

# Telemetry!

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# 1. Introduction to telemetry

*tele* = remote

+

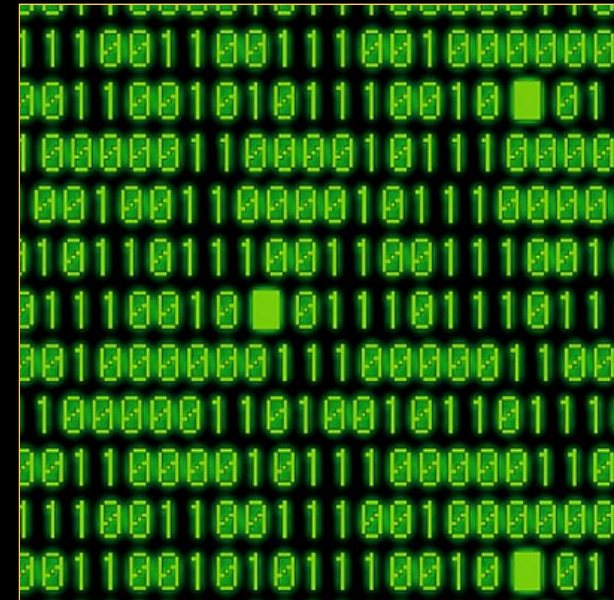
*metron* = measure

**GOAL:** get the data collected by the rocket!



# 1. Introduction to telemetry

- binary signal – carries the information  
eg. 1110101110010000 (EB90)
  - each sensor gives the information about how strong what\_it\_measures is (0-255)
  - the scale is being set up on the computer – we predict what values each sensor may give and make a scale
  - 16bits: EB90 + 16 bits FrameCounter + 8 bits from each sensor = 40 bytes
  - and over and over again
- 
- sent by the radio waves (freq 2279.5 MHz)
  - analogue signal
  - antenna receives it and sends to the computer, thanks to which we can store it





## 2. System overview



→ multicouplers →

receiver



diversity combiner



bit synchronizer



digital storage



analogue storage



synthesizer and phase meter



demodulation and visualization



## 2. System overview - antennas

- the antennas
  - provide all the radio signals which then are redistributed by the telemetry system
  - wide range available because of many types of communication
- three big antennas at ARR
  - 20" football" antenna, (most advanced, biggest, provides the best signal, in the Main TM)
  - 10" antenna (the second most important, in the Main TM)
  - Horn antenna (does not have a parabolic design, designed as a horn, controlled from the Student TM)



## 2. System overview - multicouplers and receivers

- multicouplers
  - divide the radio signals from the LNB's and send them on to the receivers
  - necessary when using multiple receivers.
- receivers
  - a lot available in both TM stations
  - all of the receivers - it is easy to record all the signals at the same time
  - extra security
- the receivers are extremely expensive (a new one: 70 000 € / ~210 000+ PLN)



## 2. System overview – combiner, synthesizers, phasemeter

- combiner
  - combining signals
  - a combined signal from two different receivers (or more) provides a better signal quality than a single one.
  - reduces the effect of polarization changes and amplitude modification
  - distributes the best signal on to the bit synchronizers
- phasemeter
  - provides the necessary information to calculate the slant range (the method of calculating the flight profile of the rocket).
  - measure the difference between the transmitted radio waves from the rocket and a synchronization device connected to the phase meter.
- synthesizer
  - synchronize a number of devices at the TM-stations.
- most important: the phasemeter, it needs an extremely stable signal to measure wave difference correctly.

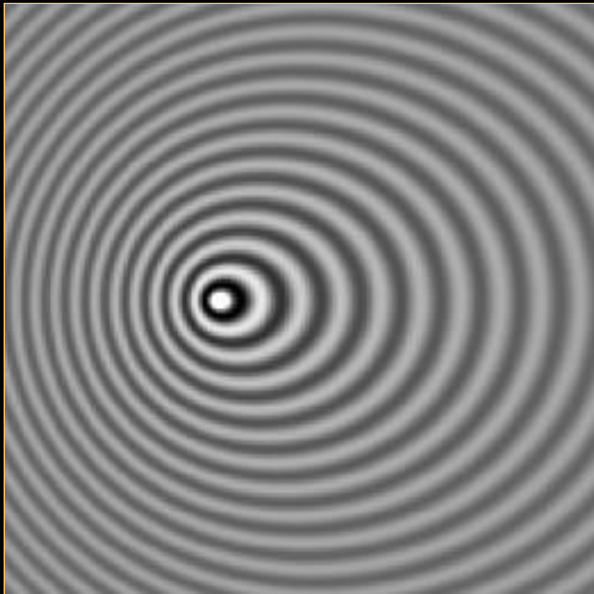




### 3. Applications of telemetry

#### The 'slant range' determination of distances

- the Doppler effect



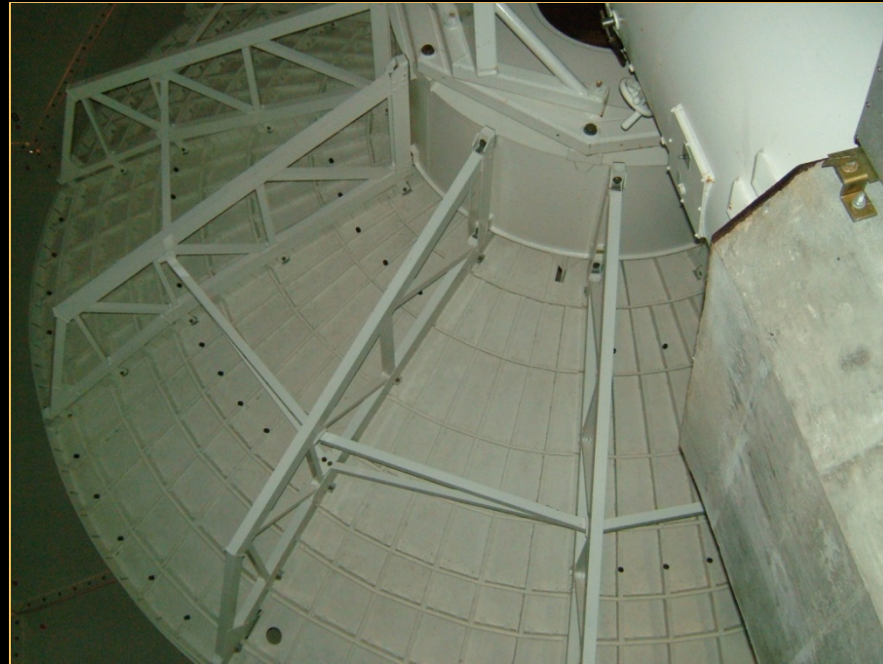
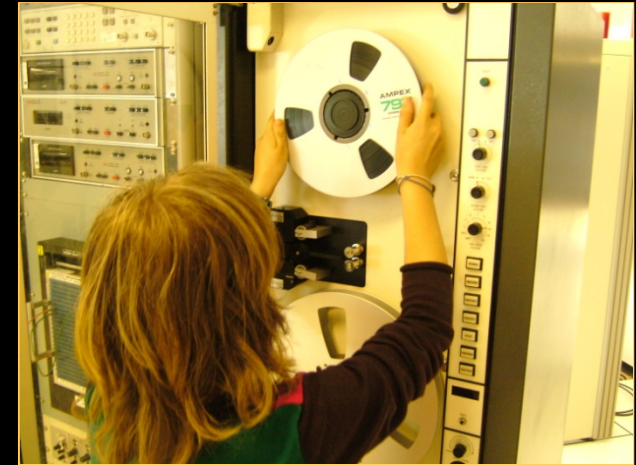
## 4. Practice - preparations

- first, turn everything on and put right settings
  - receivers (receive, amplify, down-convert, detect, demodulate the signals from the antenna)
  - diversity combiners (reduce various unwanted signals)
  - bit synchronizers (give a different code, ready for decoding by a computer)
  - antenna; the tracking system
  - computer (we can see the data when they are coming!)
  - tape recorders, paper recorder etc.
- make all the machines cooperate
- put the settings on the computer: scale settings, equations
- test
- make sure everything is ready for the launch



## 4. Practice – the Big Day!

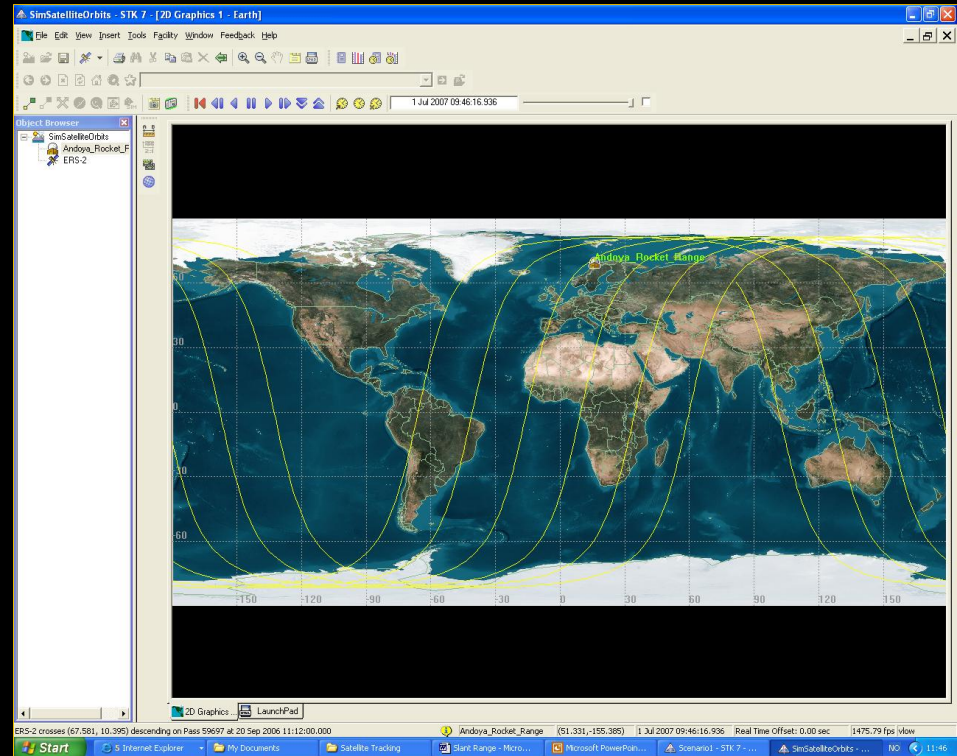
- turning everything on
- final check of the settings
- the COUNTDOWN
  - Main TM
    - confirming radio silences
    - security breach at T-45 min
    - data recording
  - USOC TM
    - communication checks
    - tape recording (small problems)
    - pointing the antenna





## 5. Other activities – satellite tracking

- theoretical understanding: Kepler's laws, types of satellite orbits
- Satellite Tool Kit – updated info about satellite orbit, azimuth and elevation
- searching for the signal with the antenna at the Main Telemetry Station
- difficult to follow it manually, autotracking worked, but finally lost the signal



## 5. Other activities – satellite tracking



The satellite (ERS-2) we tracked

- necessary angles, setting up the Main TM and the right frequencies
- ready to track!
- got a signal from one of ESA's research satellites passing over Andøya
- it was fun!



## 6. Conclusion

- no large problems
- we received and saved all the data!





thanks for your attention! 😊

questions are always welcome 😊