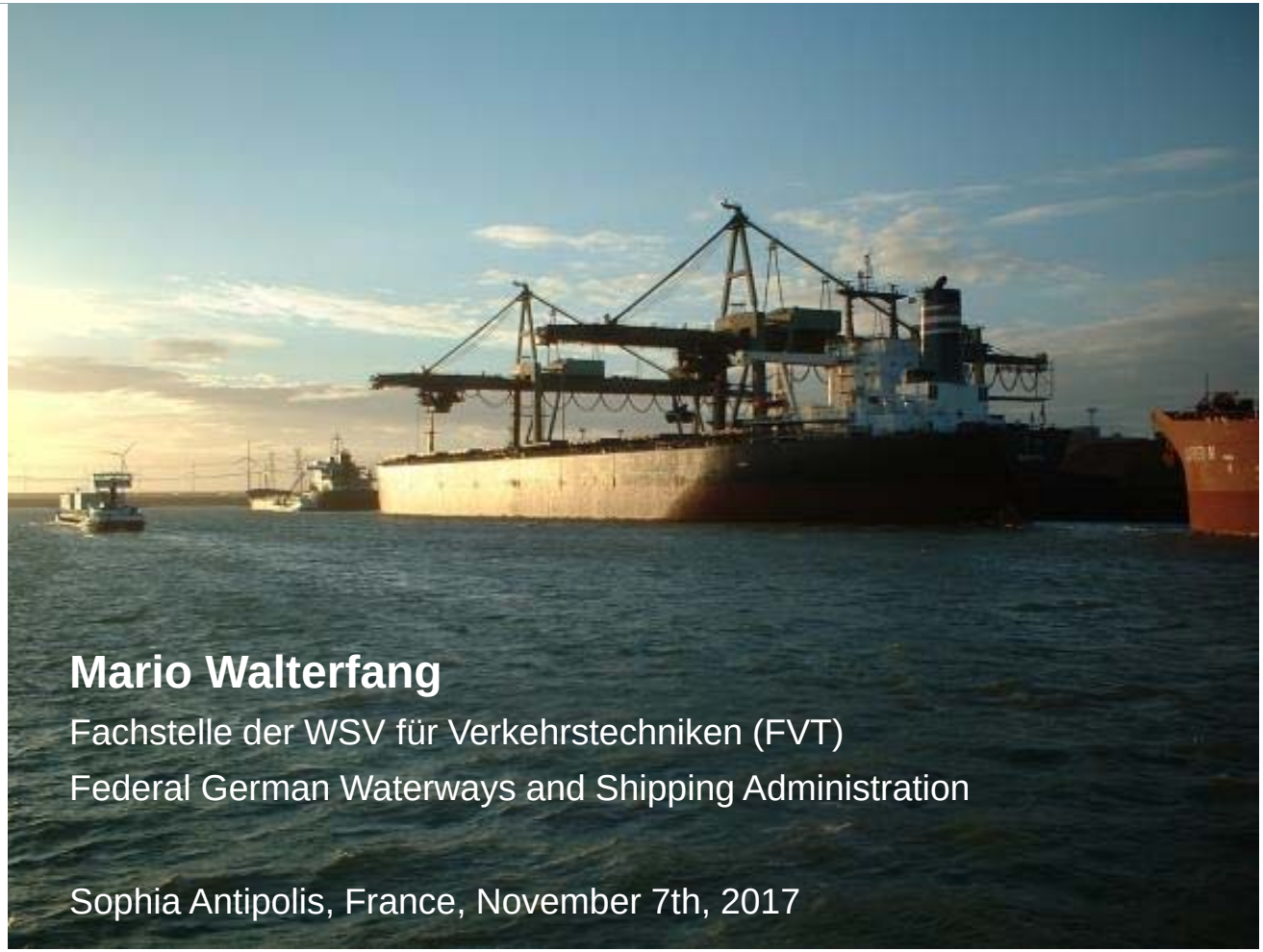
Radar evolution for inland waterways navigation





Mario Walterfang

Fachstelle der WSV für Verkehrstechniken (FVT)

Federal German Waterways and Shipping Administration

Sophia Antipolis, France, November 7th, 2017

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OVERVIEW

- Overview
- Milestones in river radar evolution
- „New Technology“ (NT-) radar
- Operational characteristics of inland navigation
- Status quo of river radar and future developments
- Impact on existing standards
- Need for new standards?

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MILESTONES IN RIVER RADAR EVOLUTION

- First radar device onboard of a maritime fishing vessel in 1947
- First radar device for use on inland vessels in 1956 based on Decca 159B

Type 159B Display with 9” CRT

Type 159B Horn Fed Double Cheese Antenna

*pictures: http://woottonbridgeiow.org.uk

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MILESTONES IN RIVER RADAR EVOLUTION

- Sinking of „Andrea Doria“ in 1956
  → leading to new training concepts and training requirements

- First regulations for inland radar equipment by CCNR in 1959

*picture: https://loomings-jay.blogspot.de/2016/11/andrea-doria.html

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MILESTONES IN RIVER RADAR EVOLUTION

- Replacement of parabolic antennas by slotted wave guide antennas in 60s
- Reduce of output power from 20 kW to 5 kW due to better receiver noise performance (1980s)
- CRT monitors without need of a tube (daylight operation)
  → one person conning bridge (1980s/90s)
- Flatscreen monitors (2000s)
  → compact space-saving (important for inland vessels!)
- Inland ECDIS in navigation mode:
  → Inland ENCs with overlaying radar picture (2000s)
- Introduction of ETSI EN 302194 in 2006 (R&TTE directive !)
- Color monitors and „mouse driven“ operation (2010s)
- Display of Inland AIS information in radar picture (2010s)
- A lot of „black box“ technical improvements:
  Better receivers, FPGAs, MC, digital Interfaces, …

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MILESTONES IN RIVER RADAR EVOLUTION

What are the next steps ahead into the future of river radar?

- Germany has been introduced inland AIS and inland ECDIS in *information* mode (chart display w/o radar) on inland waterways in 2016 and France will follow soon.
  - The future of inland ECDIS in *navigation* mode is open!
  - Will river radar be an integrated sensor or standalone navigation system in future?
- River radar may play an important role as a sensor in autonomous conning systems
- Inland ECDIS in *navigation* mode may be the right system to handle user interaction with autonomous conning systems
- The most important topic for river radar for next years will be the introduction of „**New-Technology NT radar**“!

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NT-RADAR

- The principle concept of river radar has not been changed for decades.
- Manufacturer implemented new technologies into their black boxes in the past to improve certain features of radar without fundamentally changing functionality and signal structure of radar!
- With NT radar this will change:

NT radar introduces a complete new signal structure!

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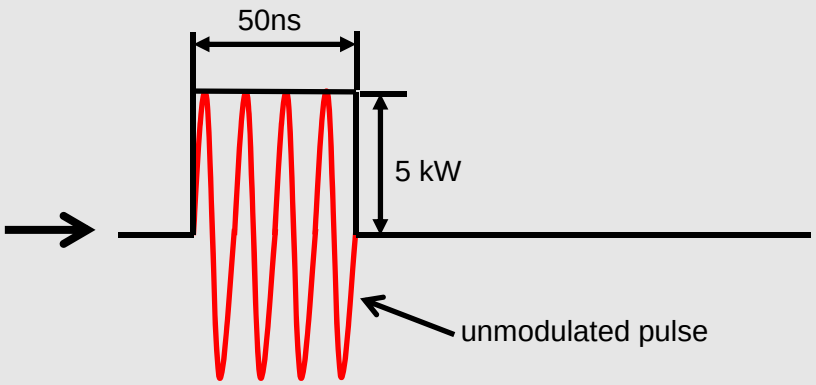
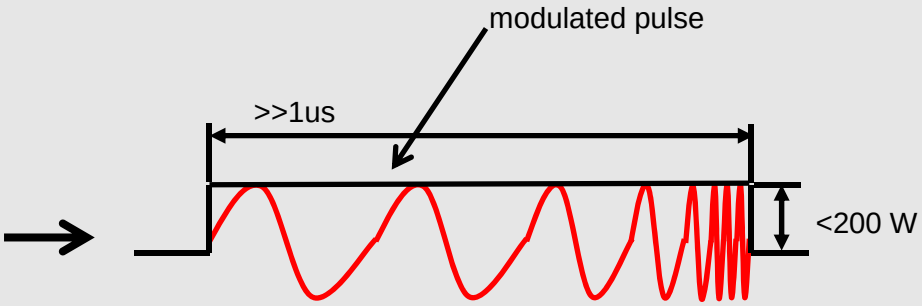
NT-RADAR

Magnetron

NT-Transmitter





“Pulse compression”

*[1]picture: http://www.radartutorial.eu/08.transmitters

*[2]picture: https://www.kelvinhughes.com/maritime/naval-radar

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NT-RADAR

- The basic concept of NT Radar is to replace legacy Magnetron tube by a signal generator and a solid state amplifier:
  - maximum output power of solid state transmitter is limited!
  - to reach comparable detection properties, pulse length must be much longer!
  - with pulse compression handled by the receiver even better range resolution can be achieved!
- NT radar is NOT defined in its parameter!
- NT radar systems are not brand new (already used in military equipment, in VTS systems and non-professional maritime radar systems)!
- The impact on functional or operational radar parameters is low (at least for river radar equipment!)

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NT-RADAR

- Basic properties of NT radar systems:
  - a solid state transmitter stage (typ. P < 200 W) replaces the high power Magnetron (P_{peak} = 5 kW) transmitter unit
  - pulse length is much longer (50 ns vs. >>us)
  - variation in pulse length to cover optimal different ranges
  - intra pulse modulation
    (typ. linear chirp but other modulation is also possible)
  - pulse compression (→ very high radial resolution despite long pulses)
  - higher bandwidth demand
  - additional disturbances (e.g. Time-Side-Lobes)
  - compatibility with conventional interference reduction mechanism?
  - possible number of NT radar in the vicinity to each other without interference?

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Operational Characteristics of Inland Navigation

Inland navigation is characterized by:

- display orientation “head-up” and “relative motion”
- the need of “rate-of-turn” – indicator
- no tracking functionality, only trails
- high density traffic areas with parallel sailing vessels, convoys etc.
- very small passing distances!
- higher resolution requirements, but lower output power of radar devices
- special radar disturbances:
  - intensive scattering echoes due to multipath effects e.g. on bridges, open hatchways on vessels, etc.
  - high voltage transmission lines crossing the waterway
  - etc.

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STATUS QUO

We are facing the situation that …

- manufacturer of NT river radar systems requesting appropriate standards to develop conform products,
- type approval authorities are needing standards to test and approve NT river radars,
- the RED directive has superseded the R&TTE directive (including the receiver now!),
- improvements in inland radar equipment have not been reflected by the present standard (ETSI EN 302 194) since 2006,
- type approvals carried out on base of current ETSI EN 302 194 showed some short comings that have to be corrected yet, and
- certain test procedures within ETSI EN 302 194 do not reflect the specific operational requirements of inland radar navigation!

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IMPACT ON EXISTING STANDARDS

Items for ETSI EN 302 194 TG26 group:

- ETSI EN 302 194 has been opened for revision, but only with respect to RED directive!
- Current functional and operational items should also be reflected by ETSI EN 302 194 and should be resolved by revised version
- It should be possible to amend ETSI EN 302 194 easily in case of new developments.

- As an alternative, ETSI should limit ETSI EN 302 194 on the quite stable “EMC” and RED related part as this is the core competence of ETSI!
- This could be an effective way as expert resources are very limited
- The functional and operational requirements could be issued by another group (e.g. CESNI/PT by EC /CCNR or “inland expert group”).

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NEED FOR NEW STANDARDS?

NT river radar equipment is not sufficiently regulated yet, as

- existing conventional radars have a complete different signal structure as NT radar systems
- there is a need for more investigations with respect to the question, whether conventional interference rejection mechanisms as implemented on existing radars can suppress not only signals from conventions radar devices but also from NT radars

As a result,

- the existing ETSI EN 302 194 should be expanded with respect to NT radar systems, or as an alternative,
- a complete new standard has to be developed.

In any case appropriate standards have to be in place that ensure sufficient coexistent of conventional and NT radar systems!

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The end

Thank you for your attention!