Information and Communication Technologies in Education, Ostrava, September 5-7, 2016

How Distance Influences Interplanetary Data Transfer Rate With Relation To Education In ICT & Astronomy

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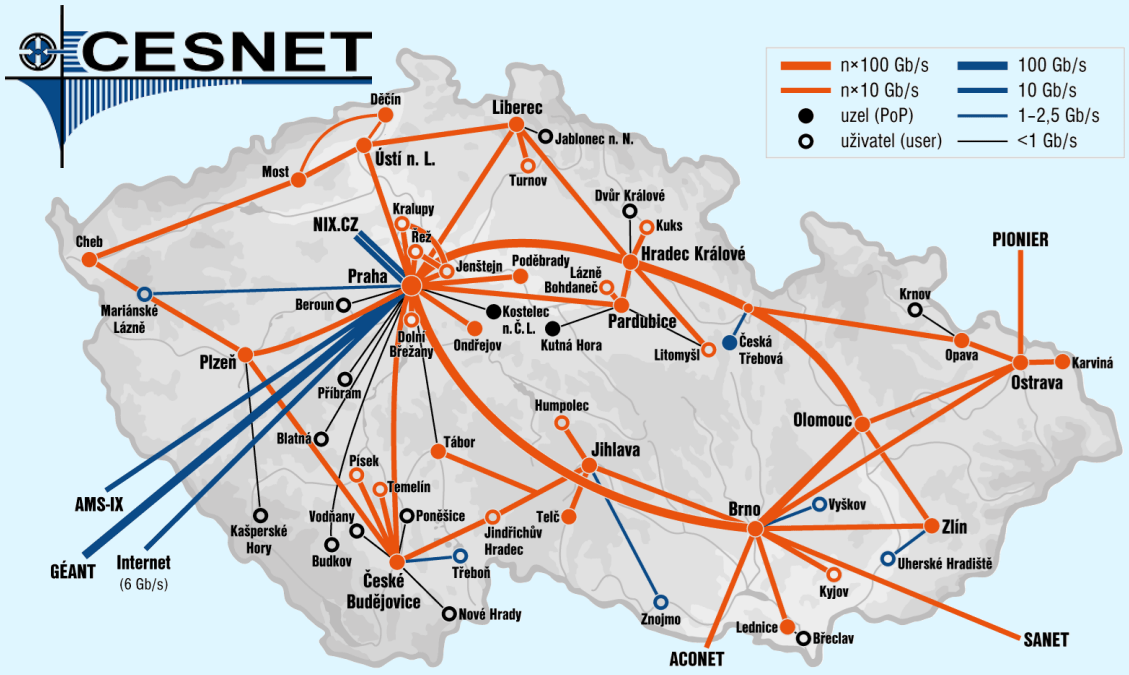
Mbps, Gbps, … W, kW, …



1997: Wi-Fi, tens of Mbps

Wi-Fi power ~ 0.1 W – 2 W, range of tens of metres

1991: 9.6 kbps

FM trans. power ~ 3.16 kW, range of tens of kilometres

Why?

Space probes

16,560,000,000 km (111 au)

Is it sufficient output power to reach Earth?

20 W

160 bps

Voyager 2

Voyager 1

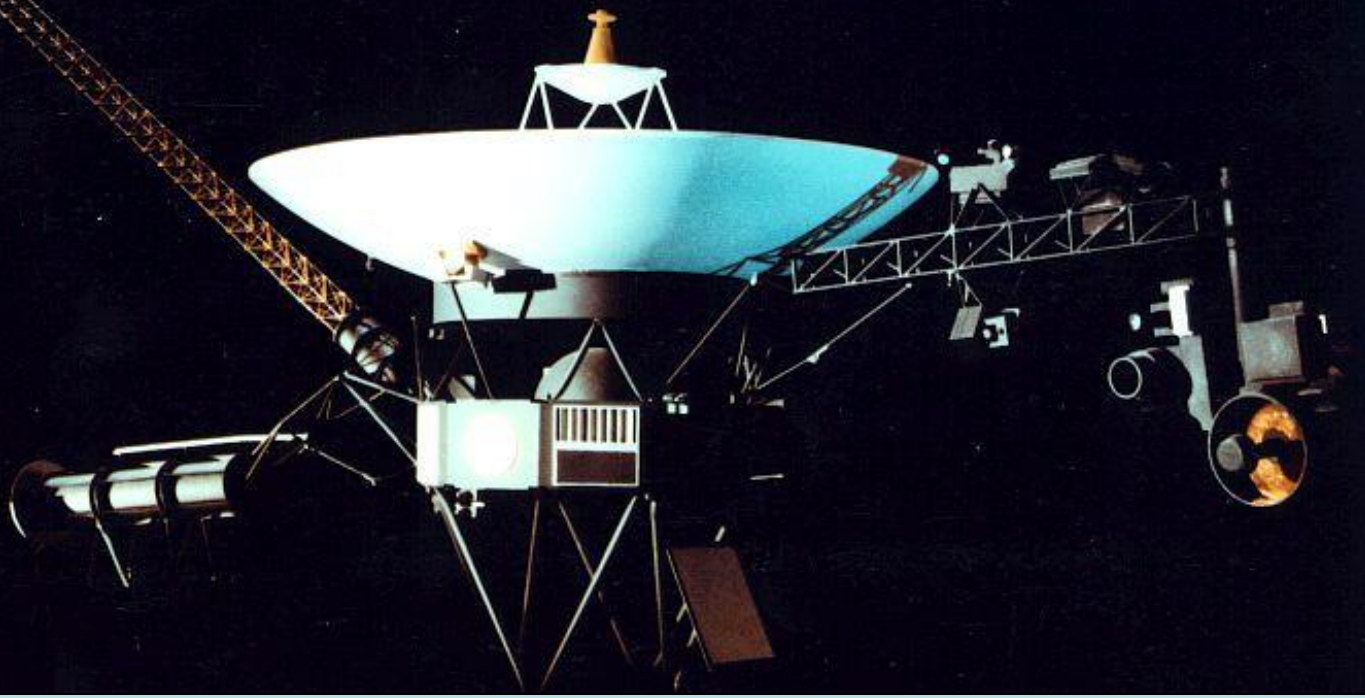
New Horizons

Cassini

Dawn

Rosetta

…

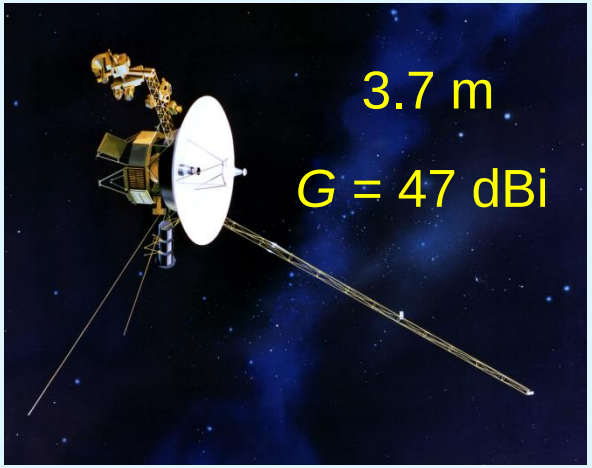


Inverse-square law in theory

$$I = \frac{P}{S} = \frac{P}{4\pi r^2}$$

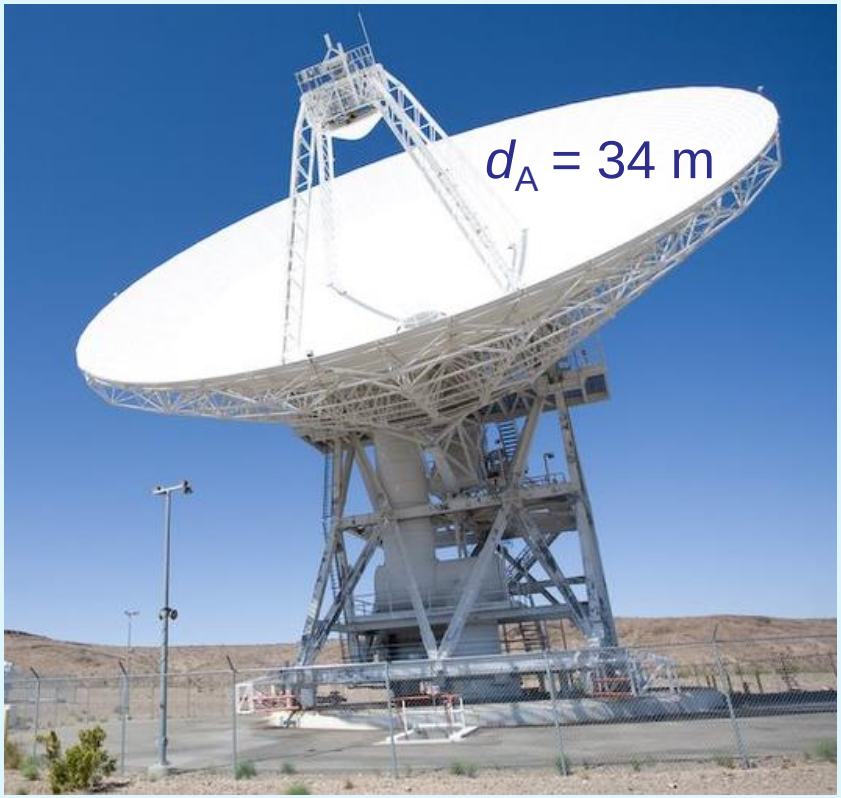
$r_S = 16.56 \cdot 10^9$ km

$P = 20$ W



$$EIRP = P \cdot 10^{\frac{G}{10}} = 1.0 \text{ MW}$$

Equivalent Isotropically Radiated Power

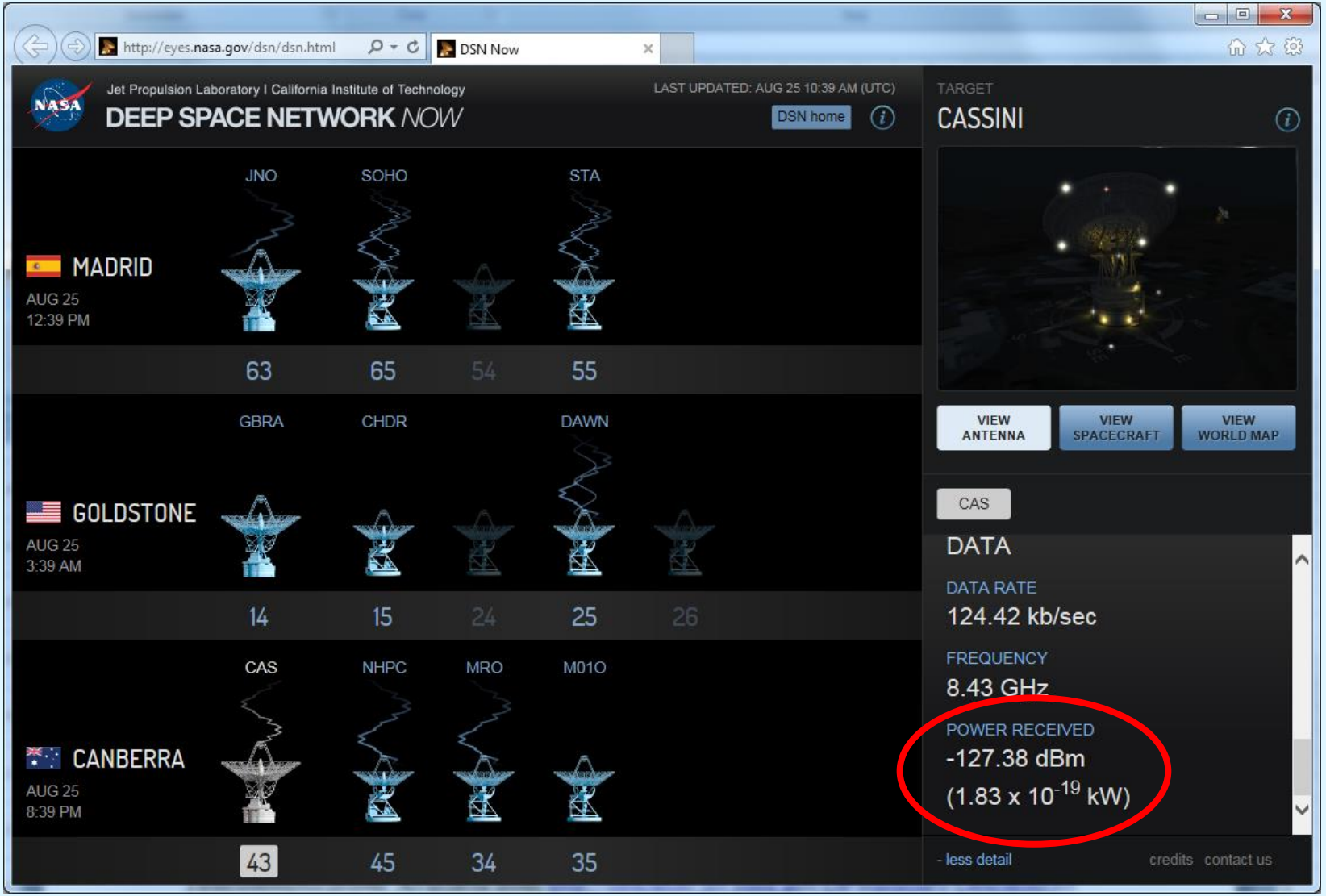


$$K = \frac{d_A^2}{16 r_S^2} = 2.6 \cdot 10^{-25}$$

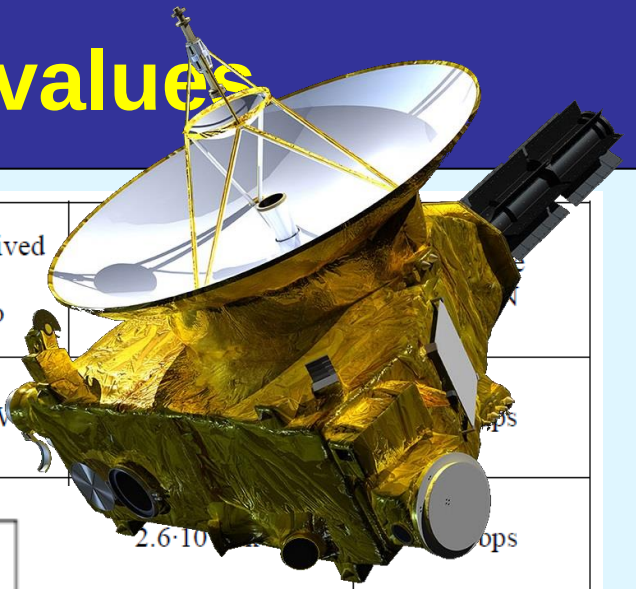
$$P_R = K \cdot EIRP = 2.6 \cdot 10^{-22} \text{ kW}$$

Deep Space Network

eyes.nasa.gov/dsn/dsn.html



Calculated vs. measured values

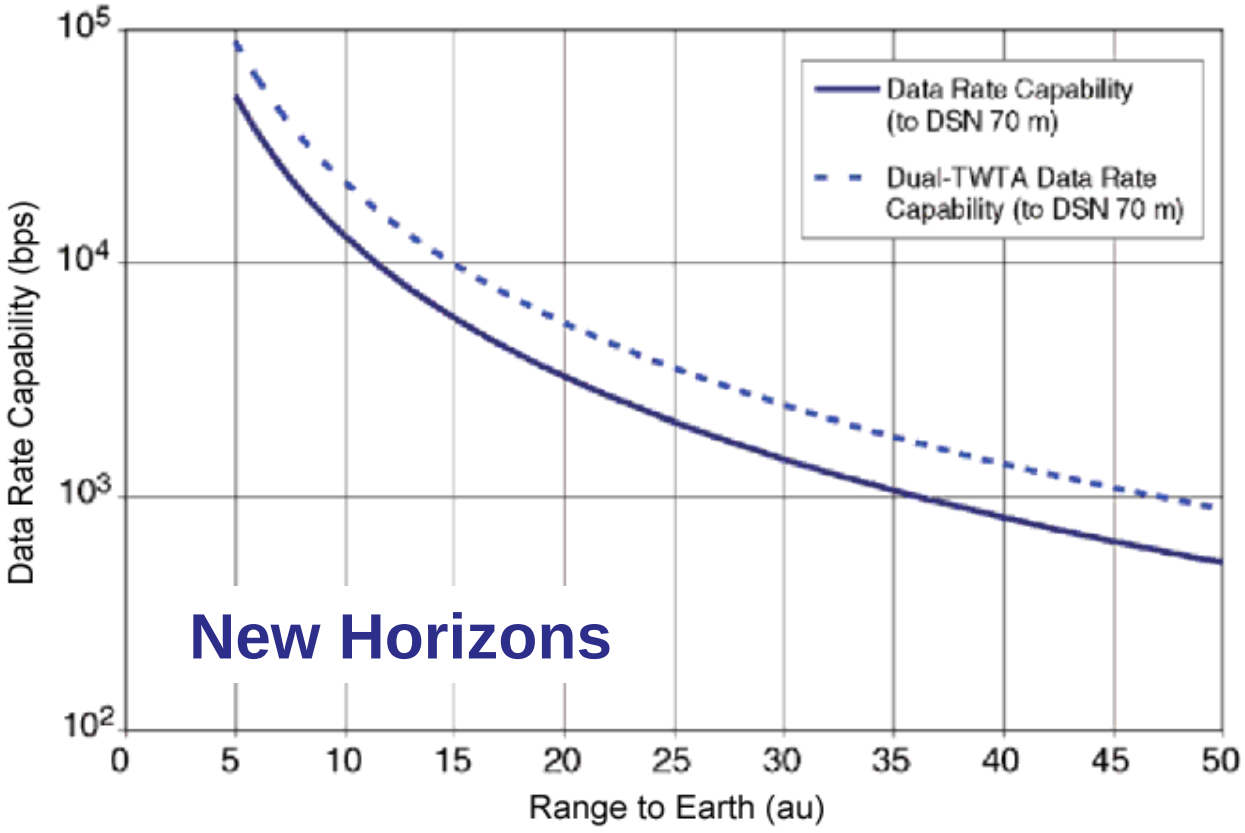


Voyager 2

calculated

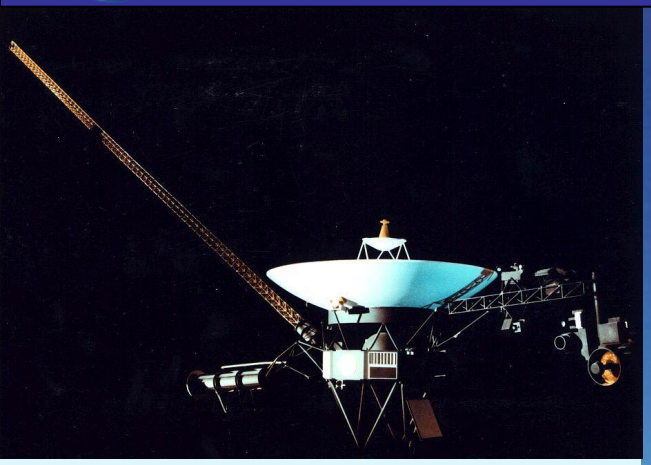
Space probe (Antenna gain, Power output) / DSN Antenna (Diameter)	Distance from Earth	Measured Received Power by DSN web
Voyager 1 (47 dBi, 20 W) / DSS 14 (70 m)	$20.08 \cdot 10^{9}$ km 134 au	$3.55 \cdot 10^{-22}$ kW
		$2.6 \cdot 10^{-21}$ kW
		$2.2 \cdot 10^{-21}$ kW
		$3.6 \cdot 10^{-20}$ kW
		$2.4 \cdot 10^{-19}$ kW
		$2.1 \cdot 10^{-19}$ kW
		$1.1 \cdot 10^{-18}$ kW
		N/A

4.21 kbps	
22.12 kbps	
125 kbps	
52.42 kbps	
245.76 kbps	
1.19 Mbps	



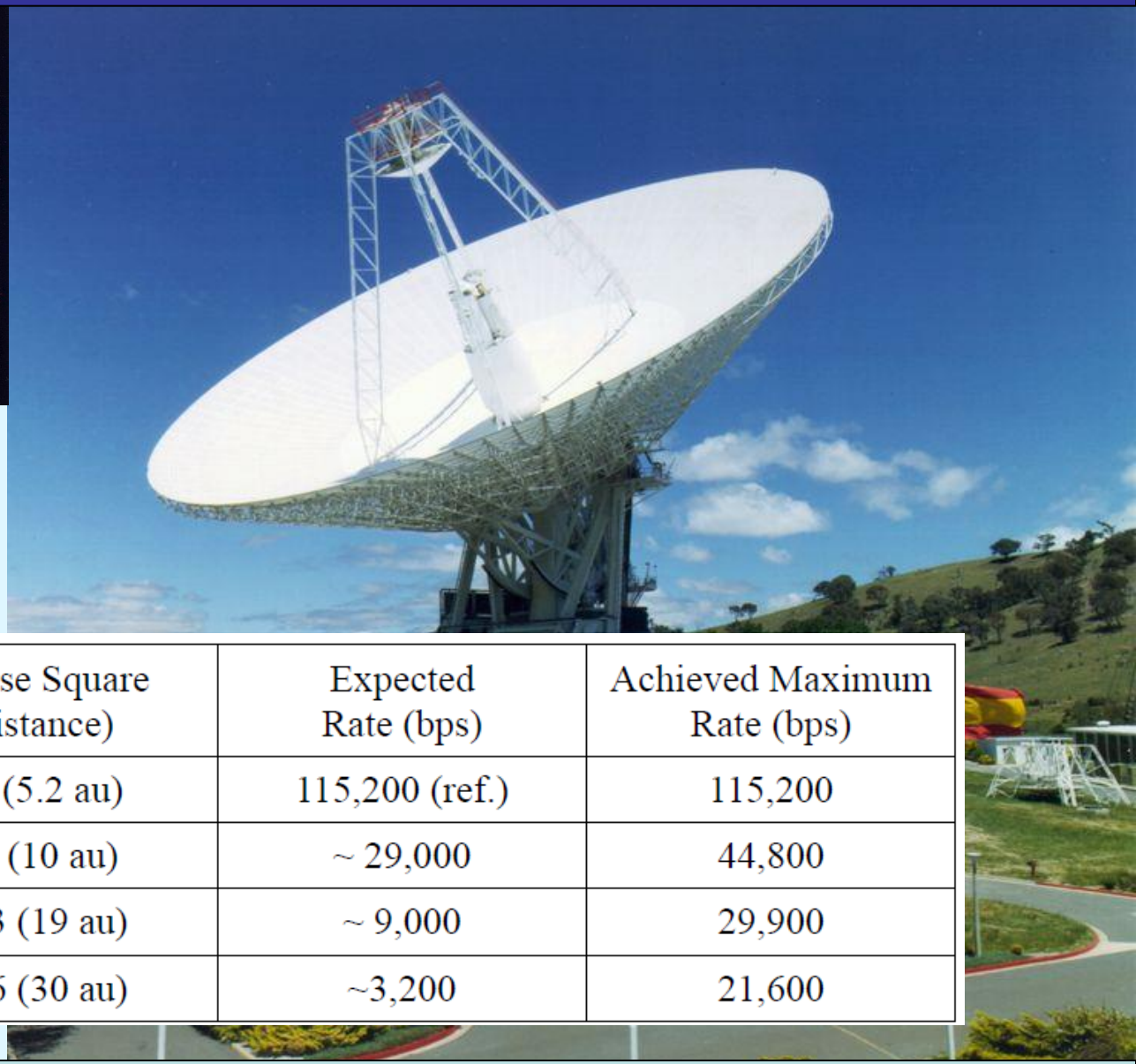
New Horizons

Receiving antenna improvements



Voyager 2

64-m to 70-m upgrade



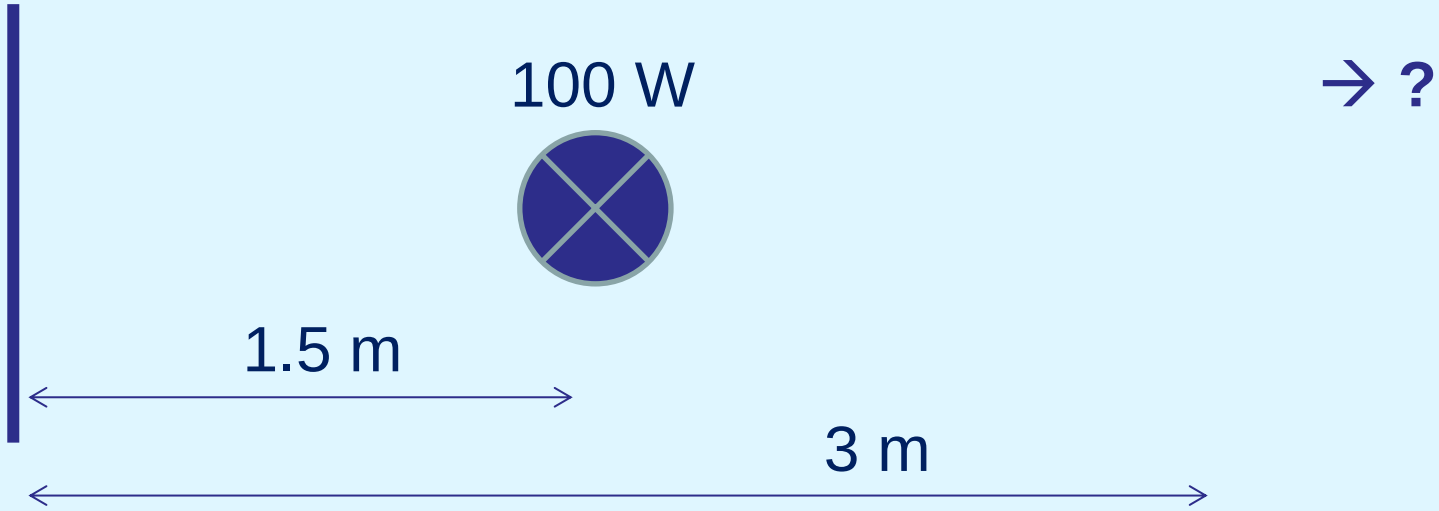
Encounter	Inverse Square (Distance)	Expected Rate (bps)	Achieved Maximum Rate (bps)
Jupiter	1/1 (5.2 au)	115,200 (ref.)	115,200
Saturn	1/4 (10 au)	~ 29,000	44,800
Uranus	1/13 (19 au)	~ 9,000	29,900
Neptune	1/36 (30 au)	~3,200	21,600

Questionnaire

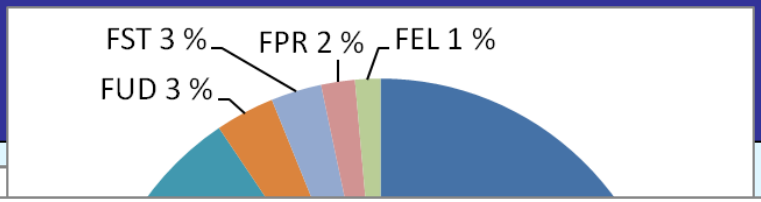
15. A person is reading a newspaper while standing 5 feet away from a table that has on it an unshaded 100-watt light bulb. Imagine that the table were moved to a distance of 10 feet. How many light bulbs in total would have to be placed on the table to light up the newspaper to the same amount of brightness as before?

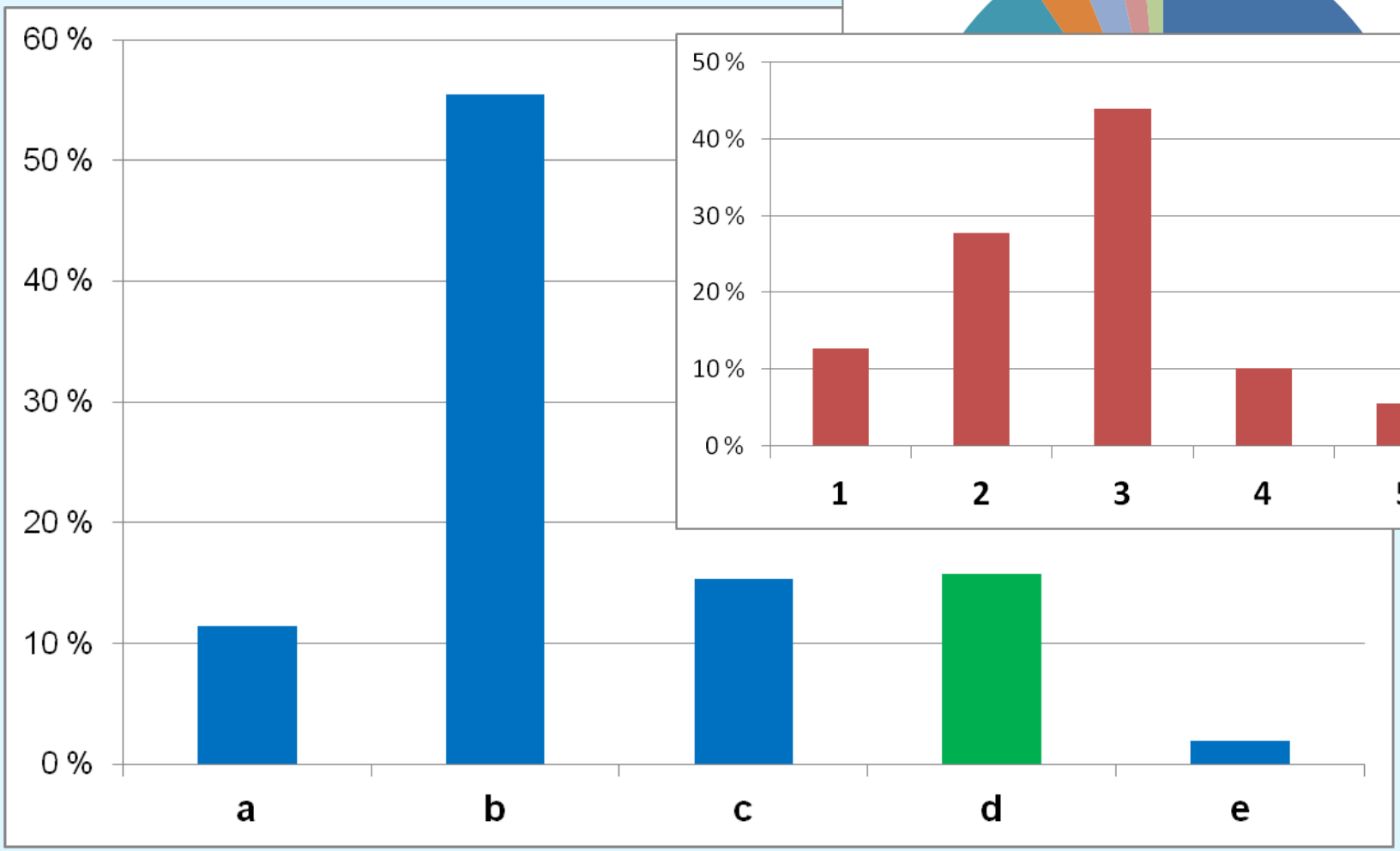
A. One bulb.
B. Two bulbs.
C. Three bulbs.
D. Four bulbs.
E. More than four bulbs.

~ 200 students of various faculties, various grades of ZČU at Plzen



Student‘s result





1 **2** **3** **4** **more**

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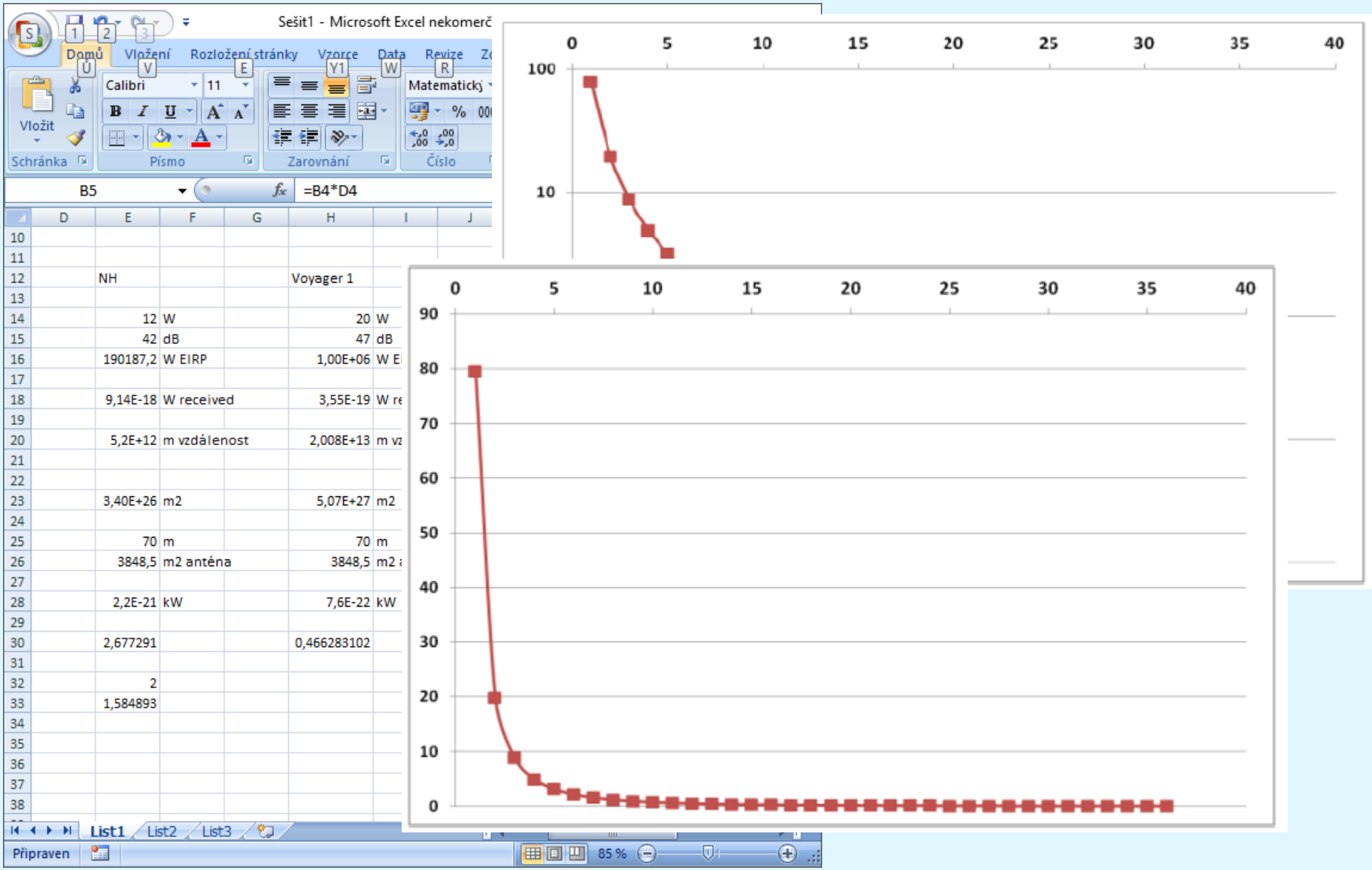
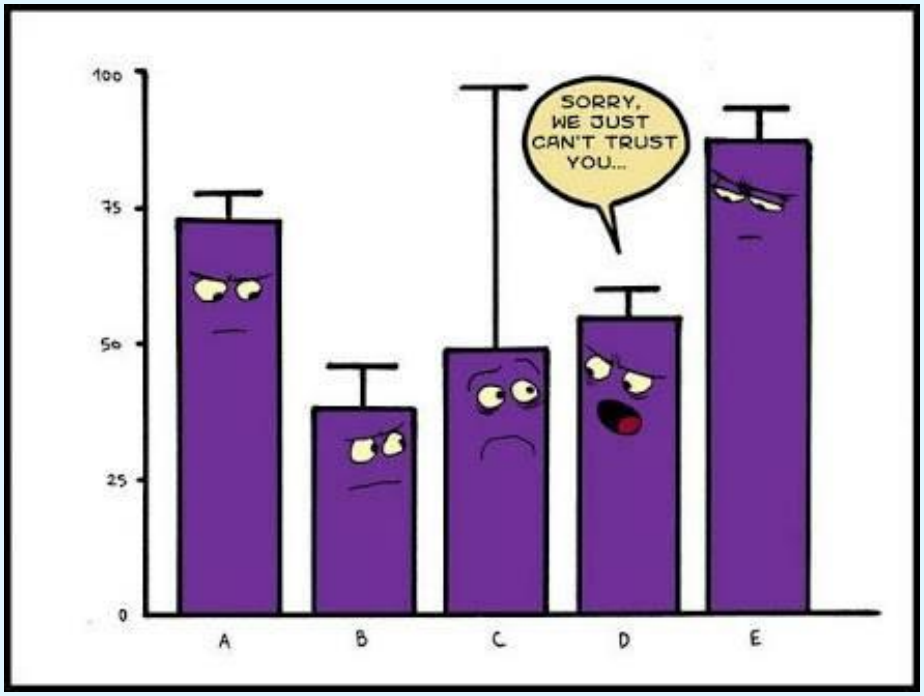
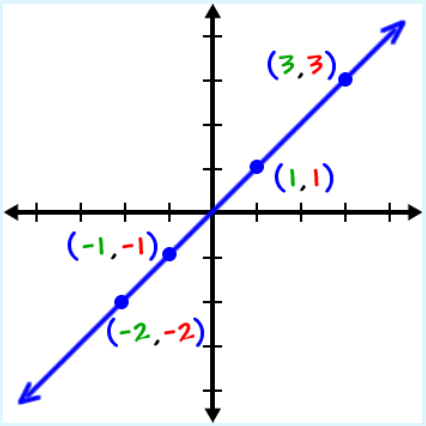
Practical activities for ICT

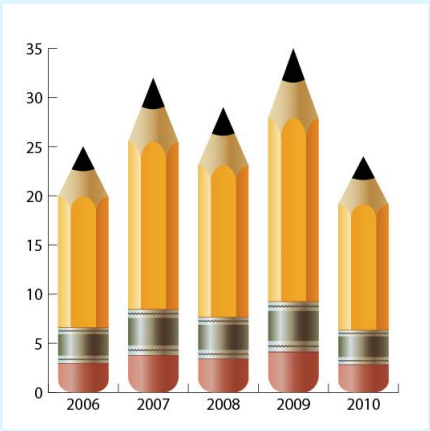


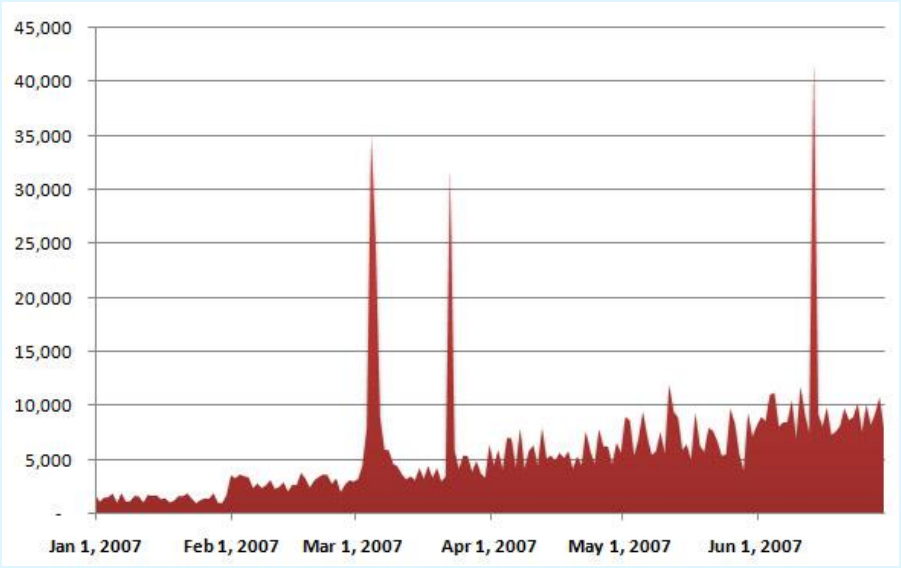
Graphs / plots / diagrams are everywhere…



ICTE 2015





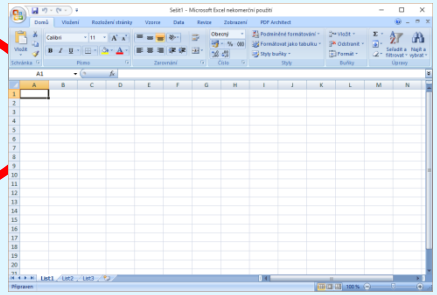


Students‘ activities

Real Data

Students

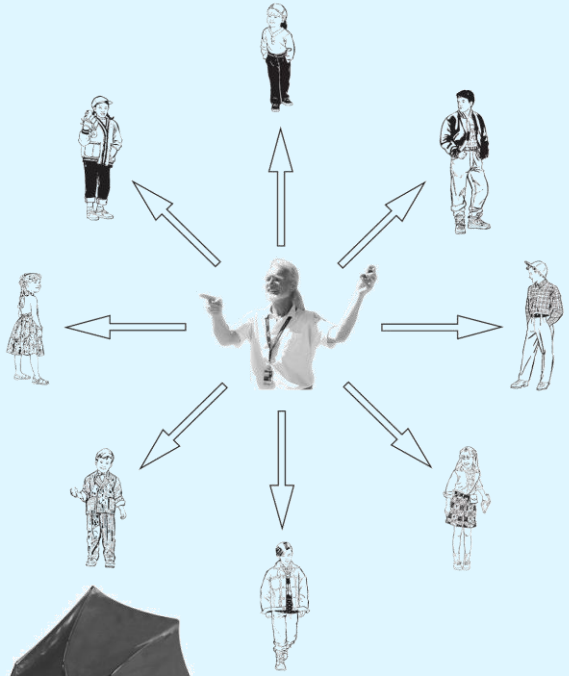
Application software



Graphs Visualization

ICTE 2015

Practical activity for Physics



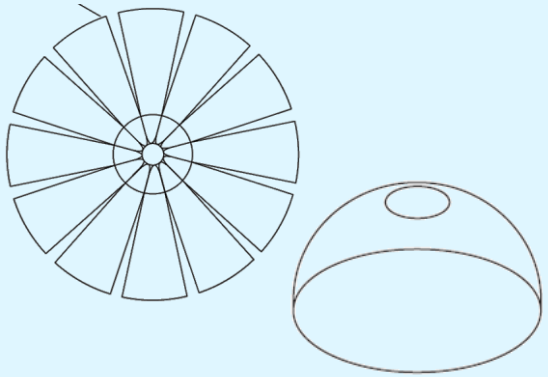
inaudible distance estimation
3x distance measurement
mean distance

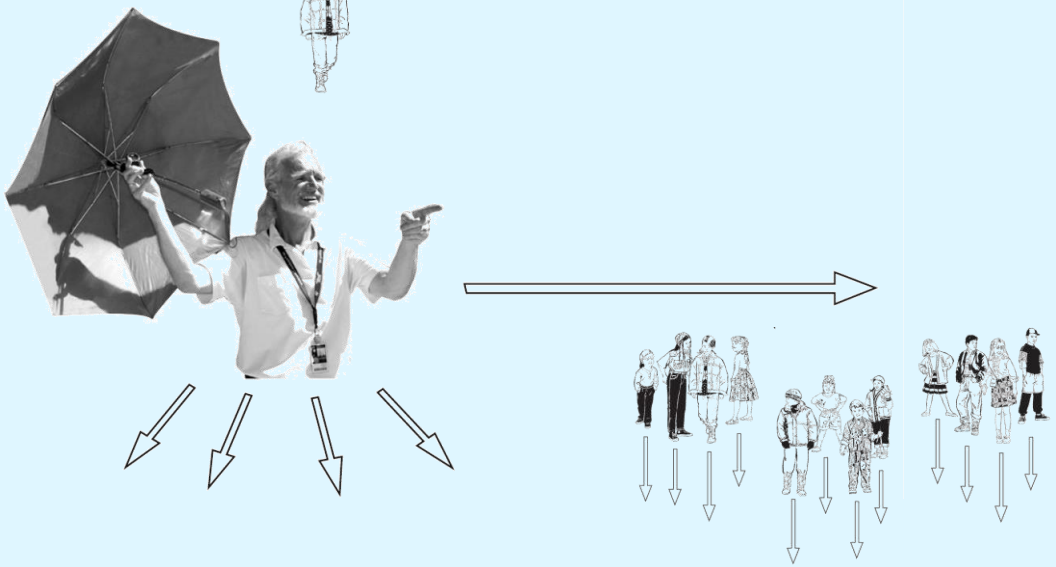
1 m **76 dB**

inaudibly at **~160 m**

intensity (calculated) **~32 dB**

Recommendation:
use lower sound volume to have suitable distance of inaudibility





Reklama

Moderní trendy v přípravě učitelů fyziky 8

Jak ICT ovlivňuje fyziku a naopak

Kdy? duben 2017 (upřesníme)

Kde? Kašp. Hory, hotel Šumava

Proč? kof.zcu.cz/ak/trendy/8/

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