Maritime Broadband Radio

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Outline

- Wireless communication in a maritime environment
- A smart antenna solution
- Test results
- Conclusion

Maritime communication requirements

A communication solution must…

… be reliable with a minimum loss of data packets

… be designed to work well in a maritime environment

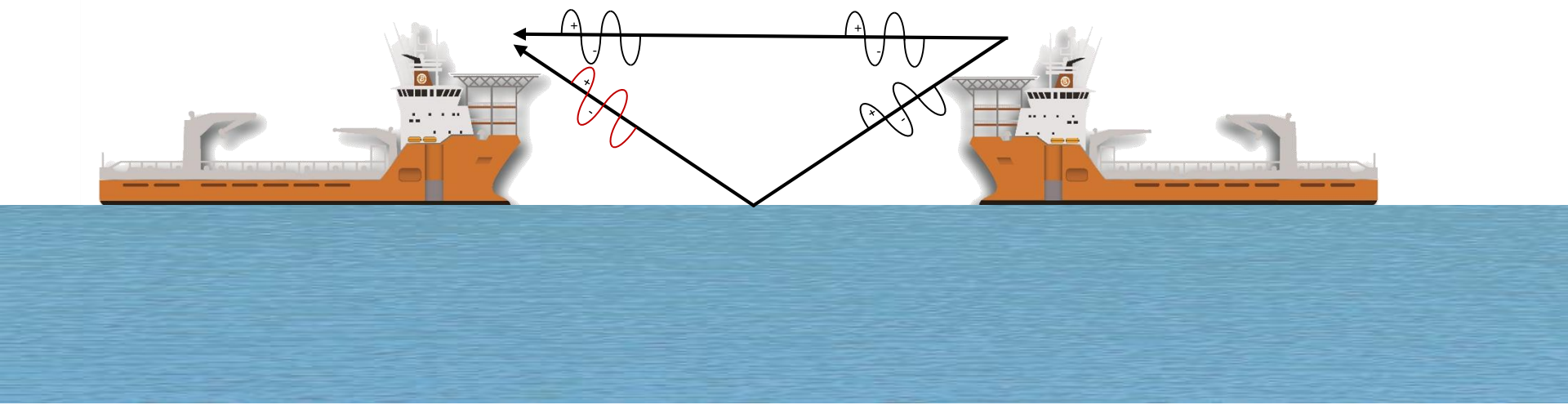
… be able to communicate simultaneously over short and long distances

… work even when signal path is obstructed by large vessels

… be easy to operate, maintain and install

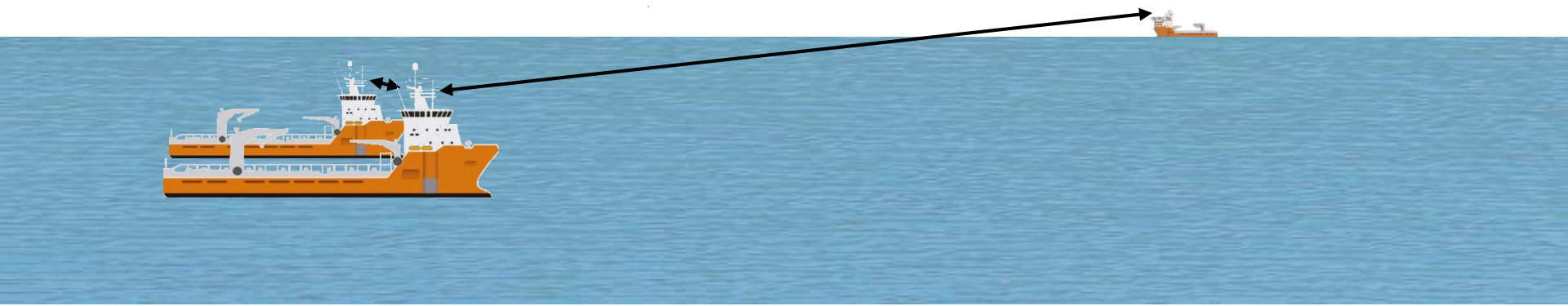
Maritime communication problem 1

- Flat sea fading
- Caused by out-of-phase Fresnel zone interference



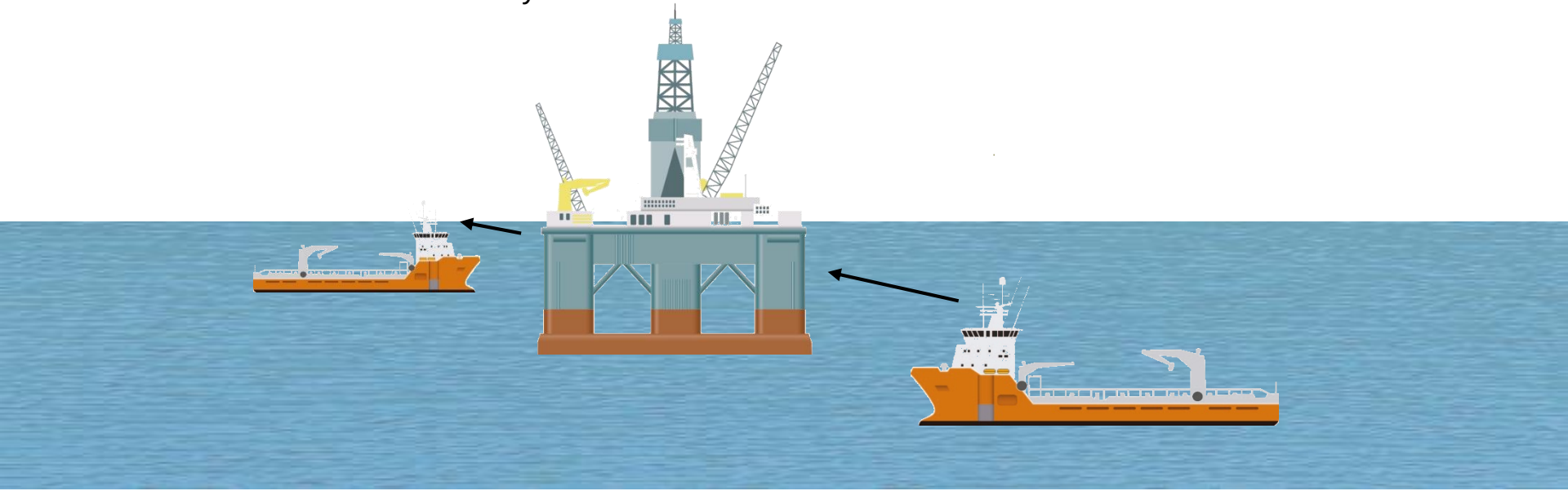
Maritime communication problem 2

- Two vessels located close to each other and a third vessel located far away
- Communication needed simultaneously between all vessels, even when one is beyond line-of-sight



Maritime communication problem 3

- Large object in the signal path between communicating vessels
- Radio communication effectively blocked in a worst-case scenario



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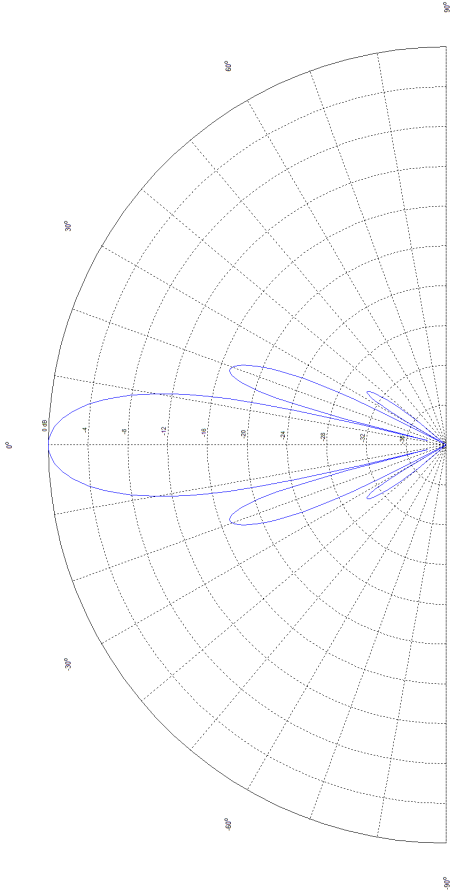
A smart antenna solution

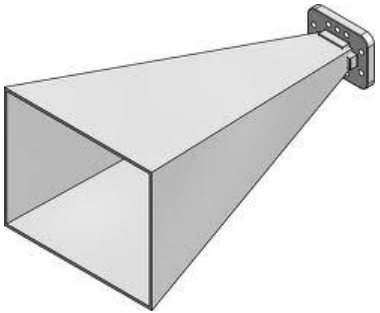


Increasing range by focusing the radio beam

- Increasing the antenna gain will increase the radio range :

$$P_{RX} = P_{TX} + G_{TX} - L_{TX} - L_{FS} - L_M + G_{RX} - L_{RX}$$

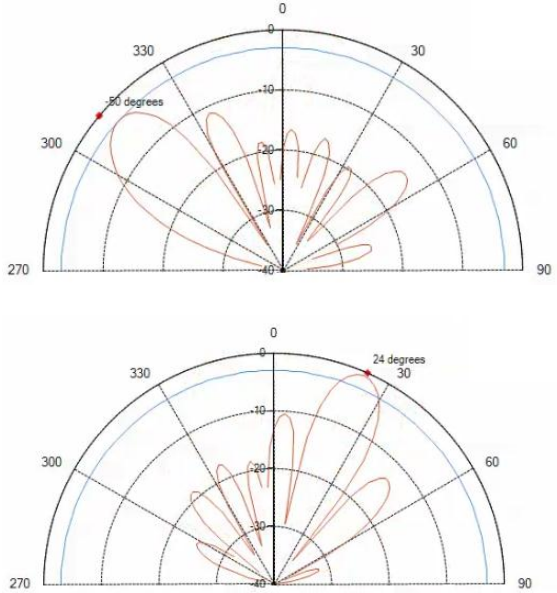
- Many traditional designs, but knowing where the direction to the transmitted signal is needed



Beam forming by antenna arrays

- With a phased array antenna the radio beam can be shaped to increase gain in specific directions
- The beam can be focused instantaneously by software both for transmission and reception

Example of phased array radar antenna found on the Internet

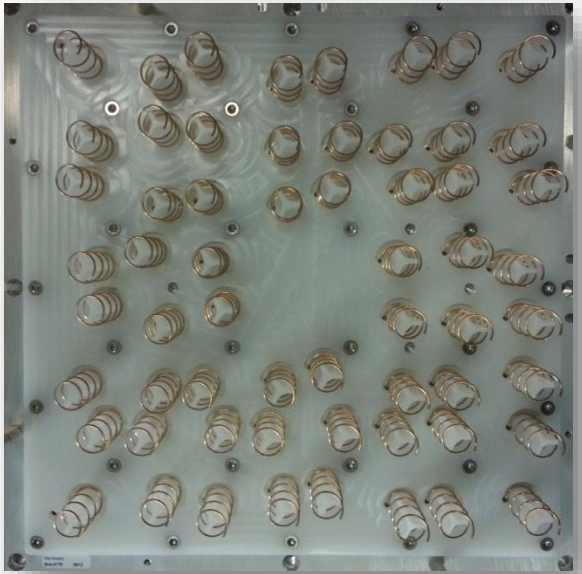


Beam forming radiation patterns

A smart antenna

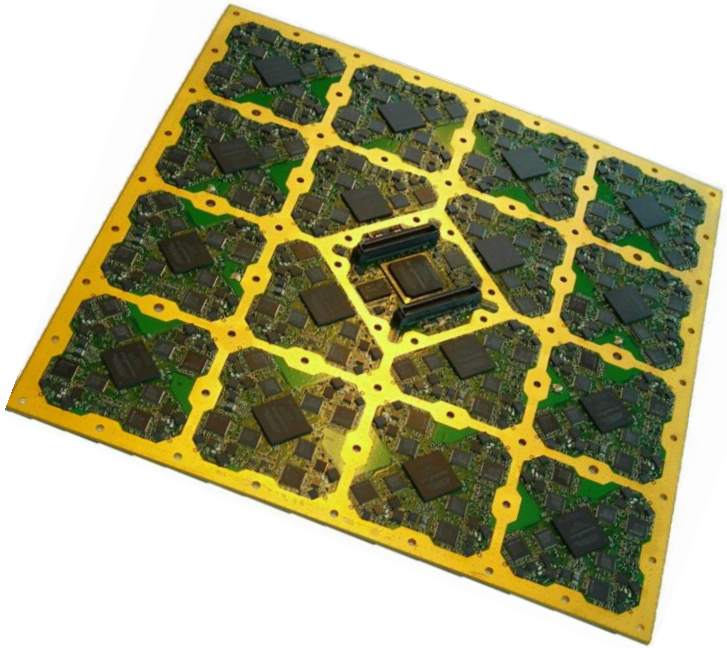
- Combining up to 60 antenna elements in one antenna panel
- Simulations and experiments used to find optimal geometry
- Enables instantaneous beam forming and spatial addressing
- Compact size
- High gain

Smart antennas are antenna arrays with signal processing used to identify spatial signal signatures such as the direction of arrival of the signal, and use it to calculate beam-forming vectors, to track and locate the antenna beam on the target.



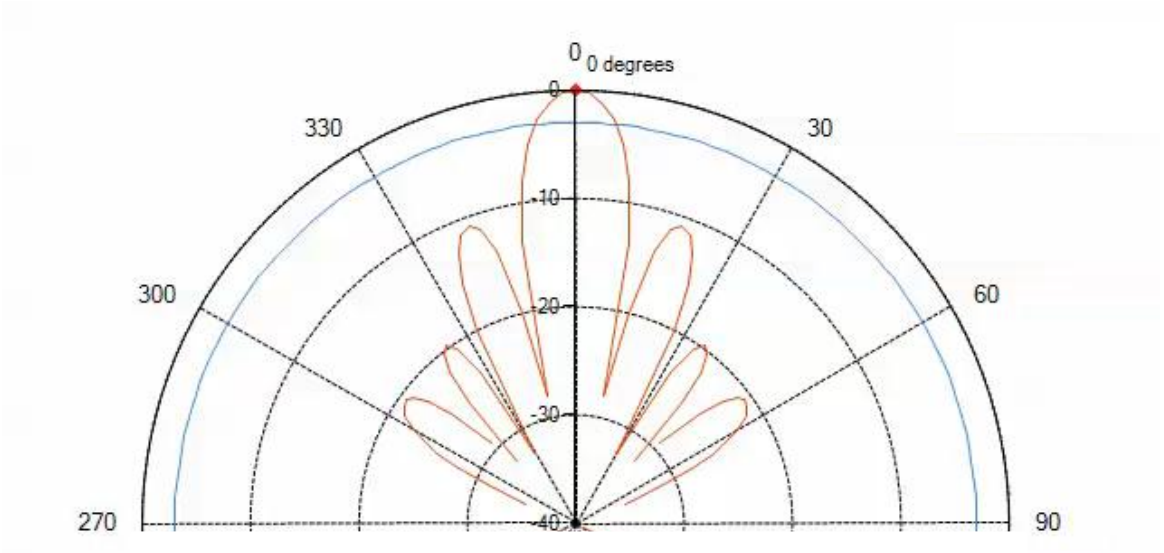
Parallel signal processing

- Massive parallel processing by use of up to 17 FPGAs handling a real-time data stream of 40 Gbps
- Operating in 5 GHz frequency band
- Real-time signal processing
- Up to 60 independent transceivers
- Fail tolerant design



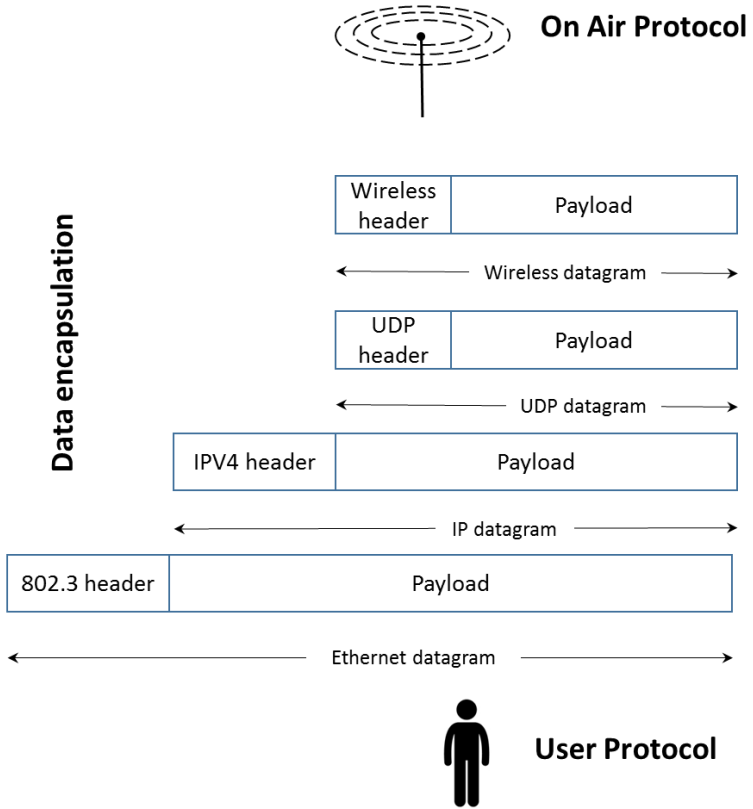
(*) FPGA – Field-Programmable Gate Array

Beamforming



Managing the communication protocol

- In most Wi-Fi solutions the underlying protocol is invisible to the user
- Optimizing the basic protocol is complex but allows several improvements (adapting the MAC/PHY layers)
- Improved real-time capability
- Improved bandwidth utilization
- More optimal priorities between data types
- Avoiding data telegram collisions (interference)



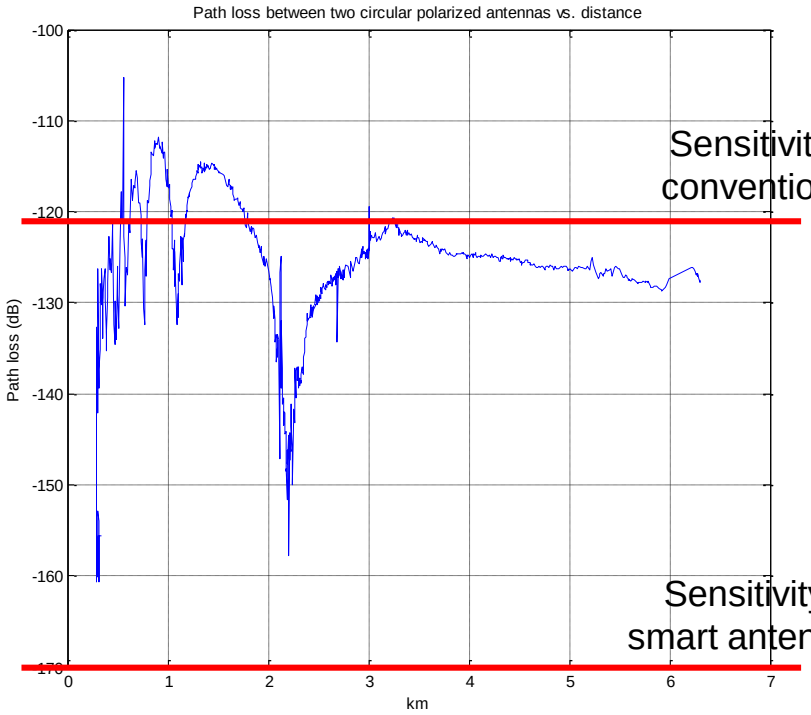
A wireless distribution system

- Several smart antenna nodes (MBR) can form a wireless distribution system to support maritime operations
- Each node can be connected to several clients by a standard IP subnet (Ethernet)
- Seamless communication between nodes (MBR units)
- Can offer virtual IP tunnels between vessels

Test results

Flat sea fading

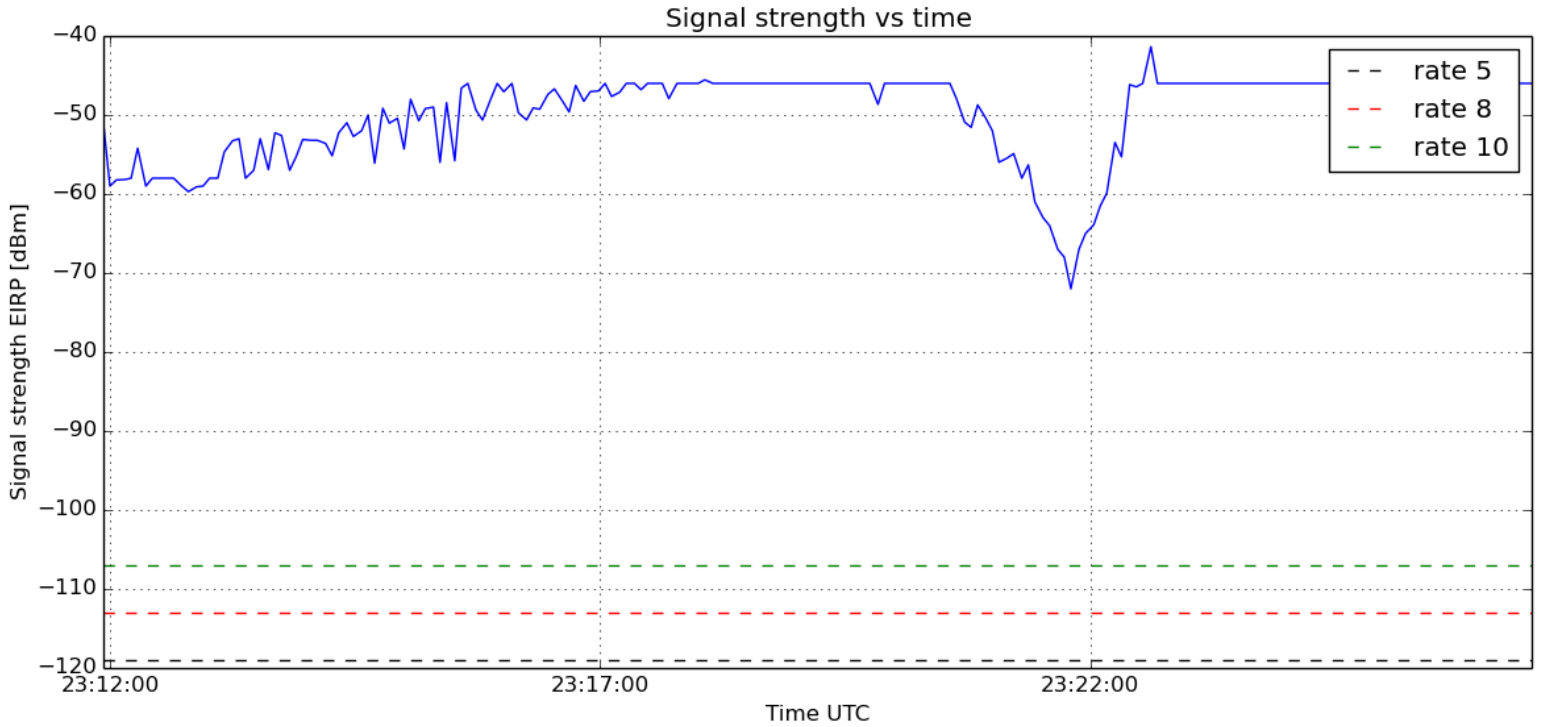
Testing flat sea fading on a freezing day in Trondheim, Norway



Sensitivity limit for a conventional system

Sensitivity limit for a smart antenna system

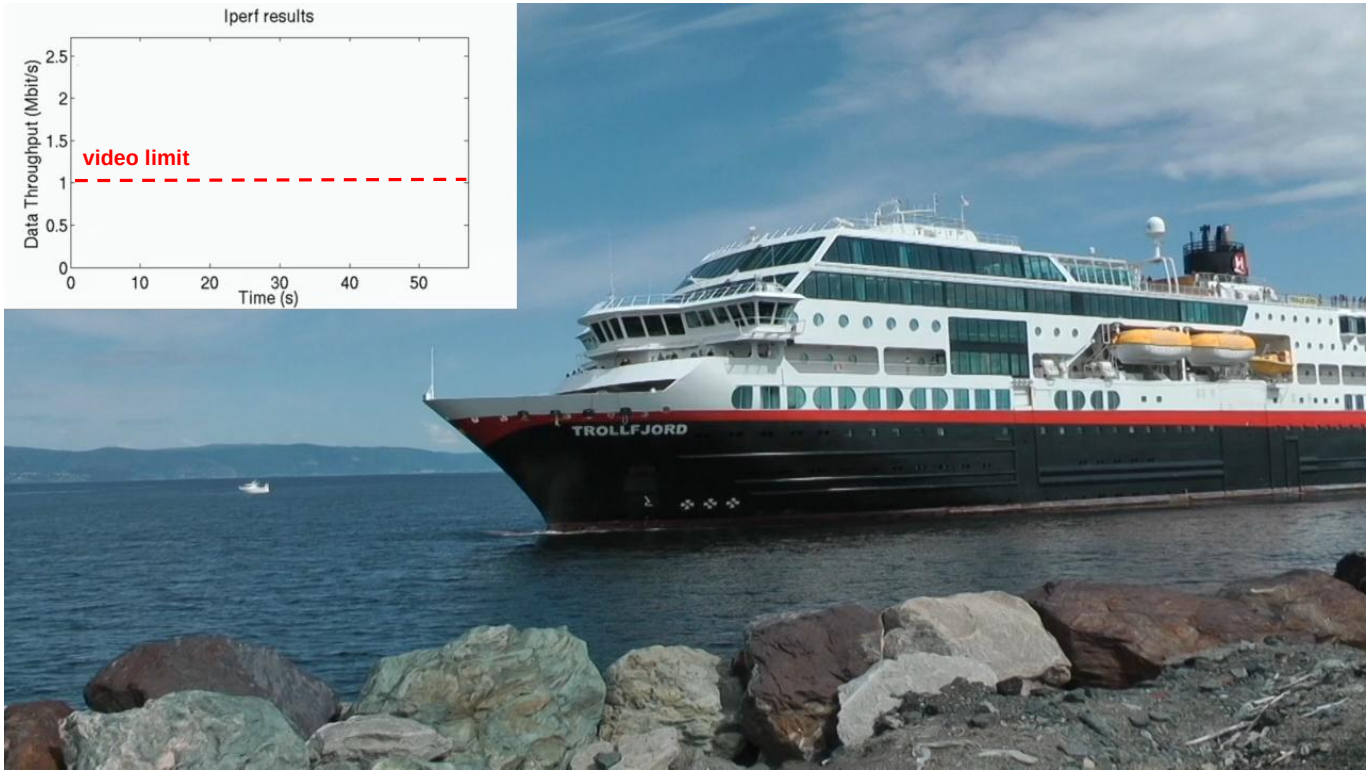
Flat sea fading – 4km to 0km



Throughput test in difficult conditions

2 Mbps

1 Mbps



Communication beyond line-of-sight

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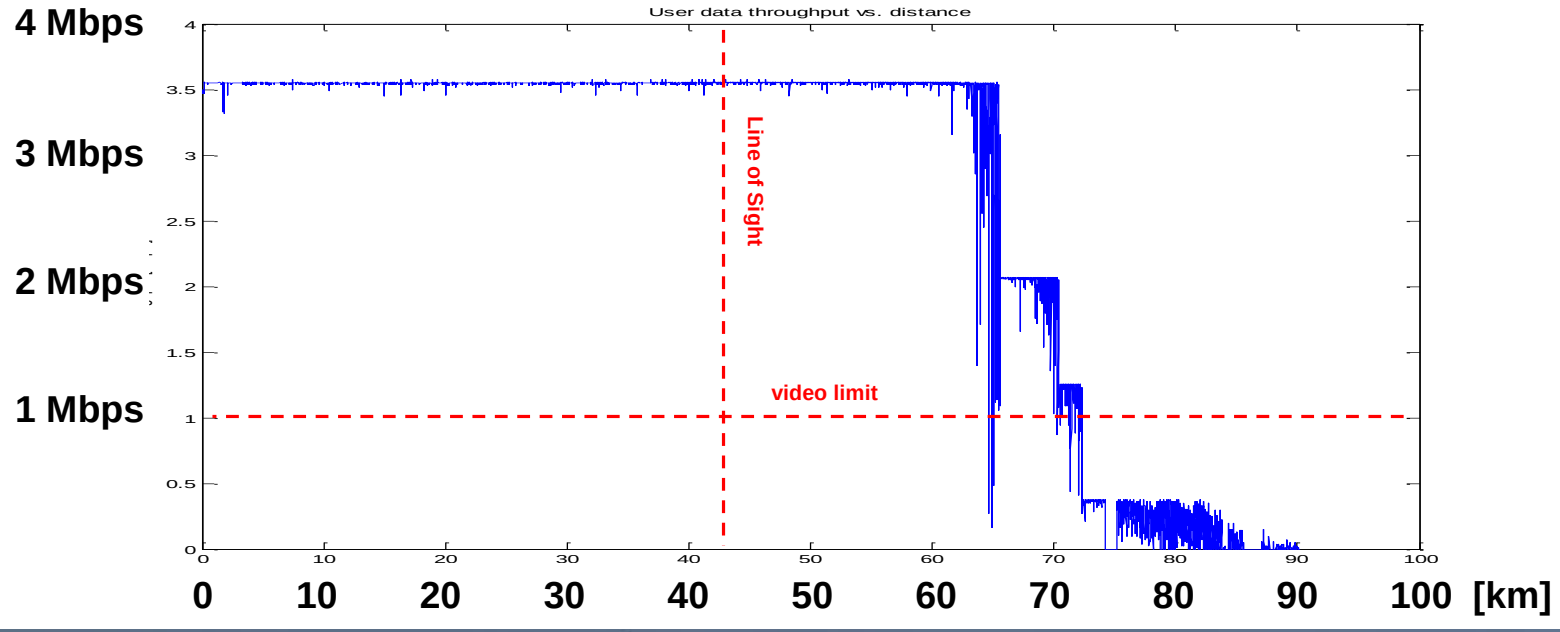
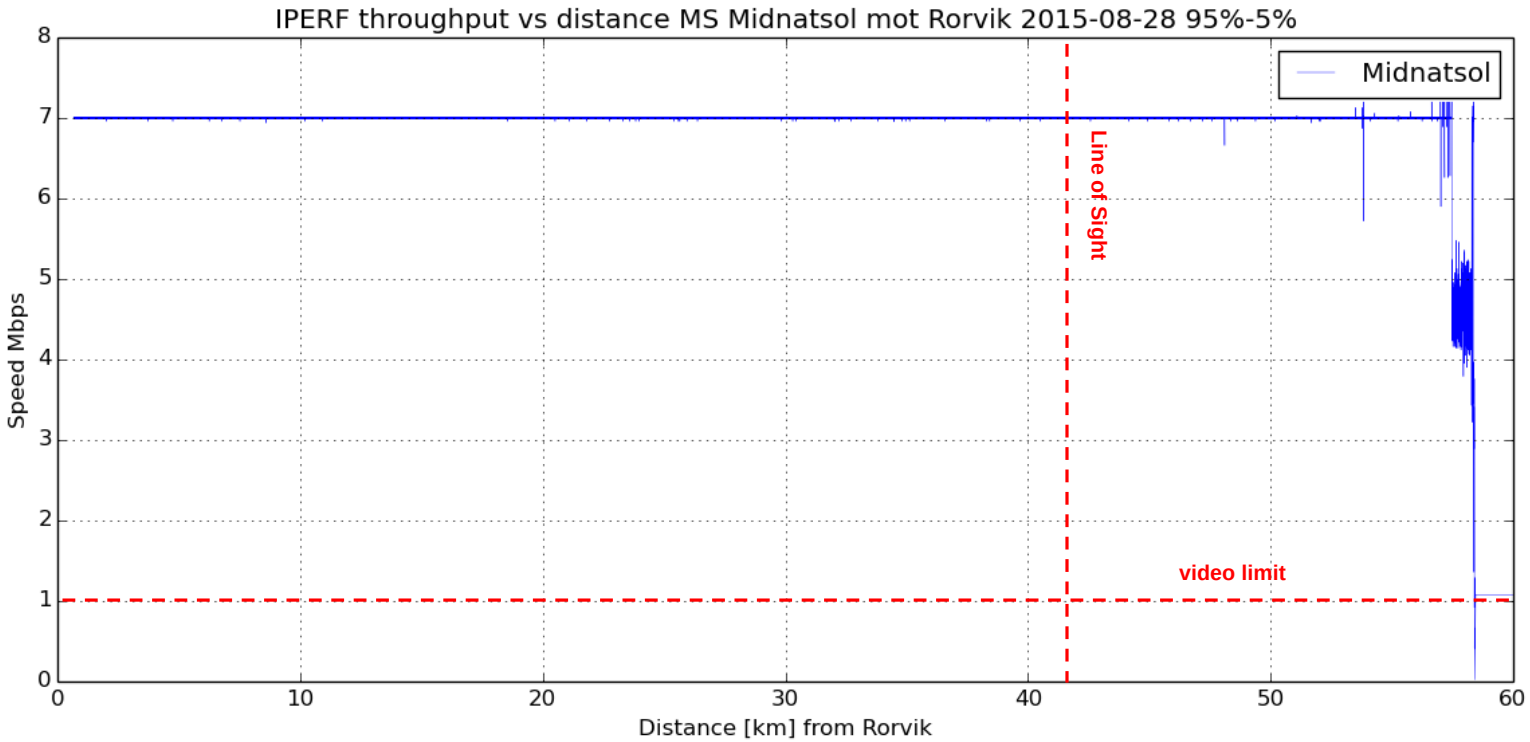
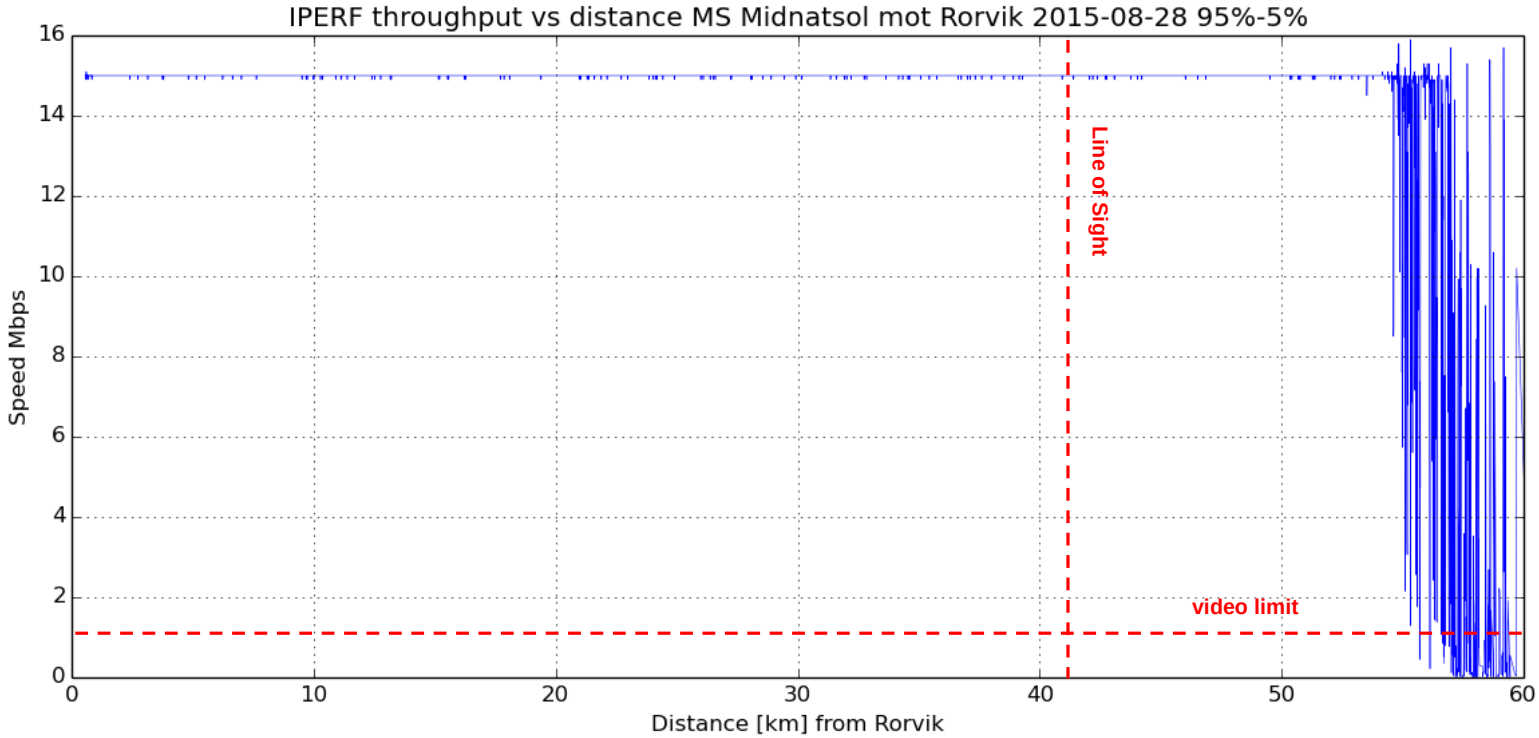


Communication beyond line-of-sight – 7Mbps



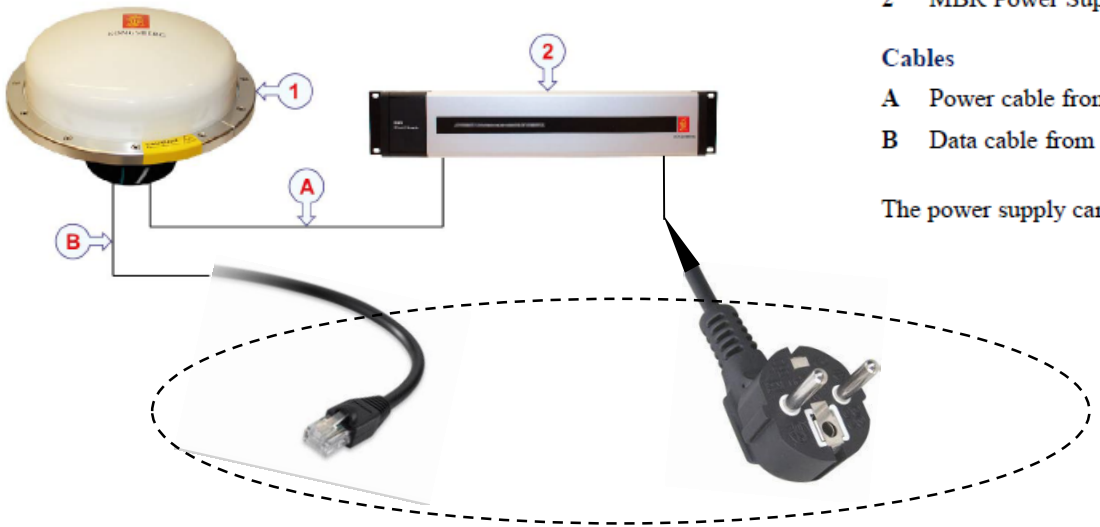
Communication beyond line-of-sight – 15Mbps



MBR System

2.2 System diagram

A basic system diagram is provided.



Units

1 MBR Radio Unit

2 MBR Power Supply

Cables

A Power cable from Radio Unit to power supply

B Data cable from Radio Unit to user equipment

The power supply can supply power to two MBR units.

MBR Products

- **MBR 189**
  - High gain version for vertical installation

- **MBR 179**
  - High gain omnidirectional version for horizontal installation

- **MBR 144**
  - Portable mobile version

MBR Products

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...more numbers

	Number of transceivers / Antenna type	Tx power [W]	Antenna gain [dBi] / Max EIRP [W]	Range [km]	Operational area
MBR 189	60 / Helix	6	24 / 1500	> 50 km	100° Horizontal and Vertical
MBR 179	60 / Monopole	6	21 / 800	> 45 km	360°
MBR 144	4 / Monopole	2	9 / 31	> 15 km	360°